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Lost in Translation in the Innovation Metrics Landscape: A Review and Framework

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Author Note

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Abstract

As management modes of innovation evolve from in house R&D to embrace open innovation, it is problematic that today's innovation metrics, as reflected in annual statements, do not capture the real investment in innovation, rather they focus on the tangible and more easily identifiable innovation investments. This study reviews the literature on existing measures of innovation and proposes a theoretical framework to facilitate better understanding of proper ways to measure innovation. Considering the dynamic context in which innovation evolves, this paper posits that it is time to introduce a stronger theoretical link in the application-oriented measurements of innovation. The proposed theoretical framework is then used to review the existing measures of innovation. Implications of the proposed theoretical framework and limitations of the study are discussed.

Keywords: innovation metrics, R&D, organizational effectiveness, literature review, competitive advantage

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Innovation is important for the growth and competitiveness of organizations and their survival (Cefis & Marsili, 2006; Cucculelli & Peruzzi, 2020; Dereli, 2015; Porter & Ketels, 2003). It needs to be measured if it were to be efficiently managed (Manoochehri, 2010). Measuring innovation is critical for managers to assess organizational effectiveness, facilitate strategy implementation, create a sustainable competitive advantage, as well as strengthen the creative and innovative capacity of firms (Chiesa et al., 2009; Cordero, 1990; Franco-Santos et al., 2012). Yet, measurement of innovation is challenging due to the complexity of the underlying phenomenon, the industrial context in which it occurs, the diversity and the volume of existing measures of innovation, among others (Adams et al., 2006; Dziallas & Blind, 2019; Manoochehri, 2010).

Despite the variety of the innovation metrics, many are context specific, rarely properly validated and seem more like ad-hoc measures. The complexity of the construct of innovation seems to be the source of issues, impacting proper measurement of innovation. For example, as different operationalizations of innovation capture a variety of aspects of innovation, researchers might obtain conflicting findings (Adams et al., 2006). Measuring innovation with the wrong metrics could be detrimental to the overall success and organizational performance (Adams et al., 2006; Richtnér et al., 2017). When not well crafted, innovation measures could impact creativity and innovation because of emphasis on tangible financial outputs and short-term orientation (Cañibano et al., 2000; Cordero, 1990; Schepurek & Dulkeith, 2013). They can also misrepresent the actual financial standing of a business as well as its future growth prospects (Cañibano et al., 2000).

As management modes of innovation have shifted from in house R&D to embrace open innovation that brings additional challenges to the proper measurement of innovation. For

example, R&D expenses, as reflected in annual statements, do not capture all of the real investment in innovation, and focus on its tangible and more easily identifiable aspects instead. Yet, firms' tangible assets have become less important than intangible ones in terms of generating new products and processes to achieve an edge over the competition (Adams, et al, 2006; Dewangan & Godse, 2014; Edison et al., 2013; Schepurek & Dulkeith, 2013; Park, 2019). Furthermore, with the shift to predominantly service sector dominated economies that problem becomes even more compelling (Evangelista & Sirilli, 1995; Miles, 2007; Sachdeva & Agarwal, 2011). Finally, extant research, using data from the PWC's Global Innovation 1000 Study (Table 1), does not find statistically significant relationship between R&D spending and sustained financial performance and identifies little overlap between the top 10 most innovative companies and the top 10 spenders on R&D (Claudia, 2019).

The complexity of measuring innovation is widely recognized for its impact on organizational performance and management (Neely et al., 2005; Ramírez-Alesón & Fernández-Olmos, 2019). Despite the ongoing efforts, there is still a need for the development and adoption of a more interpretative, theoretically driven approach to innovation measurement (Bititci et al., 2012). This study fills this gap by infusing the management perspective in the extant literature and the proposes a theoretical framework to facilitate the measurement of innovation (Bititci et al., 2012).

The rest of the paper is organized as follows. First, the relevant literature is discussed in the theoretical background section, along with prior efforts, aimed at conducting a systematic review on innovation metrics. Next, the methodology used to identify the relevant sample of papers is explained. Then, drawing on Donabedian's model of performance improvement (Donabedian, 1966), the paper proposes a theoretical framework, that is further used to explain how the innovation measures in the sample of surveyed articles, relate to one another and fit in the overall populations of metrics of innovation. Finally, the paper consolidates the findings with

a discussion of the implications of the review and ends with conclusions and limitations of the study.

