Innovation management processes and sustainable iterative circles: an applied integrative approach

Christopher Miller
Cardiff School of Management, Cardiff Metropolitan University, Cardiff, UK, and
Brychan Celfyn Thomas and Michael Roeller
Faculty of Business and Society, University of South Wales, Pontypridd, RCT, UK

Received 28 November 2019
Revised 6 January 2020
Accepted 8 January 2020

Abstract

Purpose – This study attempts to create new insights into innovation management through the integration of innovation management processes and sustainable, iterative circles. Through the exploration of the use of sustainable, iterative circles in a manufacturing environment, this paper explores their role in facilitating customer-focused innovation practices. Other supporting antecedences for innovative behavior are reviewed, and their combined effect upon delivering cost-effective product developments are assessed.

Design/methodology/approach – Data were collected through semi-structured interviews in manufacturing organizations from the automotive industry. Interviews were conducted with senior functional managers to interpret the application of sustainable, iterative development circles. Analysis of the data was undertaken via thematic analysis based upon pertinent and emergent themes.

Findings – Sustainable, iterative development circles overcame the inherent path-dependency of traditional linear development approaches, whereas, traditional approaches structure the involvement of key business functions, iterative circles facilitate more flexible approaches to product development that more closely met the requirements of the customer, especially when those requirements are in a state of flux.

Practical implications – This iterative, customer-centric approach to product development reflects the increasingly dynamic market environments in which manufacturing organizations operate. Using this approach helps to focus the organization's attention upon customer requirements rather than the challenges of adhering to the rigid dogma of a chosen development methodology.

Originality/value – This study proposes a new approach toward the development of innovations in manufacturing organizations utilizing the sustainable, iterative circles, and therefore, contrasts with the traditional, linear development methodologies that are usually employed.

Keywords Innovation, Management, Processes, Iterative circles, Integrative approach

Paper type Research paper

1. Introduction

The world around us is changing. Increasing levels of globalization and the associated allotment of international markets lead to extended rivalry around the globe. Exchange of knowledge is instigated through new means of communication, and access to technology and know-how is easier than ever, intensifying competition and the need for introducing new ideas and products (Day, 2006). Rapid technological change and shorter product life-cycles force organizations into massive research and development (R&D) investments to keep pace with developments (Noori *et al.*, 2009). This not only leads to challenges for organizations, but also social and demographic questions, such as the aging of the population, as well as legal subjects (new laws and guidelines), can create new general conditions in domestic markets,

Journal of Work-Applied Management
Vol. 12 No. 1, 2020
pp. 69-90
Emerald Publishing Limited
2205-2062
DOI 10.1108/JWAM-11-2019-0037

and thus, can force an organization to frequently introduce new ideas, technology, and products (Mothe and Nguyen-Thi, 2013).

There are many reasons and causes that can lead to changed conditions in the environment of a firm (Thomas and Murphy, 2019a; Abdulai *et al.*, 2020), and thus, to changes in the requirements or demand structures of customers (Jansen *et al.*, 2009). Some can be forecasted and faced well prepared (Alpern, 2011). Such changes can, if not recognized and interpreted, lead to obsolescence of existing technologies and products, and thus, shake firms to their very foundations (Furukawa, 2013). Loss of market share, customers, and reputation can easily be the consequence. However, such shifts do not necessarily only mean a threat to an organization. In order to encounter but also to utilize these changes, organizations need to be able to deal with them and draw the right conclusions (Kang and Kang, 2009). The answer to this challenge often lies in the introduction of innovations (Burns and Stalker, 1994). An innovation can be defined as a commercialized invention (Lander, 2012) or generally spoken, innovation is the successful commercial exploitation of new ideas (Nerkar and Shane, 2007). Innovation has been the focus of attention of many researchers, as it is widely seen as the source for competitive advantage, strategic renewal, and organizational prosperity, and thus, it secures survival, growth, and sustainability to a firm (Breitschopf *et al.*, 2005; Van Der Panne *et al.*, 2003; Lertpachin *et al.*, 2013; Thomas and Murphy, 2019b).

No matter whether the innovation comes as a new product, new feature of an existing product, new service or procedure, it is crucial for organizations to ensure that the newly developed solution meets the recreated demands from markets and delivers a (new) value that the customers are willing to pay for (O'Cass and Sok, 2013). In order to do so, manufacturing firms usually employ structured and goal-oriented innovation processes (Thomas and Thomas, 2019) that include all relevant functions (marketing, R&D, engineering, sales, etc.) (more or less) cooperating to create the desired value for the customer (Leiponen and Helfat, 2011; Bierfelder, 1994). Hence, and because of its importance to a firm, innovation at best is not a hasty reaction toward a change, but a well-elaborated outcome of several processing steps starting with the analytical or creative idea generation and ending with the successful implementation into a market (Akbar and Tzokas, 2013). There are, however, many different topics that have an influence on the quality, and hence, the success of an innovation. Despite the formalized processes, many authors have investigated the organizational and structural antecedences, as well as external and internal factors that need to be pre-existing in order to ensure a proper management and functioning of all innovative activities (Afuah, 1998; Breuer, 2013; Chander *et al.*, 2000; Kanter, 1996; Tushman and Nadler, 1986, Van Der Panne *et al.*, 2003).

Consequently, innovation management (Goffin and Mitchell, 2016) requires a holistic view of many factors in order to be effective and successful (Horn and Brem, 2013). It is, however, not only the alignment of internal resources that fosters an innovation's success (Browning and Sanders, 2012). In fact, the ability of a firm to react rapidly to emerging information and to adapt the developed solution or the product toward this information is a parameter that has still not been subject to many studies (Coviello and Joseph, 2012). Changes in the environment, including new technology, new markets or competition, etc., can force organizations to re-think their solutions and adapt them (Davenport, 1993; Thomas and Murphy, 2019a). Organizations can employ so-called *iterative processes* to push their innovations toward market conformity (Ries, 2011b). Iterative processes (or iterative circles) are regressions in ongoing projects that are triggered through a gap between the developed solution and requirements from the markets or technical feasibilities that lead to a change or an adaption of one or more parameters in the innovation (Blank and Dorf, 2012).

Originating from his findings, in theory, Eppinger (2001) proposes an increased but directed application of iterative circles in innovation development projects, which implies the capture of all the relevant information required. The research question in this study, therefore, considers whether today's innovation management systems employed in manufacturing organizations are capable of capturing and processing all the relevant information for the purposeful use of such sustainable, iterative circles. Or do changes in general circumstances during past years call for a re-orientation and re-alignment of organizational resources?

The scope of the present work is to investigate the nature of the employed innovation management processes in manufacturing organizations and their efficiency when it comes to adaptations of innovative products within the development process. Furthermore, it is targeted to unveil reasons and triggers for sustainable, iterative circles within innovation projects to create a solution for assuring an innovation's success from the very beginning of the innovative process. Finally, determinants, that were previously seen as crucial for innovation management are analyzed and investigated toward their real value for organizations. It is intended to propose a new model of an innovation management process customized for manufacturing organizations that includes all the factors that are seen as crucial for an innovation's success by representatives from practice.

2. Literature review

In accordance with the research question, the literature review considers prior work encompassing innovation management processes (Kylliäinen, 2018), sustainable, iterative processes (Baldassarre *et al.*, 2017) and organizational learning (Edmonstone, 2018), and how sustainable, iterative processes influence innovation management processes.

2.1 Innovation management processes

Innovation is hitherto regarded independently from its nature (process, product, service, etc.) (Merriam-Webster, 2020a) as antecedences and required organizational structures for successful implementation can be seen as similar. In terms of developing innovation, manufacturing organizations are, however, distinct from firms representing other backgrounds (Hauschild, 2005).

In numerous studies [e.g., (Mann, 2002; Sheu and Lee, 2011; Utterback and Abernathy, 1975)] researchers identified several characteristics and key activities in product innovation development projects that are positively related to an innovations' performance (OECD, 2019). The importance of those activities, which met broad acceptance amongst researchers, can be clustered into upfront activities (the exploration of innovative ideas - not discussed further in this work) and activities that aim to structure and routinize the development process of innovation (Enzing *et al.*, 2011). Ever since, different models and combinations of activities (Cooper, 1994; Mann, 2002; Mascitelli, 2000; Veryzer, 1998) were developed in order to increase the efficiency of such innovation development projects (da Silva *et al.*, 2016). Hence, an innovation process, the definition of which is described by Davenport (1993), as a specific sequence of cross-functional, delimitable activities in a structured order, can be chosen. Within that sequence, the input (ideas, resources, etc.) is processed to an output (innovation) that creates value to an organization or a customer. Hence, innovation management processes (Kylliäinen, 2018) are, as Loewe and Chen (2008, p. 18) state "critical to bringing structure to a fundamentally unstructured activity."

