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20th Anniversary Invited Article

Innovation and New Product Development: Reflections and Insights from the Research Published in the First 20 Years of *Manufacturing & Service Operations Management*

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Abstract. In this short essay, we reflect on the innovation-related studies that have appeared in *Manufacturing & Service Operations Management* (M&SOM) in its first 20 years of publication and consider the future work that M&SOM could publish in this domain. Innovation management can be defined broadly enough to encompass the efforts of organizations to effectively design and develop novel solutions to existing or new needs. Several different approaches and thematic lenses have emerged in the academic community to address diverse questions in innovation management; however, the work published in M&SOM has a narrow focus. This gap reveals an opportunity for the M&SOM community, which may be addressed in part by improvements in the review process of the journal. We also suggest some specific innovation topics that the researchers in the community might tackle.

History: This paper has been accepted for the *Manufacturing & Service Operations Management* 20th Anniversary Special Issue.

Keywords: innovation • new product development • product design • service design • business model innovation

Introduction

In its broadest sense, *innovation* represents a novel match between a solution and a need. When successful, innovation creates value for the solution-seeking entity. Whereas in the majority of cases the created value represents a financial return, this need not be the case, and some organizations seek only to create social value through innovation. The management of innovation comprises efforts to create and operate effective and efficient organizational processes for recognizing needs, creating solutions, and/or matching existing solutions and needs. As with any organizational process, differences in competitive environment, organizational context and capabilities, and technological domains can lead to substantial variation in practice.

Innovation may occur *internally* within an organization—developing and improving solutions for doing business better, faster, and less expensively—or *externally*—developing and improving products and services for customers. One can also view innovation at the level of an industry or society generally, in which case multiple institutions participate in creating and improving solutions to address societal needs.

Management scholars have taken descriptive and prescriptive approaches to studying innovation at various levels of analysis, be it the industry level, the

firm level, or the level of individual projects that seek to achieve a certain innovation objective (Chao and Lenox 2018). The resulting academic literature has tried to capture differences in approach through several classification schemes, be it process versus product innovation (Utterback and Abernathy 1975), incremental versus radical innovation (Ettlie et al. 1984), or others (Chandy and Prabhu 2010).

Innovation and the Operations Management Community

The operations management (OM) community has participated to some extent in the field of innovation management since its early days. Starting with the work of scholars in the 1980s and 1990s (Clark and Fujimoto 1991, Wheelwright and Clark 1992), the innovation subfield of *managing new product development* emerged (Krishnan and Ulrich 2001, Loch and Kavadias 2008). These studies adopted a process perspective focusing on the design and development of new products and led to the formation of a critical mass of OM researchers. Eventually, this group established a recognized community within OM, which led to the foundation of the Research and Development (R&D) and Product Development Department in the journal *Management Science* in 2001

as well as the Department of R&D, New Product Development, and Project Management in the journal *Production and Operations Management (POM)* (Kavadias 2014).

Starting with this historical activity in the domain of product development, OM researchers have extended their approach to broader questions of innovation management. Shane and Ulrich (2004), in their contribution to the celebratory issue for the 50th anniversary of *Management Science*, identified the need to expand the set of questions explored, a call that was taken to heart by the community. For example, the studies that appeared in the focused issues published by both *Management Science* in May 2008 and *POM* in 2014 contain an assortment of themes much broader than product development.

Within the same timeframe, *Manufacturing & Service Operations Management (M&SOM)* was founded by INFORMS (also the publisher of *Management Science*) to focus on research in OM given the fact that the original home for much of OM research, *Management Science*, was fast growing into a journal with a much broader audience and scope. Given its origins and the original community that it served, *M&SOM* initially attracted primarily work on product development. In fact, one of the inaugural papers accepted in the second issue of its first volume in 1999 was a product development study by Krishnan et al. (1999) entitled “Model-Based Approach for Planning and Developing a Family of Technology-Based Products.” Since then, *M&SOM* has featured a broader assortment of work on innovation, and as of 2016, Chris Tang (editor-in-chief) focused one of the journal’s departments on innovative operations, currently edited by Hau Lee (Tang 2015).

Innovation and Product Development Research in *M&SOM*

The 20th anniversary of *M&SOM* offers a natural milestone for reflection. As we have already noted, the *M&SOM* community welcomed the study of some aspects of innovation from its formation, but how did that warm start evolve over the years? Did *M&SOM* attract significant numbers of submissions from the innovation community? And what type of work did it attract?

Such reflection could prove useful along two dimensions. First, it helps us understand whether the journal has attracted, incubated, and delivered insightful contributions to innovation management challenges. We have both served as department and associate editors for innovation and product development departments across different journals, and a key question that looms large for editors is how to publish impactful papers. A reflective analysis of the journal’s past publications could help in understanding

how to enhance impact. Second, an analysis of the past might offer insights as to where additional research could focus, either because of thematic gaps that researchers could address or because of the natural next steps from previous research.

