Approaches and Metrics to Control Innovations:
A systematic Literature Review

Seminar Paper

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Abstract

As the business environment is becoming more and more unpredictable through the digital transformation, new business forms or intensified competition, the ability to develop innovations in a continuous process to sustain the competitive advantage and be viable in the market has gained on relevance for companies. The challenge for many enterprises is to bring out successful innovations effectively and efficiently. A reliable approach with suitable metrics to control innovation is a crucial factor for that. The present paper reviews 16 selected papers regarding the topic of successful innovation controlling frameworks and associated metrics. The results of the frameworks are categorized by their static or process view on the controlling approach. General requirements on metrics are outlined as a guideline and the metrics are clustered in input-, process-, output- and customer-oriented-metrics. The review points out, how innovation control can be done by different approaches and outlines that the right set of metrics is depending on several individual factors in the company. In conclusion the paper underlines the main commonalities and differences of the approaches and makes suggestions for the implication in the management practice and for further research.

Keywords: innovation controlling, innovation metrics, innovation accounting, frameworks, innovation

Table of Contents

1   Introduction

The ability to generate and develop innovations in a company has become a crucial factor over all industry sectors in the last years. Since business environments became unpredictable and changing through trends like the Digital Transformation, new business forms, short-end product lifecycles or intensified competition, the competitive advantages of firms are no longer sustainable over a period of time (Chen and Reyes, 2017). Therefore, companies are forced to erupt innovations and improve themselves in a continuous change process to sustain in the market and ensure their competitive advantage in the long-term (Collins and Smith, 1998). Those innovations regard not only product or service innovations. Process and even business innovations influencing entire business models are required to sustain. While it is commonly accepted that constant development of innovations depends on capabilities like velocity, flexibility, creativity, and risk-taking behavior, only recently companies have moved on to a well-managed innovation process where resources are efficiently used and innovations get established successfully (Davila et.al., 2004). Many companies understood already the urgency of being constantly innovative and founded innovation programs in forms of incubator/ accelerator programs or own business units to strive for innovations in the organization (Muller et. al., 2005). The real pain point for those organizations exists in sustaining these innovations and establishing them successfully and efficiently so that they be used to ensure the viability of the company (Chen and Reyes, 2017).

Recognizing this challenge, a controlling approach with requisite metrics becomes more and more urgent to improve the management and monitoring of the innovation process, to help to make informed decisions and evaluations about the innovations and to align the regarding goals and activities in the interest of the company (Muller et. al., 2005) (Collins and Smith, 1998). A reliable planning and controlling approach which, manages the process from the required resources through the process itself to the outputs, would ensure the optimized use of all resources, competencies and the time and can give guidance to prevent an early failure of the innovation project (Bürgermeister, 2012) (Collins and Smith, 1998) (Davila et.al., 2004).

1.1   Relevance and objective of the topic

Managing innovation successfully is a vital factor, but "according to a survey of 500 leaders conducted by the Center for Creative Leadership in the USA, only 14% of business leaders are confident about their organizations' ability to drive innovation" (Chen and Reyes, 2017). Due to the increased relevance of innovation control approaches for successful and sustainable innovations, there is already research being done on developing first approaches to control innovations appropriately. But the challenge in this area is that managing and controlling innovations is not that easy. Standard project management tools and control techniques „were considered inappropriate" for innovations (Kerssens and Cook, 1997). Innovations distinguish themselves from traditional processes and activities in a company by being unpredictable and not straight, pre-planned, flexible, iteratively developed and run through shortened product lifecycles. Changes in innovations are made continuously and the results can mostly not be planned (Frattini et.al. 2006). Therefore, traditional metrics like the Return On Investment (ROI), productivity, quality, or low-cost resources as well as approaches like a business plan and 'hard' Key Performance Indicators (KPI) for example, are not useful to control and measure during innovation. They are lagging indicators which means that they take time to show up adequately and try to measure future success with past success metrics (Collins and Smith, 1998). Connected to lack of guidance and control many innovation projects are brought to fail (Saucer, 2009). The failure rate of innovation processes can be measured around 50 to 70% in a company (Berman, 2010). As a consequence of that, finding the right metrics and an appropriate framework for innovations is a crucial success factor for managers in a company. The challenge of determining the right metrics for innovation can be called the 'paradox of innovation'. On the one hand the control mechanism should be a well-balanced combination of metrics, which are not too complex or unprecise, but on the other hand facilitate enough freedom and uncertainty on the to bring innovations in a company to success (Cuthbertson, 2019).