The intention of a product innovation process (OECD, 2019) is, according to Tidd and Bessant (2013) to interweave possibilities (new technologies, market niches, etc.) with (market or customer) needs that have been identified and its success depends on a firm's ability to manage the resources, applied to those processes (so-called *organizational routines*). These routines include the selection of project teams, project planning, and monitoring, and reflect an organizations' current practice of what works well. Hence, these routines are constantly evolving, as new findings or knowledge, are integrated and utilized within an innovation management process (Enzing *et al.*, 2011). Additionally, innovation management processes (Cortimiglia *et al.*, 2015) and their sole activities are encircled and influenced by the internal and external factors. Therefore, changes in those factors can require modifications in the alignment and structure of an innovation management process (Globocnik, 2010). Consequently, as Sheu and Lee (2011) state, an innovation management process is not a static construct but an adaptable series of activities that can be optimized at any given time. The use of such a systematic and flexible innovation management process has, as Anderson (2008), or Wittel *et al.* (2011) found, a significantly positive influence on the performance of the new product.

There are proposed models and prototype processes developed for innovation activities (Lendela *et al.*, 2017) that can be used by organizations and represent contemporary findings or the state-of-the-art (Merriam-Webster, 2020b) in technology and process theory. Additionally, different approaches toward the structuring of activities that are intended to lead to an innovation are given. However, the consensus that can be found throughout all concepts is the initiation with an innovative idea and the commercial launch of a product innovation at the end of the process (Globocnik, 2010). The differences can be found in the schematization of several aspects of activities or decisions. Processes subdivided into a sequenced series of activities, as described, e.g., by Mann (2002) or Brandenburg (2001), see innovation as the outcome of those activities and do not regard any relevant personnel or function.

Mann's four-step systematic creativity process includes the definition of the problem, the selection of the appropriate tools that helps in solving the problem, the generation of solutions by addressing a new problem with existing tools, and finally, the evaluation of the proposed solutions. It can be described as a basic and simple process to solve any problem that can occur (Figure 1).

However, during the process itself, the model does not include any valuations, and hence, success can be ascertained only after the implementation. Consequently, the process can more likely be seen as a trial and error approach toward innovation, than a systematic development process (Beckman and Barry, 2007), and is thus, doubtable for an application within product development projects (Kazimierska and Grębosz-Krawczyk, 2017), as trial and error approaches are usually accompanied by excessive investments and re-development costs (Van De Ven *et al.*, 1999).

A more detailed approach is given by Brandenburg (2001). His seven-stage W-Model includes the analysis of the future potential of an innovation, and thus, gives the opportunity of exploiting an innovation directly or investigating it in more detail and implementing it at a later stage if current technology or knowledge is not capable of guaranteeing success (Figure 2).

Thus, a strategic component is added to the approach of Mann (2002) by including several milestones or checkpoints to keep track of the success potential of an innovation. Hence, leaving the chance of modifications, as called for by Sheu and Lee (2011). Such activity-based process models facilitate a more abstract view on innovation development projects (da Silva *et al.*, 2016) without referring to organizational roles for the individual tasks. However, they can deliver a foundation for integrated innovation management processes that rely on activities and functions.

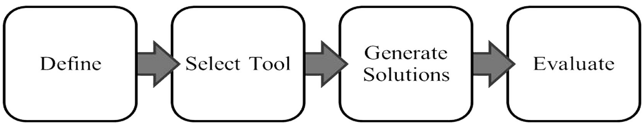

Figure 1.
Four-step systematic creativity process according to Mann (2002)

Divisional oriented process approaches as designed and developed by, e.g., Noori *et al.* (2009) or value chain approaches as described by Lindegaard and Kawasaki (2010), regard an innovation as the outcome of consecutive functions that are represented through different divisions of an organization. Noori *et al.* (2009) proposed an integrated innovation management process for R&D projects, including functions and divisions (Figure 3).

The development of an innovation is pictured as a sequenced flow of a technology or product through different stages and departments that add their individual value to the project and help in developing the innovation toward its desired outcome. Its respective activities are clustered into technical aspects that dominate the development and production stages of the process and business-building activities (Scott, 2017) toward the end. Thus, the influence of marketing and sales on the actual (technical) development of the innovation can be seen as rather low. However, all relevant stages for a product development, including prototyping and manufacturing, are represented.

Lindegaard and Kawasaki (2010) developed a similar model that focusses not only on the innovation development process itself but also on the activities and feedback after the implementation of the innovation (Figure 4).

The advantage of this approach is the clear assignment of divisions to the tasks and functions, through which it is guaranteed that the tasks are executed by the appropriate representatives of an organization. It does, however, imply just as the model of Noori *et al.* (2009) a strictly linear and chronological cycle of the tasks, and the consecutive division can only begin after completion of the previous stage (Globocnik, 2010). Furthermore, mutual feedback and consequently, changes in the innovation are hindered, as the divisions work autonomously, and there is no planned superior control mechanism (e.g., project leader) that

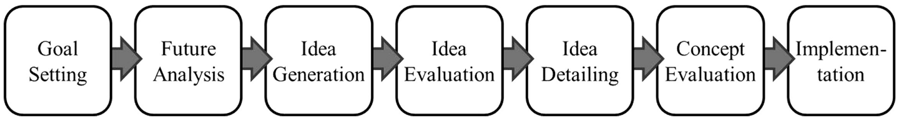

Figure 2. Seven-stage W-model according to Brandenburg (2001)

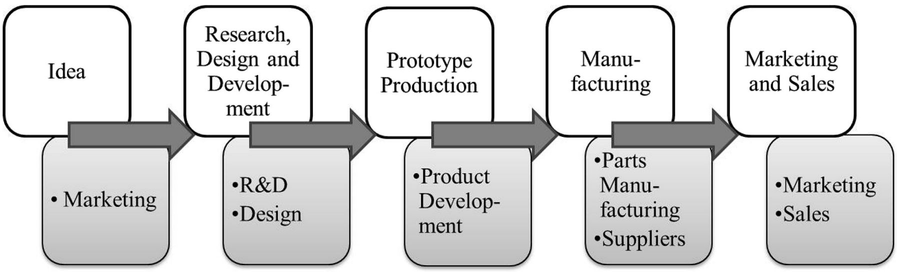

Figure 3. Integrated innovation management process according to Noori *et al.* (2009)

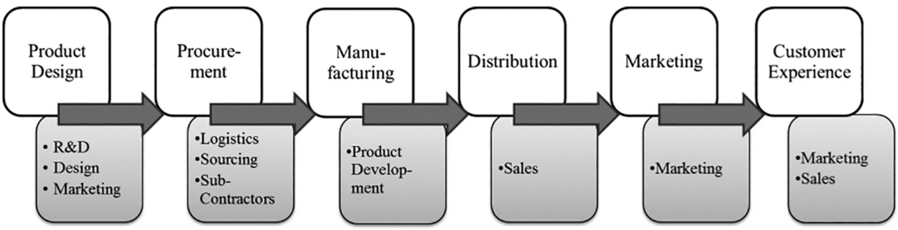

Figure 4. Innovation management process model according to Lindegaard and Kawasaki (2010)

coordinates the tasks. Thus, the influence of the divisions on the innovation is limited to the step in the process where their individual value is added (Tidd and Bessant, 2013). After all, there is no real mechanism that evaluates the innovative idea and its relevance over the development process.

The combination of both activity-based and divisional-based approaches toward the structuring of innovation management processes, as well as the implementation of superior control mechanisms, is given by Cooper (1994). Following the statement that “all work is a process; if you want better results at the end—the output—focus on the process that delivered the results. Any process can be managed to be more effective,” and due to the high failure rate of new product developments Cooper was among the first to implement the idea of process management (hitherto subject to production processes) into innovation projects, and developed a new product development process consisting of five stages (Figure 5).