Table 1

2016-2018 R&D Spending and Innovation (PwC's Strategy's)

Rank	2016		2017		2018	
	Innovators	Spenders	Innovators	Spenders	Innovators	Spenders
1	Apple	Volkswagen	Apple	Amazon	Google	Amazon
2	Google	Samsung	Google	Google	Amazon	Google
3	Tesla	Amazon	Microsoft	Intel	Apple	Volkswagen
4	Microsoft	Google	Amazon	Samsung	Microsoft	Samsung
5	Amazon	Intel	Samsung	Volkswagen	Samsung	Intel
6	Netflix	Microsoft	Tesla	Microsoft	Netflix	Microsoft
7	Samsung	Roche	Facebook	Roche	IBM	Apple
8	Toyota	Novartis	IBM	Merck	Facebook	Roche
9	Facebook	Johnson&Johnson	Uber	Apple	Tesla	Johnson&Johnson
10	IBM	Toyota	Alibaba	Novartis	Adidas	Merck

Theoretical Background

In the management literature, scholars have made few attempts at reviews and surveys of the existing innovation measures. In one review, conducted by Cordero (1990), a model is proposed that evaluates the resources and the output of innovation as a mechanism of assessing the performance of an organization (Cordero, 1990). The paper is rather descriptive and offers limited discussion on the methodology of conducting the review and accumulation of its sample of performance measures.

Another review, explores and assesses the importance of intellectual capital for organizational performance (Mention, 2012). The focus of this review is somewhat narrow as the construct of innovation is considered as one of the many determinants of organizational performance. Edison et al. (2012) also offer a systematic literature review on the definitions of innovation and its operationalization in the software industry (Edison et al., 2013). While insightful in terms of the practice of innovation, the review is narrow in its scope as it is tied the software industry. Similarly, another "narrow in scope" review paper, grounded in the

manufacturing sector, explores specific innovation indicators and their characteristics (Becheikh et al., 2006).

Keupp et al. (2012) explore the strategic management of innovation and through the utilization of a cluster analysis identify seven important considerations for the future. However, the measurement of innovation concept is somewhat sidetracked as the main idea revolves around the strategic management of innovation initiatives.

The most recent review on the innovation indicators is conducted by Dziallas and Blind (2019) with extensive focus on those metrics, specific to a phase of the innovation process (Dziallas & Blind, 2019). While it explores indicators over an extended period of time, the review does exclude metrics not relevant to the innovation process.

Adams et al. (2006) propose a framework of the innovation management process, comprised of seven categories: inputs, knowledge management, innovation strategy, organization and culture, portfolio and project management, and commercialization (Adams et al., 2006). The review does not offer a description of how the literature was sampled and reviewed but it provides the most comprehensive survey of the innovation metrics in management. The present study extends Adams et al. (2006) effort and continues the review of the innovation metrics where Adams et al. (2006) stop.

Overview of the Literature on Innovation Metrics

Research on measurement of innovation has engaged into a discussion, informed predominantly from **four different perspectives** as summarized in Table 2. Each of the four perspectives has focused on the advancement of specific type of innovation metrics.

Table 2

Perspectives

Perspective	Papers	Indicators
1. Discipline Specific Perspective	Alegre et al., 2009, Archibugi, 1992, Chiesa et al., 2009, Cordero, 1990, Cropley et al., 2011, Dewangan & Godse, 2014, Flor & Oltra, 2004, Hagedoorn & Cloodt, 2003, Miles, 2007, Schepurek & Dulkeith, 2013, Vuolle et al., 2009	Percentage of firms that innovate, Share of sales due to products subject to incremental changes, Share of sales due to products subject to significant changes, Training expenditures, Innovation efficiency, Existence of a Project Champion, Knowledge sharing, Innovation efficacy
2. Organizational Effectiveness Perspective	Cordero, 1990, Kanji, 1996, Maguire & Hagen, 1999, Prajogo & Sohal, 2003, Sachdeva & Agarwal, 2011, Schentler et al., 2010, Subramanian & Nilakanta, 1996	Productivity, Average time from idea submission to commercial launch, Profits to growth, Cycle time, Material cost, Speed of NP development, Mean Number of Innovation adoptions, Mean Time of Innovation adoptions, Consistency of the time of adoption
3. Nature of Innovation Perspective	Alegre et al., 2009, Ali et al., 2012, Canibano et al., 2000, Carayannis & Provance, 2008, Chambers et al., 2002, Chan et al., 2001, Cirera & Muzi, 2020, Eberhart et al., 2004, Flor & Oltra, 2004, Gu & Lev, 2001, Hall et al., 2005, Kogan et al., 2012, Lev et al., 2006, Lev & Sougiannis, 1996, Sander, 2009; Penman, 2009	Resource efficiency, Actual versus planned time to market, Cycle time, Number of patents, R&D Intensity, R&D Expense, R&D Capital, R&D Assets, Increase in R&D Exp, Number of Patents, Number of New Product Introduction, Advertising Expense;
4. Innovation Impact Perspective	Camisón & Monfort-Mir, 2012, Cheng & Shiu, 2012, Crown et al., 2020, Edison et al., 2013, Flor & Oltra, 2004	Number of significant enhancements per year, Number of new processes, New organizational programs, Share of firms engaged in acquisition of machinery, Patents Citations, Honors, Awards, Level of newness of new products,