1.2   Research question and structure of the paper

As recognized, a lot of research about the topic of methods and tools to start and develop innovation projects is already done. Regarding this topic, a broad and detailed scientific knowledge base can be found and is also applied practically. The focus on the latest research is to now to deduct the right approaches and metrics to control those innovations successfully and efficiently. The question: How to control innovation successfully? is subject of the recent scientific literature with a lot of further research potential.

Therefore, the goal of this paper is to answer the research question of 'What approaches and metrics exist in the relevant scientific literature to control innovations?' and to provide an overview of the main aspects and metrics of the most appropriate frameworks which can be found.

Answering this question properly the paper is structured as follows: As an enclosure of the topic, I will provide some important background knowledge about the innovation process and general innovation controlling for better subsumption and understanding of the subject. In the next part, I will outline the applied method of the literature review and the proceeding. Afterward, the identified literature is presented and I describe the main results. The focus for the results is made on the different categorization of the provided frameworks and the analysis of the associated metrics for the control process. Finally, I will make a comparison subsequent discussion and implication of the results and reflect further research possibilities and limitations.

2   Background

The term '*Innovation*' in general can be defined as the "creative definition, development, and commercialization of substantially new products, services or businesses" (Davila et al. 2004, p. 28). Additionally, the OECD (2015) identifies four different types of innovations: product, process, marketing and organizational innovation (OECD, 2015). According to Roberts (1988) "innovation is the successful exploitation of new ideas". It includes every element in the internal and external units of a company striving to translate an idea into a commercial success (Verhaeghe and Kfir, 2002). Commonly, innovation is not just seen as a subject, it is also described as a continuous process in combination with several activities. This innovation process itself is an own, complex research topic with many different forms of innovation-process-models. Without going in more detail, it just needs to be outlined that innovation as a process can be described in the major stages of the generation/selection, the development/building stage and the testing and launching stage (Chen and Reyes, 2017) (Kowalski, 2014). This entire flexible and iterative process, including the highly competitive environment, needs to be controlled and can be seen as an anchor for the controlling of innovations (Bürgermeister, 2012).

The term '*controlling*' in general can be understood as the goal-oriented planning and regulating in line with coordinated management of typical operational and business processes in a company (Littkemann, 2005) (Möller et al., 2011). It is a supporting function or tool of the management (Fischer et.al., 2012). By this definition, controlling should be considered as an activity for effectiveness and efficiency by reaching the organization's goals and avoiding cost and time inefficiencies simultaneously (Littkemann, 2005).

Transferring the term, *'Innovation Controlling'* means the continuous evaluation of the project during the entire innovation process in every phase to evaluate the further continuation of the innovation. Innovation controlling includes not just controlling budgets and deadlines but all the related measurement areas affected by the innovation process (Möller et al., 2011). The task of innovation controlling is to identify relevant approaches and metrics to control the innovation process resulting in completion of set innovation goals (Littkemann, 2005). The term *'Innovation Accounting'* shaped by Ries (2011) in his 'The Lean Start-up' approach can be almost seen as a synonym for 'Innovation controlling' (Ries, 2011). Innovation Accounting is defined as the activities of measuring and managing the progress of corporate start-ups from a great idea to a validated business model (Ries, 20111).

For the further understanding of the concepts in this paper the term '*Metric*' and '*Key Performance Indicator*' needs to be defined. Metrics are "measures of performance" (Kerssens and Cook, 1997, p.352) and 'can serve as an instrument of verification to check the course or direction' (Shanbhag and Pardede, 2019, p. 284). Key Performance Indicators in the common understanding are specific metrics that are more important, should be tracked regularly, and can increase the performance of the project's objective (Kerzner, 2011).

3 Literature Review

This chapter describes the method of the literature review used to identify the relevant literature for this topic. In the following part, I present the process of forming the right keywords and finding the databases for an efficient search. Subsequently, I document the selection process and the identified literature with their sources (Figure 1).
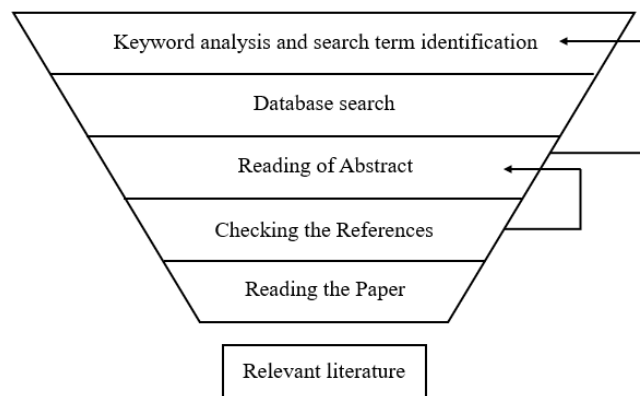

Figure 1: Process of research and selection

3.1 The process of research

The first step of my research contained a detailed keyword analysis concerning the main aspects of the topic like 'innovation', 'metrics', and 'measurement'. I identified suitable synonyms and generic terms as well as subtopics of the different aspects for an adequate overview and a focused formulation of the first search terms.