By subdividing the complete process into five manageable stages with distinct tasks and dedicated functions, as well as clear targets and commandments, it can be ensured that each stage provides the best solution for customer needs, technical aspects, or efficient manufacturing (Tidd and Bessant, 2013). However, the initial project steps are, as well, mainly dominated by technical functions (Houkes and Vermaas, 2012) that focus on technical aspects, and the influence of other functions, such as marketing or sales, is rather low. That, however, can entail high efforts and costs if a change in a technical aspect from the marketing or sales perspective is required through the emerging of new information that concern the saleability during the business building stage (Edmondson and Nembhard, 2009). For the first time, such projects are intended to be monitored by project teams consisting of specialists from different functions that attend the complete process. Thus, it can be ensured that many aspects from all perspectives can be considered throughout the development of an innovation (Cooper, 1994). The strategic alignment and the conformance of the innovation with the market are reflected in so-called *gates* after every stage. Senior decision-makers adjudge on the progress and the prospect of the project and give a release for the next stage, claim changes, or abandon a project (Sheu and Lee, 2011). Hence, the risk of expensive project failures can be reduced while confidence in the innovation is enhanced (McDermott and Prajogo, 2012). Cooper’s model of a new product development process, thus, combines the advantages of all previously named approaches and includes control mechanisms that account for keeping the project on track.

As Enzing *et al.* (2011) found, there are several activities that are crucial for an innovation’s success. Hence, the identification and formalization of those activities are a vital part of an innovation process and innovation management (Kylliäinen, 2018). Those activities are mostly represented in the previously discussed prototype processes. It is, however, as Ries (2011b) points out fundamental for organizations to customize those prototype processes to the requirements and characteristics of the internal activities and resources that are employed within the innovation management and development departments. Innovation

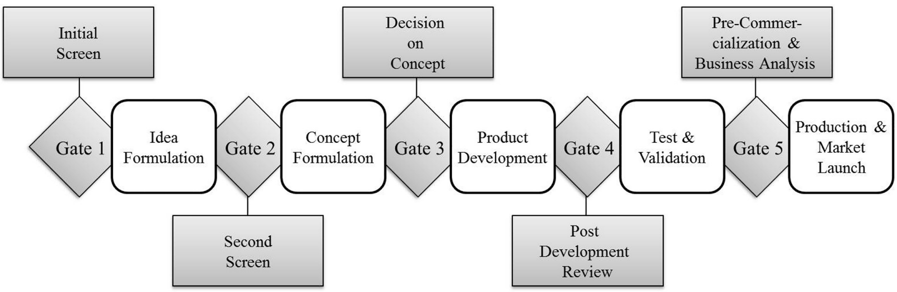

Figure 5.
Stage gate process according to Cooper (1994)

management processes are, as Tidd and Bessant (2013) state, a good means through which the internal resources and capabilities can be interweaved with the needs and demands of the market. It is, however, one objective of the present study to investigate procedures of manufacturing organizations and whether they really apply the previously proposed processes.

Furthermore, as there is no guarantee given for any organization to be successful and conform to the demands and needs from the markets with their product unless a constant scanning of the environment and its changes is maintained and the right consequences are drawn (Leiponen and Helfat, 2011). Hence, firms need mechanisms and tools in addition to innovation management processes that ensure the innovation is state-of-the-art (Merriam-Webster, 2020b) in technology or design, etc. and always in line with the requests of its customers. To realize this challenge, organizations can employ so-called *iterative processes* (also referred to as pivot circles) (Blank and Dorf, 2012).

2.2 Iterative processes and organizational learning

As described by numerous authors, innovative activities are often conducted in environments (Lewis *et al.*, 2014) that can be characterized as uncertain and volatile (Bresman, 2007; Andersen, 2000). Consequently, those development projects entail certain risks by nature. However, organizations need to take those risks, as innovation is widely seen as the source of organizational renewal and competitive advantages (Hosseini *et al.*, 2018), as well as a long-term success incitement (Witell *et al.*, 2011). Therefore, firms and the members of the development teams need to ensure that their development projects prosper (Darroch and McNaughton, 2002). That implicates a need for the innovation constantly to be adapted to the market and its requirements, including technology, marketing, business model, etc. As Ries (2011b) and Beckman and Barry (2007) found, the use of trial-and-error approaches is expensive and not really efficient. Thus, a reaction to every change and warning signal from outside may not lead to an innovation's success, as the development team and the innovation itself dissipate in their energy (Ries, 2011a). It is, moreover, crucial for them to expose and re-enact all the relevant variations of environmental and market parameters in order to draw accurate conclusions for the development of the innovation (Blank and Dorf, 2012). Through sharing and the combination of (existing) knowledge, the acquired (new) information is evaluated and prioritized, and thus, learning experiences can be drawn (Bresman, 2007). These conclusions and the learning outcome that was gained can then directly be integrated into the innovation management process to adapt the innovation toward market conformity (the actual iterative process) (Van Der Panne *et al.*, 2003). Those learning experiences are, however, not necessarily triggered by the proactive behavior of the development team members. They are, arguably, rather reactive actions to the aforementioned changes in any market or environmental parameter (Zahra and George, 2002). Those reactions, however, can lead to expensive re-developments or even to a stop for the whole project (Shenhar *et al.*, 2001).

Innovative ideas and their respective founders pursue a purpose and nature for their intended outcome (Boons and Lüdeke-Freund, 2013; Witell *et al.*, 2011). Hence, the manner of usage, target markets (Aghdaie and Alimardani, 2015), and groups or even business models (Casadesus-Masanell and Heilbron, 2015), are already in people's heads before the project starts. On the one hand, these determinations can provide a good foundation for first evaluations of the innovative idea and later on give guidelines for the development itself (Reitzig and Sorenson, 2013). On the other hand, these cognitive biases can hinder necessary changes in the project as targets have already become manifest in people's heads (Shih and Susanto, 2011). Every innovation project (Bibarsov *et al.*, 2017) is approved and launched, only after the innovative idea has been put to the acid test. However, as Stevens and Burley (1997) found, only a few of the initial innovative ideas (Teza *et al.*, 2016) lead to commercial success (Alha *et al.*, 2016). Thus, organizations need to conduct experiments and consider outside information to verify their innovations along the development process, and if necessary, change technological or strategic aspects (Evans *et al.*, 2017; Schwer, 2011).

Targets and purposes of innovations are based on two pillars. First, the information gathered from customers, markets, and existing technologies that serve as foundation and criteria for the first evaluations of innovative projects (Blank and Dorf, 2012). Second, as Ries (2011b) states, they are also based on assumptions on customer behavior, future markets, and technology and on the aspects of the product that are perceived as valuable by the customer. A change in these parameters caused by shocks or certain events in the environment or newly adapted knowledge on markets and customers can trigger a change in a strategic, technical, or marketing relevant aspect of the project (Kang and Kang, 2009). The approach from Ries (2011b) promoted by Blank and Dorf (2012), who stated that success can be engineered by following a formal process, is to, therefore, realize the iterative processes—and thus, the market conformity of the innovation—with the build-measure-learn method.

2.3 How sustainable, iterative circles influence innovation management processes

The use of sustainable, iterative circles and their effects on innovation management processes has still not been subject to studies or research. In fact, there are studies on customer integration into new product development projects, e.g., by Coviello and Joseph (2012), who found innovative projects to show higher chances of success if an early customer integration combined with necessary sustainable, iterative circles takes place. Especially when customers act as technical advisors or codevelopers, a verification of the market can be more easily assured (Evans *et al.*, 2017; Coviello and Joseph, 2012). There is, however, no evidence for the influence of customer integration or other outside information on the innovative process itself (need processes to be adapted?). Nor is there any sign of process-related initiations of iterative processes. Consequently, it is, arguably, events that trigger iterative processes and not proactive behavior that could be backed and initiated by formalized innovation management processes (Kylliäinen, 2018). Hence, it can be argued that innovation management processes and sustainable, iterative circles are two independently acting mechanisms, both designed to guarantee the highest chances of success for an innovation.

The proposed question is, therefore, to investigate, whether the integration and planned initiation of sustainable, iterative circles within innovation management processes can be a solution for:

(1) Fostering an innovation's success?

(2) Verifying the innovation management process itself?

(3) Enhancing organizational learning?

And if yes, how? To answer those questions, it is crucial to know, whether there are events, situations or events along an innovation management process or after the market entry, which are likely to have or have shown accumulations of initiating an iterative process, the actual changes that were resulting (new product features, business models, etc.) and the development of aims and intentions for innovations along the innovative process (Kylliäinen, 2018). Thus, it can be elaborated, which process steps need to be verified by outside information. By including purposely initiated market verifications and if applicable iterations into the innovation management process, proactive scanning for still not considered market parameters, can be conducted, and a mechanism to reduce the likelihood of project failures could be developed. Furthermore, current models of innovation management processes themselves need to be investigated if they suit the needs of organizations and to ensure best possible foundations for development projects (Heeks and Stanforth, 2014) or to bare room for improvement, especially in combination with an intended integration of iterative processes (Boons and Lüdeke-Freund, 2013). Finally, the organizational structure and support for innovation projects (Bibarsov *et al.*, 2017), as well as the actual prerequisites for innovative behavior, need to be analyzed in order to expose missing factors that could bring more efficiency to innovation management processes and help in preventing sustainable, iterative circles by adding previously unconsidered perspectives.