The discipline specific perspective includes innovation metrics that are context dependent, specific and unique to a particular discipline. Here, researchers examine the effects of innovation in the context of service industries, emerging economies or organizational learning and knowledge management. This perspective encompasses innovation management measurements, which rely on industry-specific instruments, multiple metrics or composite indices such as, level of stuff training, innovation efficiency, innovation efficacy, time span of

technological innovation, new product success rate, creativity, brands, trademarks, knowledge spillovers, among others (Alegre et al., 2009; Archibugi, 1992; Chiesa et al., 2009; Cordero, 1990; Cropley et al., 2011; Dewangan & Godse, 2014; Flor & Oltra, 2004; Hagedoorn & Cloodt, 2003; Miles, 2007; Schepurek & Dulkeith, 2013; Vuolle et al., 2009).

The organizational effectiveness perspective explores innovation measures that capture the productivity in organizations. The measurements in the second perspective are grounded in the decision science and operations management and rely on organizational efficiency instruments. Here researchers, explore the effects of organizational attributes and activities, such as total quality management practices, organizational structure, quality control, productivity, among others, on innovation (Kanji, 1996; Maguire & Hagen, 1999; Prajogo & Sohal, 2003; Subramanian & Nilakanta, 1996). Here, the innovation metrics are strongly oriented towards capturing the effort rather than the effect of innovation. Measures like material cost, time, quality, ability for innovation, customer satisfaction and flexibility, etc., are used for evaluation of the effectiveness and efficiency of organizational performance (Cordero, 1990; Schentler et al., 2010).

The nature of innovation perspective is grounded in the innovation process construct. Here, innovation evolves over certain stages: input, process and output (Cordero, 1990). Frequently used measures of innovation, applicable during the input stage, refer to R&D expense as well as other financial or monetary measures of resources used as input in the innovation process, such as rate of return, market share, new products' sale, new products' success rate, etc. The process stage reflects the transformation of inputs into outputs and is frequently studied through indicators that can account for organizational process management systems and their efficiency. Common metrics of innovation here are resource efficiency, actual versus planned time to market, cycle times, etc. During the final stage of innovation development, other metrics seem to be more informative: patents, citations, publications,

honors, awards, design right applications, trademarks in a given SA-3 region, effects of changes in firm's R&D activity on the trading volumes of their stocks, firms' technological output through patents granted as well as the consequent patent citations (Alegre et al., 2009; Ali et al., 2012; Carayannis & Provance, 2008; Chambers et al., 2002; Chan et al., 2001; Cirera & Muzi, 2020; Eberhart et al., 2004; Flor & Oltra, 2004; Gu & Lev, 2001; Hall et al., 2005; Kogan et al., 2012; Lev et al., 2006).

Finally, the innovation impact perspective, encompasses studies focused more on the effort, the level of commitment and the risks involved in the development of innovation. The metrics may be very diverse as the scale of the innovation effort and effect changes. Here, researchers commonly employ metrics that are context specific to properly capture the actual innovation effort: number of significant enhancements per year, number of new processes, share of firms engaged in acquisition of machinery, among others (Camisón & Monfort-Mir, 2012; Cheng & Shiu, 2012; Crown et al., 2020; Edison et al., 2013; Flor & Oltra, 2004).