As a next step, I selected the main databases for the search. Due to their access possibilities and relevance for the topic of Digital Transformation, I decided to use the databases 'EBSCOhost', 'ECONBIZ', and 'GoogleScholar' in the first way to get access to the main papers concerning my topic. For an additional search, I extended the database choice to 'Science Direct, 'ResearchGate', and 'SpringerProfessional' to ensure that a remarkably high number of relevant papers for the topic will be considered.

Finding useful search terms was a constantly evolving process during the research. In the beginning, general keywords like 'innovation metrics', 'innovation approaches', 'innovation indicators', 'measuring innovation', and innovation measurement were used. After some queries, papers were identified which broached the issue of measuring the innovation capability of a firm or country or indicators for innovativeness. These aspects were not addressing my chosen topic correctly. Additionally, some papers were concerning controlling activities on Research and Development (R&D) projects. Those papers needed to be read carefully, because R&D and the term of Innovation have not the same meaning in an organization necessarily. Therefore, I adjusted the keywords into the direction of 'innovation controlling' and 'innovation accounting'. Search terms like 'control system' and 'frameworks' in combination

with 'innovation management' and 'metrics' led to more precise and relevant literature. Adding 'innovation projects' and 'start-ups' brought up new and more adequate results.

3.2 Identified literature

The analysis and identification of the relevant literature has proceeded in three major steps. Initially I read through each papers title, abstract and the keyword outline to filter the results roughly. This resulted in less than 60 papers to be relevant. In the second step, I read the introduction and conclusion of those papers to find out which ones would address the same topic and problem. By checking through the references of some of the more relevant papers, I got some more related papers to be considered. For the final identification of the relevant papers, I read the chosen papers in total. At the end of the research process the cited sources in the papers I considered relevant, referred to the same references I already found and read. This was the sign, that an appropriate number of relevant literature should have been found and the research process can be finished.

For the topic of frameworks for innovation controlling, 16 final papers between the years 1997 and 2019 turned out to be especially relevant by presenting a framework and metrics to control innovations. Because of the novelty of the topic of innovation controlling, not just scientific articles were found. I also identified approaches from books and websites. The publication types can be seen in Table 1.

Publication Type	Article	Book	Chapter in a book	Blogpost/ Website	Whitepaper
Number of identified frameworks	9	3	1	2	1

Table 1.   Number of identified literatures by their publication type

4   Results

In this chapter, I will present my results from the literature review in detail. The identified literature can be found in the following Table 2. Each framework offers different perspectives and components on innovations and suggests a set of metrics and areas to focus on. I structured those relevant frameworks by a static point of view and a process view on innovation controlling and identified the main used dimensions, which will be relevant for effective innovation management in the organization. In the next step, I present the papers' understanding of metrics and a short guideline about the requirements for finding the right metrics in innovation controlling. Finally, I will analyze the suggested metrics by categorizing them in input-, output-, process- and customer-oriented metrics and give examples of typical KPIs for each category.

Literature			Framework		Metrics			
Author	Approach name	Year	Static View	Process View	Input Metrics	Process Metrics	Output Metrics	Customer-oriented Metrics
Brown & Svenson	Input-process-output-outcome-framework	1998		X	X	X	X	
Verhaeghe & Kfir	A Holistic Systems	2002		X	X	X	X	

	Framework of Innovation							
Muller, Välikangas, Merlyn	Innovation Framework	2005	X	X	X	X	X	
Collins & Smith	The Arthur D. Little Innovation Metrics Framework	1998	X		X	X	X	
Chen & Reyes	Conceptual Framework: Innovation process stages within the proposed approach	2017	X		X			
Kerssens-van Drongelen & Cook	Innovation Balanced Scorecard	1997	X		X	X		X
Bürgermeister	Balanced Innovation Management Accounting	2012	X	X	X		X	
Kaplan	Innovation Accounting Template	N/A		X		X	X	X
Cuthbertson	The Four Elements of Innovation	2019	X		X	X		X
McClure	Pirate Metrics AARRR	2007		X			X	X
Maurya	Lean Canvas	2016	X				X	X
Croll & Yoskovitz	Lean Analytics Framework	2013		X			X	X
Rodden, Hutchinson, Fu	HEART Framework	2010	X			X		X
Ries	Engines of Growth	2011	X	X			X	X
Möller & Schönefeld	Performance Measurement Framework	2011	X	X	X	X	X	
Shanbhag & Pardede	MESOPS Framework	2019		X			X	X

Table 2.   Structured results from the literature research

4.1   Different perspectives of the frameworks

Due to the urgency of controlling innovations successfully, all the identified papers suggest a specific framework with different dimensions as an approach. The frameworks can be structured by their orientation to a more static or process point of view on innovation controlling.