The literature review has informed the data collection and analysis by taking into account innovation management processes (Kylliäinen, 2018), iterative processes (Baldassarre *et al.*, 2017) and organizational learning (Edmonstone, 2018) and how sustainable, iterative circles influence innovation management processes and this was translated into the consideration of the nature of innovation management processes and innovations, cross-functionality, and sustainable, iterative processes in the research findings.

3. Research methodology

For the research strategy, design, and philosophy, as well as data collection, research methodology literature, including Saunders *et al.* (2015) and Yin (2012), were consulted. Since the research sought to understand how innovation processes and sustainable, iterative circles can be integrated, the study was of an exploratory nature. As the potential for new possibilities in arranging processes and organizational resources could be uncovered and the outcome of data collection could not be forecasted, an exploratory approach appeared appropriate with room for interpretation (Yin, 2012). The case study method was used as the appropriate strategy for the study to investigate the coherence within an organization and in involving organizational members and their experiences, as well as opinions and enabling interpretations (Bryman, 2016). The underlying intention was to uncover gaps between basic theory and actual praxis (Saunders *et al.*, 2015) and the events that caused them. This fulfills the requirements of the present study to compare theory and praxis and to add a new dimension to innovation management processes that are legitimated by experienced participants. Semi-structured interviews with different experts were used for the study as a major question concerned the reasons and causations of sustainable, iterative circles within innovation management processes and closed questions would hinder comprehensive answers on individual perceptions and judgments of triggers for iterations.

Data collection was based on semi-structured interviews to establish case studies for dominant procedures in innovation management. Triangulation, as described by Cresswell (2013) and Saunders *et al.* (2015), requires the safeguarding against misinterpretation or a generalization of single findings. Usually, secondary data is conducted to avoid such misapprehensions. As there is no literature on actual procedures in organizations or to assimilate material from theoretical studies, access to secondary material is not possible. Therefore, to avoid a false generalization of findings from a single organization, an expansion of the sample to two organizations was undertaken to maintain a generalization of the proposed solution. For the generalization of the proposed solution, the findings differentiated between the two organizations. Both organizations were approached to undertake interviews with different experts, and the interviews with the five participants were recorded with the permission of the interviewees. Questions on the innovation management process intended to uncover weaknesses in existing process models and their implementations into practice to propose amendments were asked. For the questions concerning sustainable, iterative circles and triggers, the technique of critical incidents (Flanagan, 1954) was conducted. It is defined as "a qualitative interview procedure, which facilitates the investigation of significant occurrences (events, incidents, processes or issues) identified by the respondent, the way they are managed, and the outcomes in terms of perceived effects." The participants were asked for critical events along the innovation management process or after the commercialization that have had a deep impact and initiated a change or a sustainable, iterative circle. This information was then analyzed and interweaved with the findings from the process perspective to propose a novel holistic perspective on innovation management.

The present study follows an inductive approach, as no clearly defined theoretical framework could be found, and the outcome is intended to arise during the process of data collection involving a categorization process and analysis. During the analysis of the data, patterns of behavior, or emerging findings will be followed up and concentrated on. Thus, the research aims at identifying new relationships between findings from the interviews, and key themes and hypotheses will be developed to propose new solutions for innovation management (Saunders *et al.*, 2015; Yin, 2012).

For analysis of the data, a categorization was conducted and populated with data from the Interviews. The categories were generated based on frequent patterns of answers and commonalities in procedures within the organizations. The terms of the categories were usually based on actual terms used by participants or existing terms and definitions from theory. Relationships between and within (similar answers) the categories were uncovered to provide an approach for addressing the research question. An overview of categories was given in the data medium, and any relationships that could be uncovered were given according to the research question/objective and subcategories, which were innovation management processes with the subcategories of linearity, milestone orientation, and parallelization; sustainable, iterative circles with the subcategories of triggers, applied changes and environmental scanning; organizational learning; antecedences with the subcategories of cross-functional teams, project leader; and systems thinking.

Target companies for investigation were manufacturing enterprises with intense annual spending in research and development. The first organization is a sub-group of a major conglomerate with an R&D effort to turnover ratio of 10.4 percent (2012, consolidated) and ca. 500 employees (14,000/group). Findings from R&D activities are accessible across the group. The organization operates in the measurement engineering industry and serves customers in several countries. Innovation and new product development activities are mainly project-based. The three interview participants represented the functions, technical development, product management, and control, whereas one acted as a project leader in several development projects. The second organization is a large representative from the automotive industry with ca. 65,000 employees and a R&D effort to turnover ratio of 6.03 percent. Innovation activities are commonly large scale projects with a usual duration of up to four years. Additionally, small scale projects for the development of part-innovations. Two interviews were conducted with a product manager and a project manager responsible for innovation management processes. Participants from both companies were chosen to represent several major functions that are important in an innovation project. All interviewees had deepened knowledge and experience with innovation projects. There were five interview partners, three from the Measurement Engineering Organization (technician/project leader (MEO1), product manager (MEO2), and controller (MEO3)), and two from the automotive organization (innovation manager (AO1) and product manager (AO2)). The characteristics of the sample from the two organizations, being in the areas of projects, product, and innovation, were directly relevant to the study of innovation management processes, and this informed the data analysis process.

4. Findings

The interviews were conducted to address the objectives of the present study, and the aim of the interviews was to contrast the theoretical implications and status quo with the procedures and practices that are employed in practice (Corbin and Straus, 1990; Eisenhardt and Graebner, 2007) through the use of the categorization process involving the categorizations of innovation management processes and sustainable, iterative circles.

4.1 Nature of innovation management processes and innovations

The organizations (MEO & AO) that were analyzed both show highly standardized and formalized processes for the development of new products and innovations that became manifest in the internal compendiums. On the one hand, participants generally appreciate clear formulated requests to act as they give guidance and structure to innovation projects (MEO1 & AO1). On the other hand, as one interviewee stated (MEO2), a lot of freedom in decision making and acting gets lost, and therefore, creative tolerances are low. Consequently, members of development teams are not instigated to pursue their own ideas or leave the initially defined scope of action, as called for by Brock (2003). This scope is predefined in a specification sheet prepared by marketing or product management and implies all significant market data. Experiences have shown that those specifications are usually complete and in accordance with the demands of the markets.

There is, however, no mechanism to be found that verifies the required specifications along the innovation management process. Changes are only applied when they are triggered by outside impulses. Furthermore, both organizations (MEO & AO) attach high importance to the evaluation of innovative ideas at the beginning of the projects and predicate their decisions on detailed business cases and calculation. Those calculations, however, are mostly focused on technical aspects, such as development costs, costs for tools, and production facilities, etc., as they are easier to predict. Marketing and sales aspects in those business cases are underlying forecasts that only can be verified at a later stage when the innovation takes a certain form and information on the actual production costs, and prices of possible substitutes are known. In accordance with that is the call of one of the interviewed developers who claimed more process steps or activities to be executed parallel to save time, and thus, development costs and finally the time to market to secure possible first-mover advantages (MEO1).

However, firms still employ rather linear processes as they are milestone or checkpoint oriented. Consequently, value-adding steps are conducted only after the release of a certain development stage or need to be accomplished to pass a valuation level. Hence, flexibility gets lost, and again certain activities need to be executed based on assumptions, and thus, at the end of the day, elementary decisions on the continuations cannot be based on profound calculations and operating figures. Additionally, as one interviewee depicted, development teams tend to focus on the achievement of the requirements for milestones, and thus, sometimes, activities are conducted only to achieve a milestone, and the desirable focus on customer needs gets lost (AO2).

Some elements of the employed linearity and the checkpoint oriented structure are, though, advantageous to organizations. It has been seen that some process steps, such as an advanced development to analyze and proof technical feasibility, can prevent massive aberrations, and thus, expensive project failures. Furthermore, some steps need to be connected in series, as, especially in technical aspects, a certain sequence needs to be maintained.