Methodology

Since the purpose of the paper was to infuse the management perspective into the innovation measurement inquiry, the review was constrained on those areas of research that have spilled over to the domain of management. This was driven by a number of considerations. On one hand, the topic was too huge to be covered in one paper if the review were to be done properly. On the other hand, as the vast majority of innovation research was conducted in the context of organizations, then the field of management provided natural, most appropriate context for assessing and evaluating the stock of knowledge on innovation metrics. Lastly, the problems with measuring innovation and its performance are fundamental considerations that executives face.

The review of the extant research was conducted following Linton and Thongpapanl (2004) approach. First, the top 25 most-cited technology and innovation management research

journals were identified (Linton & Thongpapanl, 2004; West & Bogers, 2014). Next, for each journal, the author manually reviewed all issues from 2006 to 2020 to identify articles that measure innovation. The review was restricted to issues after 2006 as a prior review paper had surveyed the literature on innovation measurement until 2006 (Adams et al., 2006). As a robustness check all references in the final sample were carefully examined to ensure all eligible articles were included in the review. A total of 241 articles were identified.

Three exclusion criteria were applied. First, papers, which did not focus on measurement of innovation as a central theme, were eliminated. Second, following existing research, the sample was restricted to only papers published in a peer reviewed journal (Mention, 2012). Lastly, the paper focused on articles in English only. Applying the exclusion criteria, a total of 124 studies were retrieved as the final sample of papers, which served as the basis for the review.

Next, the author analyzed each paper in the sample to identify and extract the innovation metrics. In addition, each innovation measurement was classified as either quantitative or qualitative, depending on the nature of the data that constitutes the measure (Alegre et al., 2009). Furthermore, it was categorized as an output, process or structural innovation metrics, depending on the Donabedian's typology of metrics (Donabedian, 1966). An excel database was created to incorporate all extracted innovation metrics.

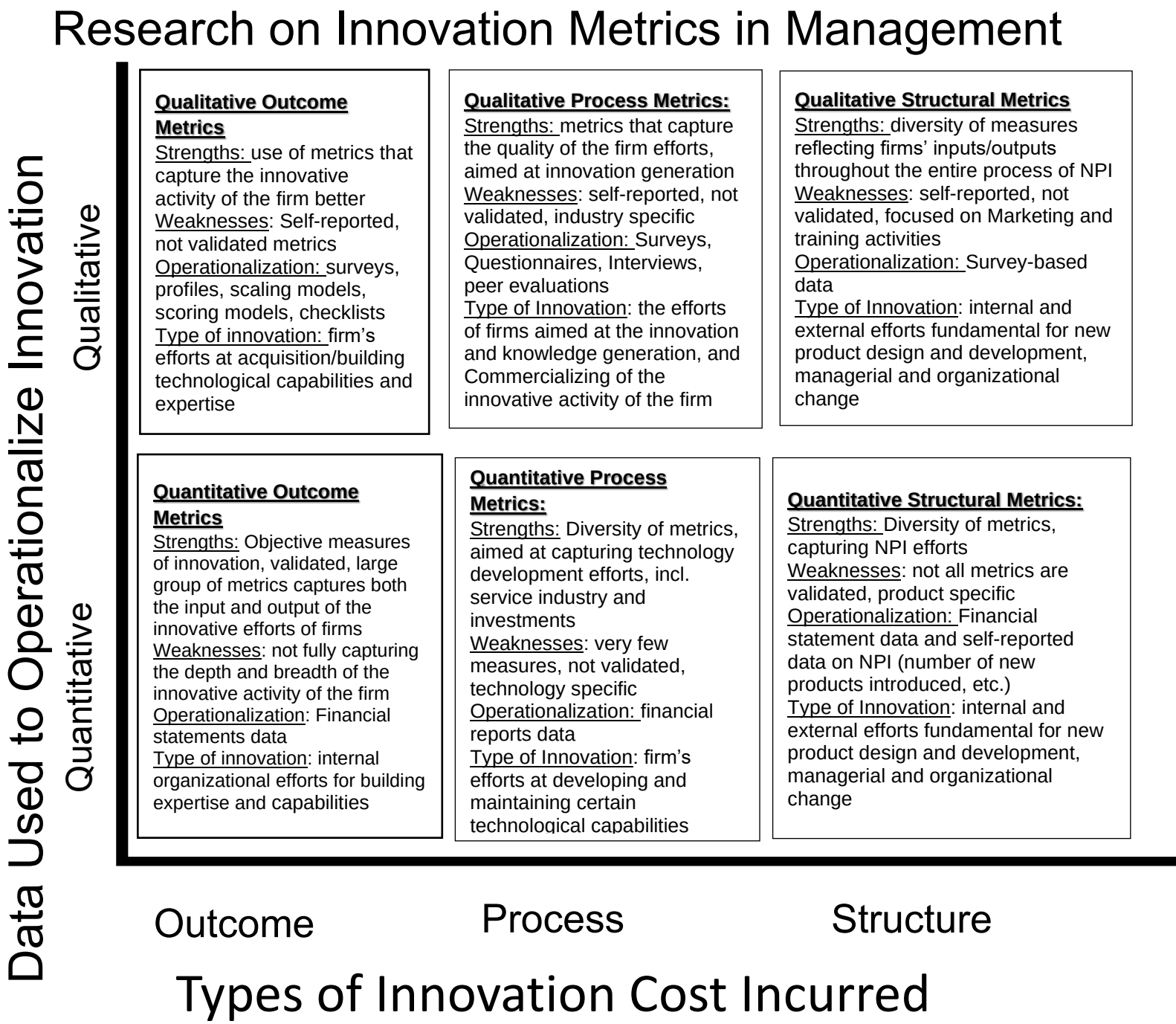
The review of the surveyed body of literature led to three important conclusions. First, that research on measuring innovation was fragmented. Second, same measures were labeled differently or operationalizations of different underlying phenomena were masked as the same measure. Finally, in the process of reviewing the papers, two distinct patterns of variations emerged. The papers varied by the type of innovation cost, incurred by the organization initiating the innovative activity and by the type of the data, utilized for generation of the metrics.