Frameworks defining a *static view* to control innovations understand the control of innovations as a holistic approach that can not be seen separated and requires many different metrics to control innovations. Several different aspects and perspectives are combined to activate innovation as a business process (Verhaeghe and Kfir, 2002). One suggested dimension which needs to be considered in innovation controlling is the organization with their culture, strategy, and employees (Chen and Reyes, 2017), (Collins and Smith, 1998) (Cuthbertson, 2019) (Muller et. al., 2005) (Möller and Schönefeld, 2011). Organizational culture and structure in a company influence the way how employees are grouped and work together (Adams et.al. 2006). Promoting a creative and innovative environment with enough freedom and flexibility on the one side but sufficient control on the other side is an important factor for successful innovations (Möller and Schönefeld, 2011) (Adams et.al. 2006).

A further dimension that can be found in those static frameworks is considering the resource an organization possesses. The question is: 'Do we have access to the right resources?' (Collins and Smith, 1998). Input factors like capital, labor, and time need to be outbalanced in an optimal way to support the innovation process (Muller et. al., 2005). Those two dimensions will be assigned to the inputs in the metrics chapter as enablers for innovations. Two other factors, which can be categorized into the output metrics later, are the customers and the stakeholders. Customers' value become increasingly important for innovations (Cuthbertson, 2019). Innovations have to be developed within close participation and engagement of the customers during the whole process (Cuthbertson, 2019) (Rodden et. al., 2010). Regular contact with the customer base and an implemented feedback loop increase the probability of an innovation result, which can be implemented in the market successfully because it meets the customer's requirements and satisfies them (Cuthbertson, 2019) (Rodden et. al., 2010) (Ries, 2011). Additional to the mentioned dimensions, the innovation processes are referred to in many of the static approaches as a central element. The question to answer is here: "Are we doing the things right?" (Collins and Smith, 1998) (Muller et. al., 2005). The innovation process interlinks the dimensions mentioned before to one holistic and static picture a manager needs to overlook when controlling innovations in a company (Muller et. al., 2005) (Chen and Reyes, 2017).

Some of the identified approaches can not be categorized as a static framework. Authors i.a. Brown and Svenson (1998), Verhaeghe and Kfir (2002), Kaplan (N/A) and McClure (2007) suggest frameworks with innovation controlling as a *process* with several steps or stages. The dimensions considered are disposed of either as inputs/ outputs before/after the actual innovation process (Brown and Svenson, 1998) (Verhaeghe and Kfir, 2002) (Bürgermeister, 2012) (Muller et. al., 2005) or several levels or steps as a guideline to control innovations (Kaplan, N/A) (McClure, 2007) (Croll and Yoskovitz, 2013) (Ries, 2011). The considered dimensions from Brown and Svenson (1998), Verhaeghe and Kfir (2002), Bürgermeister (2012), and Muller et. al. (2005) are similar to the dimensions of the static approaches, outlined before. They can just be differentiated in the arrangement but define the innovation control in a holistic way as well. In comparison, the other mentioned frameworks structure the task of innovation controlling in specific steps where they provide metrics for each one. The concepts give a more partial and individual view on innovation control. Especially the dimension of customers is dominating the frameworks. Kaplan (N/A) and Ries (2011) encourage the early implementation of customer's input to validate the innovation idea from the beginning (Kaplan, N/A) (Ries, 2011). Significant for those approaches is that the customer, as a dimension that needs control, is considered throughout all stages of the approaches (McClure, 2007) (Shanbhag and Pardede, 2019).

The frameworks and their integration into a context as the organization's structure, culture, industry, market, and regulations, gets created individually by each company (Möller et al., 2011).

4.2 General Requirements to build the metrics

To enable a concrete measurement system to control the innovation project and measure the actual success, specific metrics behind the above-mentioned dimensions in the different frameworks are suggested

to monitor the controlling process effectively. I outline the general requirements and types for building a set of metrics from the relevant approaches in the following part.