4.2 Cross-functionality

The cross-functionality of development teams, as called for by theory (e.g., Cooper and Kleinschmidt 1995), is a phenomenon that has found its way into organizational structures and procedures. Both investigated organizations (MEO & AO) practice a (minor) exchange of knowledge and ideas between functions to ensure the consideration of all relevant parameters in a development project. In one of the firms, the innovation management process is permanently attended by a cross-functional team (AO1). It is, however, not the same team that attends the whole process. Teams are replaced at certain stages of the project, and the responsibility is devolved. The composition of the team depends on the emphasis of the project stage. Whereas in the other organization, a team with an advisory and control function, consisting of different functions, attends the whole project (MEO1). The development and its value-adding activities are conducted and dominated by division, responsible for the instantaneous process step. As usual, only the division that works on the project can identify and communicate risks and potential problems with the innovation, its technical features or saleability, the hazard of happening across a substantial and not yet considered obstacle at a late stage can mess up the whole project.

The deployment and composition of cross-functional teams, however, do not exceed the functions that are immediately involved in value-adding activities. Members of strategic or financial/controlling divisions are only to be found in executive committees or decision-making bodies. The sentiments relating to the versatile composition of a development team are, however, ambivalent along with the interviewees. Some see it as beneficial to the successful completion of the project (MEO1), as the integration of different perspectives reduces the hazard of not widening risks and problems with the project. Others, however, see a risk in involving a multiplicity of members into a team (AO2). As many perspectives and opinions with equal decision authority converge, a fast decision finding can be hindered, as too many are involved and (sometimes minor) doubts and concerns thwart progress.

4.3 Sustainable, iterative circles

All participants (MEO & AO) in the interviews were united on the point that regular feedback from external sources, such as the markets or customers, is a crucial part of an innovation project. One (MEO3) stated that "only through interaction with our customers can we really understand what they want and deliver the value they ask for." As with the innovation management processes, it became apparent that an elaborate and evaluated idea for an innovation is very important for the chances of success, as first development and business-building activities are based on this idea and the less it changes, the less are the obstacles that need to be overcome and the less effort arises. However, interviews (MEO & AO) have shown that almost none of the past innovation projects were marketed based on the initial plans mostly because the underlying assumptions on market parameters were inaccurate or factors changed. Generally, sustainable, iterative circles are triggered by two main factors: Internal reasons for an iterative process are mostly uncovered in the early stages of an innovation management process, e.g., the concept or the (advance) development phase. Through the exchange of information in meetings or milestone sessions, gaps between the specification sheets and the actual feasibility of an innovation are illustrated. These gaps mostly concern technical specifications that are either missing or not realizable with state of the art technology or available knowledge, the production methods (the envisaged innovation is not producible with the utilized technology), the business model (e.g., not all customer segments can be served, or pricing needs to be adapted) or the planned development and project costs. The desired changes that are determined to scale down the gaps are then approved and handed to the responsible division that executes the relevant changes. Hence, the sustainable, iterative circle is triggered intentionally (but not based on proactive behavior) and the causes usually originate from a misinterpretation of the specification sheet or missing coordination between different functions (e.g., marketing and sales are not integrated in the technical development or developers are not aware of the possibilities in production or production/development costs are too high). In most cases, these changes are rather of a minor extent and realizable with manageable efforts.

External factors that trigger iterative processes can, however, have a deep impact on an innovation project. They are usually uncovered as a gap between the specification sheet and the actual demands or requirements of the market. Factors that have been overlooked or valuated of minor importance can, as well as changes in (governmental/legal) frame conditions lead and have led to major barriers in the progress of projects. The issue with emerging new information is its often late and sudden appearance can result in many cases to a substantial variation of one or more parameters of the project. Those variations are often not accomplishable without excessive and increasing efforts, the later the new factor appears. This can be explained and described by a highly critical step in the innovation management process that could be uncovered from the interviews (MEO & AO). After the procurement release and the arrangement of production facilities and tools that are accompanied by high investments a necessary change that would lead to a rearrangement of facilities or re-fabrication of tools and a disproportionate increase in development and project costs would be the consequence that constitutes an immense threat to the innovations' success.

The individual steps of an iterative process are usually equal in an intentional or unintentional triggered circle. After the discovery of a gap, its severity, and the potential damage to the project is evaluated. This is realized with a contrasting of the respective product feature or characteristics with its priority in a formally prepared conjoint analysis. If the relevant characteristic is considered as important and value delivered to the customer, a change will rather be released as with an unimportant characteristic. After the release of the change, in most cases a setback of the project to its early development and conceptualization stages is required. Hence, a new business case and project calculation on the additional costs are drafted and need further approval. If the new calculation is still worthwhile, the innovation passes through the stages that need to be changed, and the usual process is followed. Experiences, however, have shown that externally triggered sustainable, iterative circles often are not instantiated. In most cases, the (newly discovered or created) gap between the market or customers and the specification sheet are too profound to handle it with adequate efforts. A project stop or optionally a new project is often the more convenient option. Nevertheless, sustainable, iterative circles are seen as highly important to all interviewees, and thus, to all represented functions, as the hence stimulated regular feedback from the markets and a proactive search for new and relevant information is concordantly seen as advantageous for the overall project management and increases chances of an innovation's success.

The interviews have shown a general tendency toward new thinking on innovation, innovative, and iterative processes. Previous research and organizational efforts have focused on the isolated consideration of each of the three mentioned issues and not the holistic interplay between them. Furthermore, the interviews gave reason to question the consideration of them without their organizational and environmental context. For the innovation itself, it turned out that future success often depends on its fitting into the systemic and operational context. Innovations often are additions to current products/services or replace them entirely. Current products/services are, however, often used in combination or in addition to others. Thus, a consideration of the possible interfaces and interdependencies of the innovation with related or linked components in the (environmental) context can be required. Furthermore, through the introduction of an innovation, new possibilities in its operation or usage can be created. Hence, such potential enhancements of the usage need to be uncovered and taken into account in the development process. Consequently, in many cases, an isolated view on the innovation itself can hinder the deployment of its full potential. The same rationale can be applied to the innovative and iterative processes. Individually regarded, some development processes and sustainable, iterative circles do not add any value to the organization, as their underlying projects are predicted to be unsuccessful. Nonetheless, a continuation of the project or the execution of an iterative process can be meaningful, as valuable learning experiences and knowledge can be gained even from failing projects. These lessons can then be integrated in further projects. Hence, a mechanism to share and relay these findings can deliver valuable insights for other developments. Even development projects that are not intended to be commercially launched (research-oriented projects for new technology) can have advantageous consequences for organizations, and thus, also need to be seen in terms of their organizational context. Thus, an isolated and success-oriented view on innovation projects can hinder the acquiring of valuable knowledge or new technologies.

The data gathered and reported from the interviews undertaken informed the new conceptual frameworks through consideration of the nature of innovation management processes and sustainable, iterative circles in the form of a proposed model of an innovation management process and bidirectional iterations in the innovation management process in the discussion of the research findings, which leads to the conclusions made.

5. Discussion

By combining the previously mentioned findings and conclusions, a rearrangement of previous innovation management processes and the typical development teams can be proposed. The hitherto dominant models of sequenced activities passing through individual divisions and numerous milestones may no longer be suitable to fulfill the requirements that are demanded to an innovation. When innovation is seen as the source for organizational renewal, and it will be placed in an environment with potential mutual interdependencies to other products, a simple linear and subsequent series of activities cannot sufficiently cover the prevalent complexity and its importance. Additionally, the hazard of failure due to the missing conversation between functions is increased, and thus, poses a risk factor to the organization (Figure 6).

The proposed model of an innovation management process for manufacturing organizations concentrates on several functions and activities at an early stage in the process. The previous partition into technical design and business-building activities is now centralized to a conjoint task of all relevant functions that have an influence on the innovation. Thus, it can be assured that the innovation, from the beginning, is, already conforming to all the specific requirements and demands of the market and its customers that are introduced by the plurality of functions. Thereby, the customer and the markets are advancing into the focus of attention of the development an alteration from the previously technically dominated innovation management process (market push innovation) toward a customer-oriented innovation (market pull innovation) can be achieved. Arguably, parallelization of tasks and the increasing exchange of knowledge and ideas lead inevitably to increased complexity, uncertainty, and coordination effort. However, through these newly created communication channels an approach to the above mentioned systems thinking is arising, as new ideas for the usage of the innovation can be developed. Consequently, mechanisms as a certain culture or a project leader who can decide on or refuse these ideas, need to be installed to ensure progress and direction. The innovation or its conceptualization can consequently be improved, and an important step toward its success can be taken as a new value for customers and be offered. Room for improvement and missing validation from a certain function can be uncovered by means of innovation accounting that can also act as a replacement for excessive use of milestones.