To better analyze the fragmented literature on innovation metrics, Donabedian's highly impactful theoretical platform was employed. In his work on assessing effectiveness of organizational performance, Donabedian proposes a typology of metrics that organizations need to employ. This typology is based on three general types of indicators: (1) those based on outcomes, (2) on processes, and (3) on structures. The outcome indicators relate to the effect of organizational activities on materials or objects, focus on the end result, and capture variables like quality, efficiency and productivity. The second type of indicators refers to the quantity or quality of organizational activities, carried on by organizations. These indicators are known as process measures and they assess effort over effect. The last type of indicators, the structural indicators, assess the capacity of the organizations for effective performance. Here, the focus is on continuous and open exchange with the environment. The indicators emphasize flexibility, adaptability and information processing (Donabedian, 1966).

Donabedian's typology is appropriate for two reasons. First, the phenomenon of innovation is known to evolve over time through a number of stages, which is closely related to the output and process type of indicators, as proposed by Donabedian (1966). Second, one of the perspectives of the existing innovation metrics is grounded in the idea that type and scope of innovation are impactful, context dependent and pose specific issues for proper measurement of innovation. This perspective is strongly correlated with the last group of indicators, discussed by Donabedian: the structure measurements or the indicators of the scope of organizational effectiveness.

Applying the Donabedian's typology in the context of the literature review on innovation metrics in management, a two-dimensional framework was developed (Figure 1). The two analytical dimensions were: (1) the type of innovation cost incurred in the production or generation of innovation and (2) the methodological assumptions about the nature of the data used for capturing the underlying phenomenon of innovation.

Figure 1
The Proposed Framework



The first analytical dimension refers to the type of innovation cost incurred in the development of innovation, i.e. the source of innovation. This dimension captures the differences in existing research in terms of the origin of innovation. Innovation can occur in the form of activities of different nature. For that reason, the performance improvement typology of indicators is quite fitting as it offers a potential mechanism for differentiating between the various types of innovation.

The second analytical dimension, quantitative vs qualitative type of data, captures the distinctions between the nature of the data that constitutes the measure (Alegre et al., 2009). For the metrics, based on qualitative data, the cost of innovation is commonly perceived as a proxy for the level of innovative effort. Metrics, utilizing qualitative data frequently reflect the sum of R&D expenditures, the investment in acquisition of technology, training costs as well as the costs for tooling-up and marketing of new products (Rogers, 1998). For the quantitative data, innovation is commonly measured with proxies, grounded in the tangibility and objectivity of the underlying phenomenon, such as patents, licenses, trademarks, etc.

Crossing these two dimensions, six categories of “innovation metrics” are identified: (1) quantitative outcome metrics, (2) qualitative outcomes metrics, (3) quantitative process management metrics, (4) qualitative process management metrics, (5) quantitative structural metrics, and (6) qualitative structural metrics. Each innovation metrics is mapped along the framework. Finally, the paper analyzes the metrics within each category as well as their characteristics and overall distribution trends.