Within the frameworks, an associated set of metrics as a measurement system plays an important role to control innovations (Davila et.al., 2004) (Kerssens and Cook, 1997) (Möller and Schönefeld, 2011). The metrics are the source of information to measure the performance during the innovation process and control the accorded activities aligned with the company's innovation goals. They need to be determined for an innovation project in a company individually (Möller et al., 2011). The following general requirements to build the metrics are suggested by the authors.

The metrics should be comprehensive for all dimensions of the approach and should be manageable. Otherwise, they would limit the flexibility in the innovation (Muller et. al., 2005) and waste too much time and effort on the measurement (Kirsner, 2015). Furthermore, the metrics should be simple and not too complex to enhance an easier measurement and application in the entire organization and to enable internal and external benchmarking with certain metrics (Muller et. al., 2005) (Collins and Smith, 1998) (Brown and Svenson 1998) (Shanbhag and Pardede, 2019) (Croll and Yoskovitz, 2013). Additionally, simple metrics are better to understand by the employees, who need to remember and discuss them (Shanbhag and Pardede, 2019). Otherwise, the metrics would just present numbers, which are not used actually in the innovation context (Ries, 2011). The set of metrics should also be limited to a few important ones. It allows them to stay manageable and doesn't limit flexibility (Muller et. al., 2005) (Shanbhag and Pardede, 2019). Another requirement outlined in the literature describes how metrics should be balanced with the used framework and be consistent with the current level and role of innovations in the organization (Muller et. al., 2005) (Collins and Smith, 1998). They should ensure that all the key elements are targeted and tracked, attached to the right goals, and aligned with the organization's strategies (Shanbhag and Pardede, 2019). Just measuring the stakeholder's outcomes, isn't comprehensive enough for successful innovation control metrics (Collins and Smith, 1998) (Ries, 2011). Moreover, metrics should not be focused just on traditional 'hard' factors like financial, quantitative measures. Those are not representative of complex and wide-ranging innovations and should be supplemented by other metrics (Collins and Smith, 1998) (Kristiansen and Ritala, 2018). Every set of metrics should include at least one or two customer-driven metrics. This requirement is outlined as very important in many of the reviewed literature (Muller et. al., 2005) (Ries, 2011) (Collins and Smith, 1998) (Rodden et. al., 2010) (Cuthbertson, 2019) (Kaplan, N/A). Especially Ries (2011), points out, that the metrics should be able to be used in comparison with other user groups, projects, or competition to identify long-term trends and remark the change in the performance of the innovation (Ries, 2011). This connects to an important purpose of metrics. Metrics should be used in the innovation control to change the behavior based on the metric's results. They show how close the activities or the project to achieving set goals or the ideal model during the innovation process while also aiding with adjustment and optimization of further steps (Ries, 2011).

For a better understanding and application of metrics, I also identified following different types of metrics measuring several dimensions of innovation projects from the relevant literature.

Looking at the measured content it differs between *quantitative* and *qualitative* metrics. Quantitative metrics present data in numbers, which can be used in scientific contexts, are scalable, and can be aggregated. Qualitative metrics are subjective and imprecise. To gather them, customers need to be asked questions for example (Ries, 2011). Focusing on the results the *exploratory* metrics find out something new, while *reporting* metric types just measure something already renowned for the innovation (Ries, 2011). Furthermore, Ries (2011) and Collins and Smith (1998) outline the time dimension as a metric type. *Lagging* metrics give information about past performance. While *real-time* metrics measure current performance and *leading* metrics try to give an outlook on future performance (Ries, 2011) (Collins and Smith, 1998). *Correlated* metrics show possible connections between two metrics and *causal* metrics on the other side can identify causal reasons for certain developments. The last-mentioned type is regarding the measured object (Ries, 2011). *Activity* metrics control the current innovation activities

going on. *Impact* metrics instead capture the tangible results which are emerged from the innovation activities (The Next Amsterdam, 2019).