The intention of the conjoint project team and the parallel tasks is to build a prototype that represents ideas and expertise from all functions, and thus, relevant findings concerning design, pricing, and state-of-the-art technology, etc. Market valuations can then be executed by conducting customer surveys or product clinics based on the prototype. Findings from these evaluations can directly be considered in the innovation management process by means of sustainable, iterative circles. The ideas of the build-measure-learn loop (Ries, 2011b) and possibly resulting pivots can be applied to increase the chances of success. However, as argued before, the use of sustainable, iterative circles for continuous improvements is not advisable due to high redevelopment costs. Thus, the market valuations are intended to uncover small contraries that trigger sustainable, iterative circles with rather small extent. With a jointly created prototype, the possibility of contrary or negative results can be minimized, and thus, market conformity can be supported from the beginning.

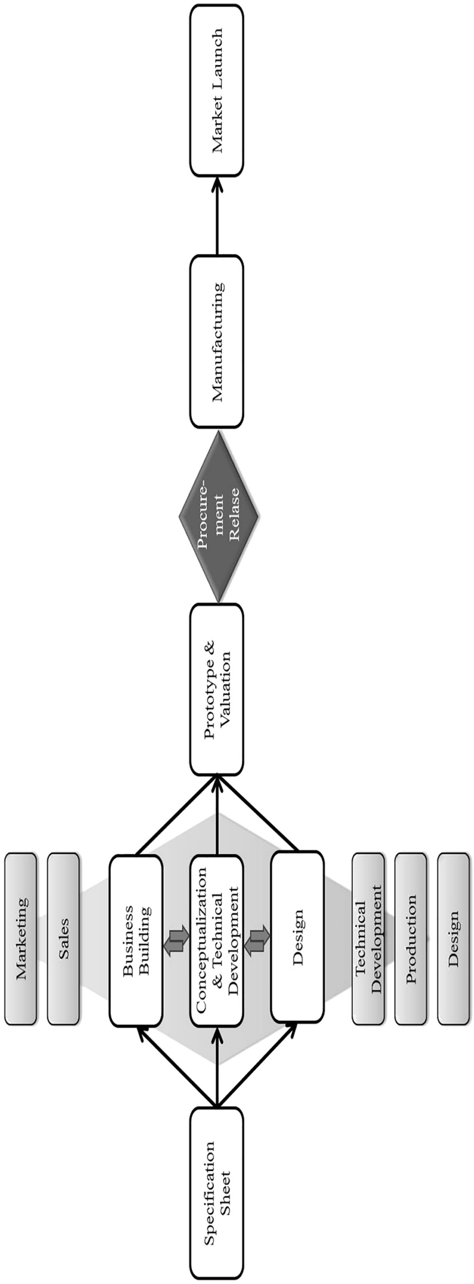

Figure 6.
Proposed model of an innovation management process

The ulterior motive for the parallelization of tasks, the instalment of cross-functional development teams, and the use of prototypes for market evaluation is to be found in the need of an organization to ensure the market conformity before the procurement release. As a change in any technical aspect of the innovation after this critical stage is hard to realize, the innovation needs to be comprehensively validated, and all relevant aspects of all functions need to be considered beforehand. Hence, the underlying assumptions need to be verified or at least supported, and many uncertainties eliminated in order to release production/manufacturing. The above-mentioned mechanisms can comply with these requirements and maximize the innovation's success potential at the stage of procurement release as they can intentionally trigger sustainable, iterative circles that adopt the innovation. Thus, a proactive scanning of the environment for new information and access to past learning experiences and critical incidents (through a knowledge management system) should be a constant component of a development process (Figure 7).

In spite of a high effort to reduce uncertainty during the development phase, new information on any environmental aspect can emerge. Any incident occurring after the release can usually only be considered in a follow-up project, and thus, sharing of knowledge between project development teams and their replacements is a crucial tool for the organizations to foster organizational learning and to utilize prior experiences. Consequently, an occurring incident that calls for a change does not necessarily have to be considered as a threat to the organization. An efficient knowledge management system can accumulate experiences from all projects and draw conclusions that can prevent new projects from failure. Thus, innovation projects should not be regarded as fully isolated but also with respect to the approaches from systems thinking, as some development projects build upon prior projects, and through sharing and accumulation of knowledge, the overall project work can be improved.

7. Conclusion

An integration of sustainable, iterative circles and (re-arranged) innovation management processes in conjunction with an installation of cross-functional teams that are supervised by a holistic and permanent innovation accounting can have a positive influence on the effectiveness of, and customer/market integration into, the development of innovations in manufacturing organizations. The re-orientation from a technically dominated toward an integrated development of innovations with exchange and cross-fertilization between team members representing different functions and parallelization of different tasks and activities can save time and unveil potential for improvement in early stages of the development process. Furthermore, cooperation and exchange between functions can also maintain the integration of all relevant issues from different perspectives that may influence the shape or business model of the innovative product. Through the comparison of requirements and recommendations proposed by the involved functions, weaknesses, and ambiguities, the innovation can be uncovered and missing information can be obtained. Thus, it is enabled to trigger sustainable, iterative circles during stages where changes can be applied with manageable efforts, and the uncertainty, as well as the amount of assumptions, can be reduced. Finally, new possibilities, and thus, chances for a broadening of the offered portfolio can be reached by contrasting potential technical feasibilities (introduced by technicians) with potential new fields of applications (provided by marketing and sales) and not simply developing a product with directions from one function.

As the findings show, organizations need to verify their innovations as good as possible prior to the procurement release as iterations are only practicable with excessive efforts and high costs. Thus, the call for a re-arrangement of tasks is supported. By concordantly determining the aspects that are seen as central and crucial to the innovation, the development follows a directed, and holistic vision of the innovation and all functions can

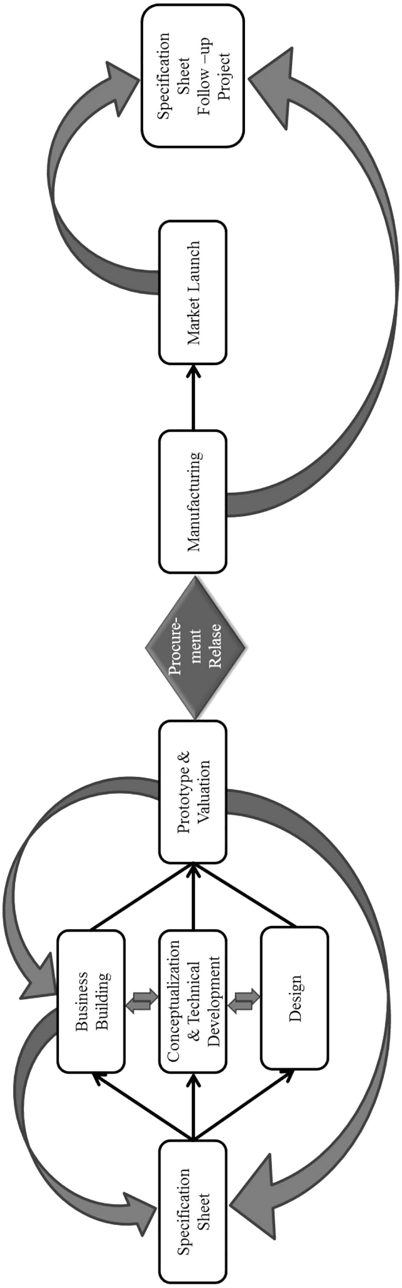

Figure 7.
Bidirectional iterations in the innovation management process

proactively search for information that verifies it and feedback from the markets can be integrated through intentionally triggered iterations to foster the project's success.

Experiences from prior projects ought to be shared between development teams, and thus, reasons for past failures and sustainable, iterative circles can be faced and avoided. Consequently, an enabling and fostering of organizational and inter-functional learning can support the chances of success.

The proposed model of a new innovation management process is to be seen as an approach for organizations to integrate cross-functional teams, innovation accounting, and organizational learning into the management and development of innovations. However, it does not provide a customized solution for every industry or firm. Moreover, it provides a base for organizations to adopt the findings and proposed alignments toward their individual needs and characteristics, and thus, follows the findings from Tidd and Bessant (2013) who request firms to adapt proposed models in terms of team composition, the sequence of tasks and tracking of progress.

As with any research, this present work has its limitations and exposes several issues with relevance for further research efforts. The proposed model for an innovation management process with the integration of sustainable, iterative circles is limited to manufacturing organizations that produce rather complex products with many influences from different perspectives and functions. Other manufacturing firms that do not require excessive investments in tools and production facilities, such as software and others, can apply changes to their products easier and do not necessarily need full market conformity at a certain stage, as updates or follow-up products can be produced fast. Furthermore, the proposed model represents a general approach that is, as with other innovation management processes, subject to adaptations toward specific requirements in industries and organizations (Tidd and Bessant, 2013).