The contribution of the framework is threefold. First, the framework offers an overview of the existing research on metrics of innovation. Second, by comparing and contrasting the different types of incurred innovation costs, the framework reveals the tensions among these different sources of innovation, and emphasizes the emergence of specific pattern that are otherwise difficult to observe. Third, by mapping each innovation metrics on the framework

space, this paper further advances the existing research by facilitating understanding of the linkages and overlaps between the existing innovation metrics.

Findings

The review of the measures, assigned to each of the six categories of innovation metrics revealed a number of characteristics and trends, discussed next.

Quantitative Outcome Metrics

The measures assigned to this group are objective and capture the effect of innovation. These metrics are quantifiable measures of innovation, which rely on data that can be accessed through financial statements. Some of the metrics of this category are financial objective measures, such as profits, market share, sales, rate of return, present value, Innovation ROI, Tobin's Q and other financial outputs, as well as firm performance indicators (Cañibano et al., 2000; Cordero, 1990; Dziallas & Blind, 2019; Manoochehri, 2010; Rogers, 1998; Schepurek & Dulkeith, 2013). Other measures that fall in this category are metrics, relevant to new product introductions in organizations. They are fundamental for capturing the internal technological efforts and capabilities in terms of product design and trial production (Evangelista et al., 1998). Metrics that are classified here are number of new products introduced, the rate at which new products or services are being launched, the ratio of selected ideas to ideas submitted (Dewangan & Godse, 2014). Because of the difficulty in understanding or clearly distinguishing between the cause and effect in every organizational activity, these types of indicators are more difficult to interpret.

Qualitative Outcome Metrics

This category of metrics is similar to the quantitative outcome metrics as they capture the effect of innovation. However, the metrics in that category are not derived from objective measurements. Some qualitative outcome metrics are: self-reported survey-based measures of number of new technologies introduced, the time span of technological innovation, improvement

in product quality as a result of innovation. (Brattström et al., 2018; Brouwer & Kleinknecht, 1997; Cordero, 1990; Dziallas & Blind, 2019; Edison et al., 2013).

Quantitative Process Management Metrics

The third large group of innovation metrics refers to the internal organizational efforts and capabilities, focused on research and development, acquisitions of patents and licenses, as well as marketing, advertising and commercializing of the innovative activity (Schepurek & Dulkeith, 2013).

The quantitative input measures are expected to assess tangible, raw materials needed for the development of innovation. Such measures reflective of the innovation input, are R&D expenses, R&D intensity, the ratio between expenditure and numbers, employed in R&D roles. In terms of the outcome of innovation or the technological capabilities of firms, the evidence finds frequent utilization of intellectual property metrics, like trademarks, goodwill, brands, inventions, scientific publications, etc. (Archibugi, 1992). In addition, among metrics that offer insight on the outcome of a knowledge development innovation in the extant research, the paper identifies measures of innovation such as licenses for acquisition of technology from others, patents and citations (Brouwer & Kleinknecht, 1997; Dewangan & Godse, 2014; Dziallas & Blind, 2019; Schepurek & Dulkeith, 2013). These metrics reflect the way organizations' systems and processes work to deliver the desired outcome.

Qualitative Process Management Metrics

The group of qualitative innovation measures, is specifically grounded in a survey-based approach to studying innovation. Commonly utilized process management metrics seem to rely on a number of self-reported scores or self-assessed percentages, and may combine many facets of innovation. Among the innovation metrics, examined as part of this category, qualitative measures such as profiles, scaling models, scoring models and checklists are assigned (Cordero, 1990; Dziallas & Blind, 2019; Rogers, 1998). Another key measure of the

innovation input, based on survey data is the self-reported metrics of number of ideas produced (Rogers, 1998).

Quantitative Structural Metrics

The fifth group of measures relates to the innovation incurred costs for purchase and use of technologies, embodied in plants, machinery and equipment. Here, frequently assigned metrics would be indicators that are applicable not only to the manufacturing industry but also to the growing number of service industry segment (Evangelista et al., 1998). These are the type of indicators that provide information for the capacity of the organization to generate and commercialize innovation. Other metrics further classified here are: investment in IT or the development of software products, specialized business services and other high-technological products (Coombs & Miles, 2000; Dziallas & Blind, 2019; Edison et al., 2013). Other quantitative metrics that belong to this category are the expenditures on tooling-up, industrial engineering and manufacturing start-ups, related to new products introduction (Rogers, 1998).