4.3 Different categories of metrics

After the general requirements and types of metrics, I identified and clustered the relevant metrics in the following categorizations from the frameworks. For each category, I present precise examples including several metric types and specific KPIs, which are suggested in the relevant frameworks for the actual use in innovation controlling:

- Input-Metrics

- Process-Metrics

- Output-Metrics

- Customer-oriented Metrics

Input Metrics

Input-metrics capture i.a. the dimension of resources like employees, equipment, financial resources, information, and know-how, which the system receives and processes for the innovation (Brown and Svenson, 1998). Exemplary concrete KPIs could be (Möller and Schönefeld, 2011) (Muller et.al., 2005) (Kristiansen and Ritala, 2018):

- R&D-Expenses/ percentage of capital that is invested in innovation activities

- Number of innovation tools and methodologies available to employees

Möller and Schönefeld (2011) adjudged that pure straight financial or quantitative metrics are not sufficient enough to use them as the only basis of decision-making. The aggregated numbers are not significant for controlling the input dimensions for innovation control. Integration of further input-metrics like the employees and physical resource equipment is recommended (Möller and Schönefeld, 2011) (Kristiansen and Ritala, 2018). The employee value and corporate value are examples for important input-metrics because the success of an innovation is strongly remaining on the working team behind. Especially their skills, motivation and the size and quality of their professional intrapreneur networks influences innovations sustainably. The more connected the employees are, the more they have contacts to get feedback from the customers and engage the stakeholders. Besides, the purpose and value of the innovation should be easily articulated by the innovation team in terms of the firm's corporate values and strategies (Cuthbertson, 2019) (Kristiansen and Ritala, 2018). Precise metrics are suggested (Cuthbertson, 2019) (Möller and Schönefeld, 2011):

- Employee values and employee engagement, the heterogenic composition of the project team

- Size of intrapreneur network and network size of entrepreneurs, the average turnover rate among employees

Furthermore, the culture, leadership, strategy, and stakeholder orientation are dimensions to be considered as input-metrics. Those measure and control i.a. the climate for innovation, the innovation goals, or the level of inquiry within an organization (Cuthbertson, 2019) (Collins and Smith, 1998). Possible concrete KPIs could be (Muller et. al., 2005) (Collins and Smith, 1998):

- Percentage of managers with training in the concepts and tools of innovation.

- Gross contribution of new products for the stakeholders, net present value (NPV) of idea portfolio

- Innovation climate, external alliances being pursued

The input-metrics can help to determine reference points and comprehensive values, which can be compared with internal and external data. The resulting output from the input is still depending on the effectivity and efficiency during the further innovation process (Möller and Schönefeld, 2011).

Process-Metrics

Process-metrics play an essential role in innovation controlling by ensuring the effectivity and efficiency during the innovation transformation process (Möller and Schönefeld, 2011). The process efficiency for example can be measured and controlled by a comparison of the metrics' target values and actual values. Process-metrics also control the quality of the internal and external cooperation related to the innovation (Möller and Schönefeld, 2011) (Adams et.al. 2006). In regard to measure and control the success of innovations the project speed as a metric becomes relevant as well. Cuthbertson (2019) outlines that the success of innovation comes more from the speed within an innovation project than the initial quality and value proposition (Cuthbertson, 2019). 'Killing' projects or ideas in an early stage and identifying the right ideas quickly, turns out the possibility that the innovation can be developed and scaled more rapidly and efficiently. The organization can take advantage of learning from it and applying this knowledge towards developing further innovations and value propositions for the customer (Cuthbertson, 2019). Further, adoption and retention metrics concerning the customer can be used to provide stronger insights into the present performance (Rodden et. al., 2010). Following examples for exact metrics are outlined (Muller et. al., 2005) (McClure, 2007) (Collins and Smith, 1998) (Kaplan, N/A) (Rodden et. al., 2010) (Cuthbertson, 2019) (Möller and Schönefeld, 2011) (Kerssens and Cook, 1997) (Brown and Svenson, 1998):

- Number of ideas at each stage of the innovation process, number of ongoing experiments and ventures, the average time from idea submission to commercial launch, the take-up rate of new processes, number of killed ideas

- Number of milestones completed, duration market entry, enrollments, signups, used the service at least once, subscriptions, conducting research

- Repeat purchase rates, Retention rates, open rate, search results, traffic, percentage of active users in a given week are still present sometime later, time to complete a task, percentage of tasks completed, the error rate

- Amount of participating internal business units, amount of external cooperations

Output-Metrics

The output-metrics at the end of the innovation process can be used to measure and control the improvements of the competitive advantage and success of the innovation (Verhaeghe and Kfir, 2002). They reflect the value for the organization or the customers (Brown and Svenson, 1998) and try to quantify the innovation targets (Muller et. al., 2005). Typical outputs-metrics can include patents, new products, new processes, publications, or knowledge unknown before (Brown and Svenson, 1998). Those metrics ideally capture the success of innovation and the improvements in the competitive advantage for the organization (Verhaeghe and Kfir, 2002). Critically is here, that measuring the direct or indirect success effect of innovations is not simple and always measurable (Möller et.al 2011). Following metrics and KPIs could be captured (Kaplan, N/A) (Muller et. al., 2005) (McClure, 2007) (Maurya, 2016) (Ries, 2011):