Issues that require further investigation and delineation are the innovation accounting framework. As with the proposed innovation management process, a general framework can be developed with recommended categories, as well as key figures that possess a monitoring function and a mechanism that unveils missing information or assumptions that need to be confirmed. Organizations can then adapt this framework toward their needs. Furthermore, guidelines and characteristics for an innovative culture within innovation development teams should be created that give recommendations to organizations concerning the composition and the internal communication, as well as coordination of their teams.

Since both of the case studies were conducted in larger organizations, the findings might apply to small businesses in a number of ways with consequential policy implications. These ways include innovation and performance of small businesses, structuring and managing innovation, involving critical incidents, actual changes and systems thinking, as well as innovation management processes and cross-functionality, milestone orientation, and sustainable, iterative circles and applied changes.

References

Abdulai, A.-F., Murphy, L. and Thomas, B. (2020), "University knowledge transfer and innovation performance in firms: the Ghanaian experience", *International Journal of Innovation Management*, In Press.

Afuah, A. (1998), *Innovation Management Strategies, Implementation and Profits*, Oxford University Press, New York.

Aghdaie, M.H. and Alimardani, M. (2015), "Target market selection based on market segment evaluation: a multiple attribute decision making approach", *International Journal of Operational Research*, Vol. 24 No. 3, pp. 262-278.

Akbar, H. and Tzokas, N. (2013), "Charting the organisational knowledge-creation process: an innovation-process perspective", *Journal of Marketing Management*, Vol. 29 Nos 13/14, pp. 1592-1608.

Alha, K., Koskinen, E., Paavilainen, J. and Hamari, J. (2016), "Critical acclaim and commercial success in mobile free-to-play games", in *Proceedings of 1st International Joint Conference of DiGRA and FDG*, University of Tampere, Finland, Tampere.

Alpern, P. (2011), "Why we still cling to flawed forecasts", *Business Finance*, Vol. 17 No. 3, p. 4.

Andersen, T.J. (2000), "Strategic planning, autonomous actions and corporate performance", *Long Range Planning*, Vol. 33 No. 184, p. 200.

Anderson, A.M. (2008), "A framework for NPD management: doing the right things, doing them right, and measuring the results", *Trends in Food Science & Technology*, Vol. 19 No. 11, pp. 553-561.

Baldassarre, B., Calabretta, G., Bocken, N. and Jaskiewicz, T. (2017), "Bridging sustainable business model innovation and user-driven innovation: a process for sustainable value proposition design", *Journal of Cleaner Production*, Vol. 147, pp. 175-186.

Bibarsov, K.R., Khokholova, G.I. and Okladnikova, D.R. (2017), "Conceptual basics and mechanism of innovation project management", *European Research Studies Journal*, Vol. XX No. 2B, pp. 224-235.

Bierfelder, W. (1994), *Innovationsmanagement - Prozessorientierte Einführung*, Oldebourg, München.

Blank, S. and Dorf, B. (2012), *The Startup Owner's Manual*, K&S Ranch, Pescadero, CA.

Boons, F. and Lüdeke-Freund, F. (2013), "Business models for sustainable innovation: state-of-the-art and steps towards a research agenda", *Journal of Cleaner Production*, Elsevier, Vol. 9, pp. 9-19.

Brandenburg, F. (2001), *Methodik zur Planung Technologischer Produktinnovationen*, Shaker, Aachen.

Bresman, H. (2007), "Learning strategies and performance in innovation teams", *Academy of Management Annual Meeting Proceedings 2007*, No. 1, pp. 1-6.

Breuer, H. (2013), "Lean venturing: learning to create new business through exploration, elaboration, evaluation, experimentation, and evolution", *International Journal of Innovation Management*, Vol. 17 No. 03, pp. 1-22.

Brock, D. (2003), "Autonomy of individuals and organizations: towards a strategy research agenda", *International Journal of Business and Economics*, Vol. 2 No. 1, pp. 57-73.

Browning, T.R. and Sanders, N.R. (2012), "Can innovation be lean?", *California Management Review*, Vol. 54 No. 4, pp. 5-19.

Bryman, A. (2016), *Social Research Methods*, Oxford University Press, Oxford.

Burns, T. and Stalker, G.M. (1994), *The Management of Innovation*, Oxford University Press, Oxford.

Casadesus-Masanell, R. and Heilbron, J. (2015), "The business model: nature and benefits", Working Paper 15-089, Harvard University, Harvard Business School.

Chander, G.N., Keller, C. and Lyon, D.W. (2000), "Unraveling the determinants and consequences of an innovation-supportive organizational culture", *Entrepreneurship: Theory & Practice*, Vol. 25 No. 1, p. 59.

Cooper, R.G. (1994), "Perspective third-generation new product processes", *Journal of Product Innovation Management*, Vol. 11 No. 1, pp. 3-14.

Cooper, R.G. and Kleinschmidt, E.J. (1995), "New product performance: keys to success, profitability & cycle time reduction", *Journal of Marketing Management*, Vol. 11 No. 4, pp. 315-337.

Corbin, J.M. and Straus, A. (1990), "Grounded theory research: procedures, canons, and evaluative criteria", *Qualitative Sociology*, Vol. 13 No. 1, pp. 3-21.

Cortimiglia, M.N., Delcourt, C.I.M., De Oliveira, D.T., Correa, C.H. and Danilevicz, A.de M.F. (2015), "A systematic literature review on firm-level innovation management systems", in *IAMOT 2015 Conference Proceedings, International Association for Management and Technology*, Cape Town, June 8-11.

da Silva, F.M., Araujo Querido Oliveira, E.A. and de Moraes, M.B. (2016), "Innovation development process in small and medium technology-based companies", *RAI Revista de Administração e Inovação*, Vol. 13, pp. 176-189.

Darroch, J. and McNaughton, R. (2002), "Examining the link between knowledge management practices and types of innovation", *Journal of Intellectual Capital*, Vol. 3 No. 3, pp. 210-222.

Davenport, T.H. (1993), *Innovation: Reengineering Work through Information Technology*, Harvard Business School Press, Boston.

Day, G.S. (2006), "Aligning the organization with the market", *MIT Sloan Management Review*, Vol. 48 No. 1, pp. 41-49.

Edmonstone, J.D. (2018), "Organisational learning", *Leadership in Health Services*, Vol. 31 No. 4, pp. 434-440.

Eisenhardt, K.M. and Graebner, M.E. (2007), "Theory building from cases: opportunities and challenges", *Academy of Management Journal*, Vol. 50 No. 1, pp. 25-32.

Enzing, C., Batterink, M. and Janszen, F. (2011), "Where innovation processes make a difference in products' short- and long-term market success", *British Food Journal*, Vol. 113 No. 7, pp. 812-837.

Eppinger, S. (2001), "Innovation at the speed of information", *Harvard Business Review*, Vol. 79 No. 1, pp. 149-158.

Evans, S., Vladimirova, D., Holgado, M., Van Fossen, K., Yang, M., Silva, E. and Barlow, C. (2017), "Business model innovation for sustainability: towards a unified perspective for creation of sustainable business models", *Business Strategy and the Environment*, Vol. 26 No. 5, pp. 597-608.

Flanagan, J.C. (1954), "The critical incident technique", *Psychological Bulletin*, Vol. 51 No. 4, pp. 327-358.

Furukawa, Y. (2013), "The struggle to survive in the R&D sector: implications for innovation and growth", *Economics Letters*, Vol. 121 No. 1, pp. 26-29.

Globocnik, D. (2010), *Front End Decision Making*, Gabler, Wiesbaden.

Goffin, K. and Mitchell, R. (2016), *Innovation Management: Effective Strategy and Implementation*, 3rd ed., Palgrave Macmillan, London.

Heeks, R. and Stanforth, C. (2014), "Understanding development project implementation: an actor-network perspective", *Public Administration and Development*, Vol. 34 No. 1, pp. 14-31.

Horn, C. and Brem, A. (2013), "Strategic directions on innovation management – a conceptual framework", *Management Research Review*, Vol. 36 No. 10, pp. 939-954.

Hosseini, A.S., Soltani, S. and Mehdizadeh, M. (2018), "Competitive advantage and its impact on new product development strategy (case study: Toos Nirro technical firm)", *Journal of Open Innovation: Technology, Market, and Complexity*, Vol. 4 No. 17, pp. 1-12.