Qualitative Structural Metrics

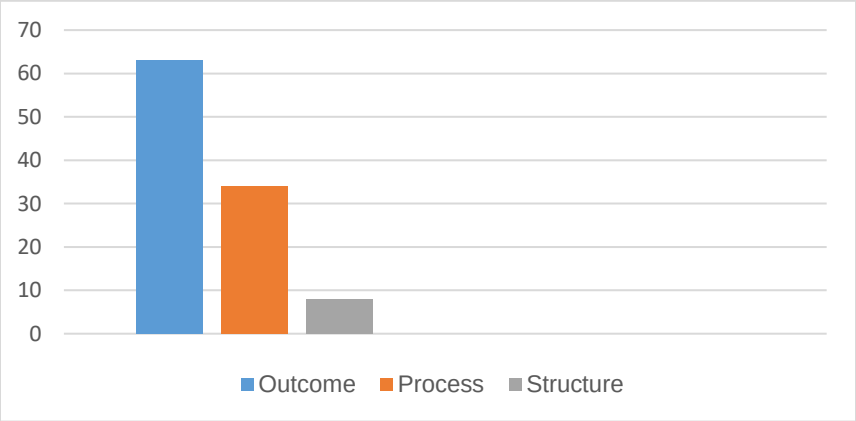
In the final group of metrics, fewer measures are assigned as qualitative structural measures. One such measure is the Innovative work behavior measure that evaluates the innovation generation input in four areas, such as idea exploration, idea generation, idea championing and idea implementation (Schepurek & Dulkeith, 2013).

Similarly, on the qualitative side of the measurements addressing structural metrics scholars have also utilized peer evaluations completed by managers or technical experts to measure the technological development capabilities (Cordero, 1990). In addition, self-reported managerial and organizational change expense measures belong to that category of innovation metrics. Among the qualitative new product development metrics, assigned in this category are the self-reported marketing and training expenditures relevant to new product introduction as extracted from survey-based data (Brattström et al., 2018; Brouwer & Kleinknecht, 1997).

Next, the paper discusses the emerging trends in the six categories of innovation metrics. One important pattern of variability that emerges out of the review is related to the distribution of metrics per category. It appears that the volume of innovation metrics is unevenly distributed over the framework categories, as shown in Figure 2.

Figure 2

Distribution of Metrics per Aggregate Category



There are more quantifiable metrics than qualitative or self-reported metrics. In addition, the number of process and structural metrics of innovation is limited. Innovation metrics based on outputs and hard data seem to be the most developed and widespread group of metrics. It is likely due to the ease of access of publicly available data and of the traditionally stronger influence of the fields of accounting and finance on the performance measurements research (Dziallas & Blind, 2019).

The second most populated category of innovation metrics is the quantitative process management group of metrics. While it is not as strongly developed as the output metrics group, measurements of innovation that belong in this category can be traced back to the rational decision-making science and operations management field (Scott, 1981). The number of metrics in this group is smaller than the number of outcome metrics group. Furthermore, it appears that to be the group with the greatest variety of types of innovation measurements.

Finally, the least populated group of innovation measures is the third category of quantitative innovation metrics, encompassing metrics based on assessing the structural capabilities of the organization. It has started to gain prominence in extant research only recently. Main reason for this trend is likely the difficulty in distinguishing the structural characteristics of organizations that impact innovation.

Another important finding is that both the outcome and the process innovation metrics appear to be application or practice oriented, predominantly ad hoc measurements while the structural innovation metrics are more theoretically driven in their origins. The review further suggests that the structural innovation metrics are predominantly developed and proposed in the technology and innovation management research streams.

Discussion and Conclusions

This paper surveys the literature on innovation metrics in management from 2006 to 2020. Prior studies have offered a number of reviews, limited in their scope of exploration of innovation metrics and focused on indicators, capturing innovation input/outcomes and/or innovation process. This study uses the comprehensive model of performance improvement introduced by Donabadian (1966) to expand the boundaries of the review of innovation metrics beyond the input-process-output logic.

The scarcity of metrics of innovation that track the structural characteristics of organizations and capture their interaction with the external environment is a limitation that should be addressed by practitioners and academicians.