- Number of new products/ services/ businesses launched, number of visitors/ transactions/ buyers

- Customer lifetime value, conversion rate, click-through rate, churn rate, customer acquisition cost, time to customer breakeven, revenue per user/ transaction

- Number of new competencies or strategic options

Customer-oriented Metrics

As outlined in the previous subsection, it is recommended to implement at least one or two customer-oriented metrics in the individual metric set for successful innovation control. Those metrics can especially be found in the more partially viewed and rather start-up related frameworks (Ries, 2011) (McClure, 2007) (Rodden et. al., 2010) (Maurya, 2016) (Shanbhag and Pardede, 2019) (Croll and Yoskovitz, 2013) (Kaplan, N/A). The customer-oriented metrics accompany the entire innovation process and ensure that the customer's problems are still addressed correctly and the needs are satisfied (Shanbhag and Pardede, 2019). By comparing the customer values against the corporate values of the organization, the right value propositions to satisfy the customer's needs can be deducted (Cuthbertson, 2019). Therefore, metrics like customer satisfaction, discussion, and customer feedback are highly recommended (Rodden et. al. 2010) (Kaplan, N/A). Implementing rapid feedback loops with customers supports the guiding of the innovation process and customer engagement additionally (Kaplan, N/A) (Ries, 2011). The aim is to keep the innovation's solution relevant and competitive after the launch as well and achieve new customer values. This can only be guaranteed by controlling the innovation with customer-oriented metrics like customer revenue, customer growth or the provided feedback from customers (Shanbhag and Pardede, 2019) (Kaplan, N/A). Below some detailed metrics and KPIs are outlined (Maurya, 2016) (Kaplan, N/A) (Kerssens and Cook, 1997):

- Customer satisfaction score, ease of use, visual appeal, the expectancy of customers demand,

- Feedback Scores, independent ratings, customer-worded descriptions, survey results, search

- Number of customers or customer's feedback, depth of interaction, interaction intensity rate, number of customers trying the product, amount a customer is willing to pay, old and new customer values

- Word of mouth referrals, ability to take revenue from one customer and invest it into new customer acquisition, number of visits

The outlined metrics are suggested to be suitable to control innovations. The optimal selection and combination of the metrics and the resulting value of any particular metric will still vary from company to company (Muller et. al., 2005) (Collins and Smith, 1998).

5 Discussion

Based on the identified literature I analysed the current frameworks, which are suggested to control innovations in a company, and outlined the main metrics. Through those frameworks, I discovered following commonalities and differences and implications in the practical work with innovations.

5.1 Commonalities and differences

Throughout this paper, it became clear that there is a common understanding in the literature about the importance of continuous innovation in a company to stay viable in the market and the related urgency of an innovation control framework to ensure the success of innovations. Therefore, different control approaches are defined in the literature. Those approaches have in common, that they suggest metrics which can be used to measure certain dimensions within the framework to control innovation activities and align them with the innovation goals. The analyzed papers are also closely related to their definition of innovation as a process. Even though some of the frameworks provide a static view to control innovations, they still define innovation itself as a continuous process, which needs controlling and management. A common result of the identified approaches is, that the arrangement of the framework and the choice of the suitable set of metrics is depending on the individual requirements, business form, and phase, structure, and culture of a company.

On the other hand, some main differences are striking. As already outlined, some approaches are built up to control innovations as a process and present several steps and metrics in a certain order. Other authors as Collins and Smith (1998) or Chen and Reyes (2017) state a static approach to analyze and control innovations. Comparing the kind of view, it can also be differed between approaches, which define the controlling of innovations as a holistic task, and approaches with a more partial view. In the holistic frameworks, many different metric dimensions over the whole organization are considered, like culture, leadership, and the employees, while the partially approaches are free from any structures and are concentrating on one innovation and few metrics in more detail.

Another significant difference between the approaches is the different company stages which were used as the basis for the metrics. Ries (2011), Kaplan (N/A), Rodden et. al. (2010), McClure (2007), Maurya (2016), and Croll and Yoskovitz (2013) are writing about start-ups or companies in an early development phase. Per contra, approaches from Brown and Svenson (1998) Verhaeghe and Kfir (2002), Muller et. al. (2005), Collins and Smith (1998), Chen and Reyes (2017) or Kerssens and Cook (1997) are describing the innovation control activities and metrics for a more matured company status and see the innovation controlling within the company's context.