Houkes, W. and Vermaas, P.E. (2012), "Technical functions: on the use and design of artefacts", *Philosophy of Engineering and Technology Book Series (POET)*, Vol. 1, Springer, Berlin.

Jansen, J.J., Vera, D. and Crossan, M. (2009), "Strategic leadership for exploration and exploitation: the moderating role of environmental dynamism", *The Leadership Quarterly*, Vol. 20 No. 1, pp. 5-18.

Kang, K.H. and Kang, J. (2009), "How do firms source external knowledge for innovation? Analysing effects of different knowledge sourcing methods", *International Journal of Innovation Management*, Vol. 13 No. 01, pp. 1-17.

Kanter, R. (1996), "When a thousand flowers bloom: structural, collective, and social conditions for innovation in organizations", *Knowledge Management and Organisational Design*, Vol. 10 No. 3, pp. 93-131.

Kazimierska, M. and Grębosz-Krawczyk, M. (2017), "New product development (NPD) process – an example of industrial sector", *Management Systems in Production Engineering*, Vol. 25 No. 4, pp. 246-250.

Kylliäinen, J. (2018), "Innovation management processes – figuring out the right one", available at: https://www.viima.com/blog/innovation-management-processes.

Lander, J. (2012), "Invention or innovation?", *Inventors' Digest*, Vol. 28 No. 2, pp. 38-39.

Leiponen, A. and Helfat, C.E. (2011), "Location, decentralization, and knowledge sources for innovation", *Organization Science*, Vol. 22 No. 3, pp. 641-658.

Lendela, V., Moravčíkováa, D. and Latkaa, M. (2017), "Organizing innovation activities in company", *Procedia Engineering*, Vol. 192, pp. 615-620.

Lertpachin, C., Wingwon, B. and Noithonglek, T. (2013), "The effect of marketing focus, innovation and learning organization on the building of competitive advantages: empirical evidence from ISO 9000 certified companies", *Journal of Strategic Marketing*, Vol. 21 No. 4, pp. 323-331.

Lewis, J.M., Ricard, L.M., Klijn, E.-H., Grotenbreg, S., Ysa, T., Albareda, A. and Kinder, T. (2014), "Innovation environments and innovation capacity in the public sector", Research Report no. 1 of the LIPSE Project (Work Package 1), LIPSE "Learning from Innovation in Public Sector Environments" (www.lipse.org), European Union, Brussels.

Lindegaard, S. and Kawasaki, G. (2010), *The Open Innovation Revolution: Essentials, Roadblocks, and Leadership Skills*, John Wiley & Sons, London.

Loewe, P. and Chen, G. (2008), "For innovation that works, dispel obsolete assumptions and ask new questions", *US Industry Today*, Vol. 11 No. 3, pp. 18-19.

Mann, D. (2002), *Hands-on Systematic Innovation*, Creax Press, Belgium.

Mascitelli, R. (2000), "From experience: harnessing tacit knowledge to achieve breakthrough innovation", *Journal of Product Innovation Management*, Vol. 17 No. 3, pp. 179-193.

McDermott, C. and Prajogo, D. (2012), "Innovation and business performance in SMEs", *International Journal of Operations & Production Management*, Vol. 32 No. 2, pp. 216-237.

Merriam-Webster (2020a), *Innovation*, available at: https://www.merriam-webster.com/dictionary/innovation.

Merriam-Webster (2020b), *State of the Art*, available at: https://www.merriam-webster.com/dictionary/state%20of%20the%20art.

Mothe, C. and Nguyen-Thi, T.U. (2013), "Sources of information for organisational innovation: a sector comparative approach", *International Journal of Technology Management*, Vol. 63 Nos 1/2, pp. 125-144.

Nerkar, A. and Shane, S. (2007), "Determinants of invention commercialization: an empirical examination of academically sourced inventions", *Strategic Management Journal*, Vol. 28 No. 11, pp. 1155-1166.

Noori, S., Jafari, M., Fathian, M. and Ebrahimi, M. (2009), "The presentation of a network model for the development of innovation in R&D centers", *Journal of Chinese Entrepreneurship*, Vol. 1 No. 2, pp. 121-135.

O'Cass, A. and Sok, P. (2013), "Exploring innovation driven value creation in B2B service firms: the roles of the manager, employees, and customers in value creation", *Journal of Business Research*, Vol. 66 No. 8, pp. 1074-1084.

OECD (2019), *Oslo Manual 2018 Guidelines for Collecting, Reporting and Using Data on Innovation*, 4th ed., Organisation for Economic Development, Paris (accessed 22 October 2019).

Reitzig, M. and Sorenson, O. (2013), "Biases in the selection stage of bottom-up strategy formulation", *Strategic Management Journal*, Vol. 34 No. 7, pp. 782-799.

Ries, E. (2011a), "Build measure learn uncertainty waste value", *Inc. Magazine*, Vol. 33 No. 8, pp. 56-63.

Ries, E. (2011b), *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, Random House Digital, New York.

Saunders, M., Lewis, P. and Thornhill, A. (2015), *Research Methods for Business Students*, Financial Times/Prentice Hall, Harlow.

Schwer, L.E. (2011), "Building confidence in innovation", *Mechanical Engineering*, Vol. 133 No. 5, p. 42.

Scott, J.T. (2017), *The Entrepreneur's Guide to Building a Successful Business*, EFMD, Belgium.

Shenhar, A.J., Dvir, D., Levy, O. and Maltz, A.C. (2001), "Project success: a multidimensional strategic concept", *Long Range Planning*, Vol. 34 No. 6, pp. 699-725.

Sheu, D.D. and Lee, H.-K. (2011), "A proposed process for systematic innovation", *International Journal of Production Research*, Vol. 49 No. 3, pp. 847-868.

Shih, H.-A. and Susanto, E. (2011), "Is innovative behavior really good for the firm?: innovative work behavior, conflict with coworkers and turnover intention: moderating roles of perceived distributive fairness", *International Journal of Conflict Management*, Vol. 22 No. 2, p. 111.

Stevens, G.A. and Burley, J. (1997), "3,000 raw ideas = 1 commercial success!", *Research-Technology Management*, Vol. 40 No. 3, p. 16.

Teza, P., Miguez, V.B., Fernandes, R.B., Dandolini, G.A. and de Souza, J.A. (2016), "Ideas for innovation: a systematic mapping of the literature", *Gest. Prod., São Carlos*, Vol. 23 No. 1, pp. 60-83.

Thomas, B.C. and Murphy, L.J. (2019a), *Innovation and Social Capital in Organizational Ecosystems*, IGI Global, Hershey.

Thomas, B. and Murphy, L. (2019b), "Innovation in organizational ecosystems: a preliminary investigation", in *Advances in Management and Innovation Conference*, May 2019, Cardiff Metropolitan University, Cardiff.

Thomas, B. and Thomas, A. (2019), *The Business of New Process Diffusion: Management of the Early Float Glass Start-Ups*, Routledge, Abingdon.

Tidd, J. and Bessant, J. (2013), *Managing Innovation: Integrating Technological, Market and Organizational Change*, Wiley, London.

Tushman, M. and Nadler, D. (1986), "Organizing for innovation", *California Management Review*, Vol. 28 No. 3, pp. 74-92.

Utterback, J.M. and Abernathy, W.J. (1975), "A dynamic model of process and product innovation", *Omega*, Vol. 3 No. 6, pp. 639-656.

Van De Ven, A.H., Polley, D.E., Garud, R. and Venkataraman, S. (1999), *The Innovation Journey*, Oxford University Press, New York.

Van Der Panne, G., Van Der Beers, C. and Kleinknecht, A. (2003), "Success and failure of innovation: a literature review", *International Journal of Innovation Management*, Vol. 7 No. 3, pp. 309-338.

Veryzer, R.W. (1998), "Discontinuous innovation and the new product development process", *Journal of Product Innovation Management*, Vol. 15 No. 4, pp. 304-321.

Witell, L., Löfgren, M. and Gustafsson, A. (2011), "Identification ideas of attractive quality in the innovation process", *The TQM Journal*, Vol. 23 No. 1, pp. 87-99.

Yin, R.K. (2012), *Applications of Case Study Research*, SAGE, Thousand Oaks, CA.

Zahra, S.A. and George, G. (2002), "Absorptive capacity: a review, reconceptualization, and extension", *The Academy of Management Review*, Vol. 27 No. 2, pp. 185-203.

Corresponding author
Brychan Celfyn Thomas can be contacted at: brychan.thomas@southwales.ac.uk