With the paradigm shift towards “open system” organizations and open innovation that brings additional challenges to the proper measurement of innovation. New metrics are needed to capture the real investment in innovation, with focus on its intangibility, market orientation and track the organization’s interaction with the external environment and its ability to learn and

grow (Dewangan & Godse, 2014; Kristiansen & Ritala, 2018; Park, 2019; Richtner et al., 2017; Tadeu & Silva, 2014).

Traditionally employed measures of innovation, based on financial outputs, dominate the landscape of innovation metrics. There are many problems with metrics based on financial outputs. For example, they cannot properly demonstrate the specific innovation contribution since the financial outputs occur with a significant delay (Schepurek & Dulkeith, 2013). They also impact creativity and innovation in firms because of the restrictive emphasis on tangible financial outputs (Cordero, 1990; Schepurek & Dulkeith, 2013). Moreover, these measures overemphasize the short-term orientation of managers, driven by their bonuses and financial incentives (Cañibano et al., 2000; Schepurek & Dulkeith, 2013). Traditional indicators are focused on the input or output of innovation, are static and fail to capture the process of innovation or what happens inside the firms (Bhatti et al., 2008; Schentler et al., 2010).

The paper proposes a theoretical framework, grounded in the Donabedian's work on organizational effectiveness and the surveyed body of diverse innovation metrics, that facilitates the weaving of useful bits and pieces of extant research together into an integrated and less fragmented scholarship (Cordero, 1990; Keupp et al., 2012). The proposed framework will address calls in the extant research for the development of a more theoretically driven innovation metrics in respond to the complexity of the modern innovation technology field (Neely et al., 2005).

The proposed theoretical framework makes it possible to see the relationship between the categories of innovation metrics and the four perspective that emerged in the extant literature. It appears that the outcome measures of innovation are mostly the ones that belong to the innovation impact perspective. Moreover, the process innovation indicators from the proposed framework seem to dominate the efficiency of organization perspective and partly the

discipline specific perspective. The metrics of innovation that are lacking in the literature are the structural innovation metrics, which are also specific to the nature of innovation perspective.

These results may be explained with the ease of access and convenience to publicly available data. Availability of data may further drive the dominance of specific group of indicators over another metrics category. Since researchers are more likely to get a hold of data from financial statements, outcome and some process innovation metrics are quite widespread, and easy to discuss. However, these metrics are less efficient in explaining the underlying causes of the problem and are not easy to interpret as they do not offer much insight into what is going on within the particular organization (Dziallas & Blind, 2019).

The results of the paper further suggest that more discipline specific measures are being used especially in the category of process and structure indicators. These outcomes can be explained with the difficulty to measure the process and structure of innovation with concrete values that can be generalized beyond the specific organizational context.

Finally, structural innovation metrics that would be appropriate to capture the potential growth and success of innovation are severely lacking. This is likely due to the fact that data on the structural aspects of organizational performance capacity are not easily available, which further challenges the measurement of innovation.

Limitations and Future Research

The process of measuring innovation is a complex one, involving quantifying, evaluating and benchmarking innovation competence and practice of an organization (Adams et al., 2006). Organizational innovation capabilities depend on many factors from the external and internal environment. Because of these many determinants of the success of innovation, measuring innovation is and will always be challenging. Despite the fact that a great proportion of the existing studies addresses the measurement of innovation, the results of the surveyed papers suggest that traditional outcome measures dominate the landscape of innovation metrics. With

the shifting context of innovation and the transformation of the economy to reflect the global and digital age reality, practitioners and executives need better metrics to capture the underlying phenomenon of innovation.

While the proposed theoretical framework does offer direction and a recipe for scholars and practitioners to use better measures of innovation, the paper stopes short of developing universal or more generalizable innovation metrics from the structural innovation metrics category. Another limitation of the paper is that the review was conducted through a survey of the 25 highly cited journals in the field of management and technology field. Using a larger sample of journals may have offered different sample and results.

As structural characteristics and capabilities of organizations could impact the overall organizational innovation capabilities, it becomes imperative for managers and executives to understand the shifting context of innovation and how it can impact the innovative activity of their organizations. In addition, this paper implies that managers and executives should utilize and rely more on a set of measures that can provide insights for their structural organizational capabilities, alongside the information collected from “ad hoc” performance measures. In this context, there many opportunities for future research. Much work needs to be done in the development of more generic structural innovation metrics and metrics that capture the potential for innovation and growth.

In addition, considering the sheer volume of publications on the topic of innovation metrics and the fragmented state of the extant research, future exploration on this topic are needed, especially research effort that is driven by theory.

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