A controversial point is the perception of the correct amount of metrics. Gama et.al. (2007) defines innovation as "a multidimensional activity that cannot be measured by only one metric" (Gama et.al., 2007). Following this understanding, many innovation control frameworks provide a broad set of metrics, which should be set individually, while considering different dimensions to control innovations. For example, managers will choose metrics that track resources, non-financial measures of output, processes, and financial performance, rather than actively focusing attention on metrics that provide detailed information but are limited to one step in the innovation process (Davila et.al., 2004). Contrary, authors like Ries (2011) and McClure (2007) argument, that focus is success and a company should choose just a few metrics or even one metric, which the organization should focus on above all others for the current stage of the innovation (Ries, 2011). A minimal set of metrics the processes rely on, could be easier to manage in the right direction (Ries, 2011). Therefore, a precise analysis of the business model, the structure and the processes is essential (Ries, 2011). This discussion leads back to the introduced 'paradox of innovation' from Cuthbertson (2019), where a well-balanced set of metrics is crucial for successful innovation control. The metrics system needs to find the balance of the tension between a rich set of measures that captures all relevant information and avoiding costly information overload by too many metrics (Davila et.al., 2004).

Moreover, the paper's results show that pure financial, quantitative metrics are not enough to measure and control innovation activities appropriately (Kristiansen and Ritala, 2018). Despite the fact, that some of the approaches are still suggesting financial metrics like R&D expenses or the ROI to control innovations, the common opinion in the selected literature is, that those metrics can not control innovation in a successful kind of way alone (Kristiansen and Ritala, 2018). Ries (2011) for example dissociates oneself from traditional metrics and suggests nearly only specific customer-oriented metrics (Ries, 2011).

5.2   Implication and further research

This literature review is a guideline for managers to control innovations and bring them to success. Therefore, different frameworks with a versatile combination of metrics and specific examples are provided, which can be used to build an own framework for innovation controlling depending on the innovation and the organization structure and stage itself. The review outlines the understanding of innovations as a complex and various bundle of dimensions and processes, which needs to be controlled and managed to reach effective and efficient innovations in a company. Which in turn is a vital factor for companies in all industries nowadays. For the practical implication, a manager needs to decide individually how many metrics and dimensions depending on the innovation project should be used for the controlling activities (Muller et. al., 2005) (Collins and Smith, 1998). To provide an example, the

management level can be an influencing factor for the metric combination and form of the framework. Managers on top-level could be more interested in a few metrics used in a holistic framework to consider all affected dimensions.

Moreover, there are still open areas for further research. The presented approaches in this review define the control of innovations on the company's level or individual level. Research on the country level and a comparison to the company's approaches could put the different innovation cultures and stages in different countries and the handling of innovation control in an international context. Furthermore, more detailed research should be done on the requirements and relevant metrics of the frameworks depending on the innovation type. The resulting metrics could be assigned to different innovation types. Whether it is a product or service innovation like e.g. software or it is a process innovation would decide about the set of metrics, which is suitable. Another detailed research could be done on the innovation metrics depending on the status of the organization. For example, a start-up has not always enough data to use all the suggested metrics and KPIs in the literature. An assignment of the metrics to the organization's status or stage through further research could narrow down the frameworks to that point.

5.3 Limitation

This paper has several limitations. First, the review was conducted by a single author, which creates limited selections of search terms, databases, and classification schemes in the literature search and analysis. Second, the paper is limited by the language searched with. The reviewed and selected journals are published in English and German. This may exclude relevant papers in other languages. Third, the selected approaches in this paper are based on scientific and/ or recent publications or well-cited articles from commonly used scientific databases. There might be some other relevant concepts concerning this subject in less-known literature or offered and charged business services by companies.

6   Conclusion

Due to the fact, that innovation controlling is becoming a crucial factor for successful innovations in a company to sustain in the business, this literature review gives an overview of relevant approaches and associated metrics in the scientific literature to date. Controlling innovations can be built up in a more static way or as a process by following certain steps or levels. Managing the effectiveness of the innovation process requires a balanced set of metrics which should be related to different innovation dimensions. These dimensions are i.a. the innovation drivers like leadership, culture, and people participation together with innovation results, such as time to market and financial numbers. Executives are encouraged to view the innovation controlling process through a 'business lens' not just a 'financial accounting lens'(Cuthbertson). For the successful control of innovations, managers need to find the right individual amount and combination of metrics as there is no standard set of metrics than can be provided as a template (Shanbhag and Pardede, 2019). Especially the close orientation to the customers should be considered and implemented in the metrics to ensure a more efficient, structured, and effective controlling approach over all innovation dimensions and at different stages of the company (Ries, 2011) (Shanbhag and Pardede, 2019).

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