In our analysis, we do the following:

1. Consider the entire set of papers published by *M&SOM* to identify those in the broad category of innovation, of which new product development is a subcategory

2. Classify the identified papers into themes using previously published taxonomies

3. Compare the publication statistics of *M&SOM* over the past 20 years with comparable numbers from other premier journals in OM

In the first step, we have identified the research studies that explored and analyzed topics that relate to innovation. Based on keyword searches and manual scanning of all 651 papers published in *M&SOM* over the past 20 years, we identified a subset that could reasonably be considered related to innovation management. Then, based on a careful review of these papers, we finally selected 30 research papers that we believe are directly related to innovation. This approach was modeled on the approach taken by the four overview papers that have appeared in the last 20 years across the OM journals with innovation and product development departments (Krishnan and Ulrich 2001, Shane and Ulrich 2004, Krishnan and Loch 2005, Kavadias 2014). The 30 papers identified had 63 unique authors.

Per our second step, we have listed the 30 papers in Table 1, and we categorized them based on an adaptation of the taxonomy developed by Krishnan and Ulrich (2001) and Krishnan and Loch (2005). The categories follow:

- *Competitive strategy*. Some manuscripts have sought to understand how to position their products—usually characterized by a vector of performance quality variables—relative to competitive offerings.
- *Design and market positioning*. The preceding category was often combined with an analysis of what the optimal firm “design” decision should be. The usual proxy was again a vector of performance quality dimension in the spirit introduced by the earlier work of Moorthy (1988) and subsequent followers.
- *Resource allocation*. Some studies have focused on allocation of resources within innovation projects. Whereas research in resource allocation could also capture multiproject settings (Kavadias and Chao 2008), the papers published in *M&SOM* have typically considered *within-project* resource allocation decisions.
- *Project contracts*. Motivated by the supply chain contracting literature, a few studies sought to understand contractual structures between different parties in projects. Interestingly, *M&SOM* recently

Table 1. Categorization of *M&SOM* Innovation Publications, 1999–2019

Year	Title	Authors	Comp. strategy	Design/ positioning	Resource allocation	Project contracts	Performance	Entrepreneurship
1999	A model-based approach for planning and developing a family of technology based products	Krishnan et al. (1999)		x				
2000	Sustaining technology leadership can require both cost competence and innovative competence	Schmidt and Porteus (2000a)	x	x				
2000	The impact of an integrated marketing and manufacturing innovation	Schmidt and Porteus (2000b)	x					
2000	An analysis of several new product performance metrics	Cohen et al. (2000)					x	
2001	Quality and time-to-market trade-offs when there are multiple product generations	Morgan et al. (2001)					x	
2003	Managing variety for assembled products: Modeling component systems sharing	Ramdas et al. (2003)		x				
2004	New product introduction: Timing, design and pricing	Klastorin and Tsai (2004)		x	x			
2005	Product line selection and pricing with modularity in design	Hopp and Xu (2005)	x	x				
2006	Timing successive product introductions with demand diffusion and stochastic technology improvement	Krankel et al. (2006)			x			
2006	Product line design with component commonality and cost-reduction effort	Heese and Swaminathan (2006)	x	x				
2007	Project performance and the enabling role of information technology: An exploratory study on the role of alignment	Bardhan et al. (2007)					x	
2008	Design architecture and introduction timing for rapidly improving industrial products	Ramachandran and Krishnan (2008)		x				
2008	Mass customization vs. mass production: Variety and price competition	Alptekinoğlu and Corbett (2008)		x				
2010	Leadtime-variety tradeoff in product differentiation	Alptekinoğlu and Corbett (2010)		x				
2010	Project management contracts with delayed payments	Kwon et al. (2010)				x		
2013	A population-growth model for multiple generations of technology products	Li et al. (2013)					x	
2013	Business model innovation for sustainability	Girotra and Netessine (2013)	x					
2012	The role of modular upgradability as a green design strategy	Agrawal and Ülkü (2012)		x				
2013	Linking cyclical quality and product quality	Sosa et al. (2013)					x	
2014	Optimal design of coproductive services: Interaction and work allocation	Roels (2014)		x		x		

Table 1. (Continued)

Year	Title	Authors	Comp. strategy	Design/ positioning	Resource allocation	Project contracts	Performance	Entrepreneurship
2015	Dynamic knowledge transfer and knowledge development for product and process design teams	Özkan-Seely et al. (2015)			x			
2015	Incentive contracts in serial stochastic projects	Chen et al. (2015)				x		
2015	The limits of planned obsolescence for conspicuous durable goods	Agarwal et al. (2015)		x				
2016	Optimal time allocation for process improvement for growth-focused entrepreneurs	Yoo et al. (2016a)			x			
2016	The time–money trade-off for entrepreneurs: When to hire the first employee?	Yoo et al. (2016b)						x
2017	Clinical trials for new drug development: Optimal investment and application	Kouvelis et al. (2017)			x			
2017	The car sharing economy: Interaction of business model choice and product line design	Bellos et al. (2017)	x	x				
2017	Contract theory: Impact on biopharmaceutical alliance structure and performance	Taneri and De Meyer (2017)				x		x
2017	R&D investments in the presence of knowledge spillover and debt financing: Can risk shifting cure free riding?	Ning and Babich (2017)	x					
2017	Decision structure and performance of networked technology supply chains	Wang et al. (2017)	x	x				

published an empirical study of biopharma contracts (Taneri and De Meyer 2017), a widely studied topic in strategic management (Rothaermel and Deeds 2004).

- *Performance.* A few studies have assessed innovation performance both at the project level and at the firm level.

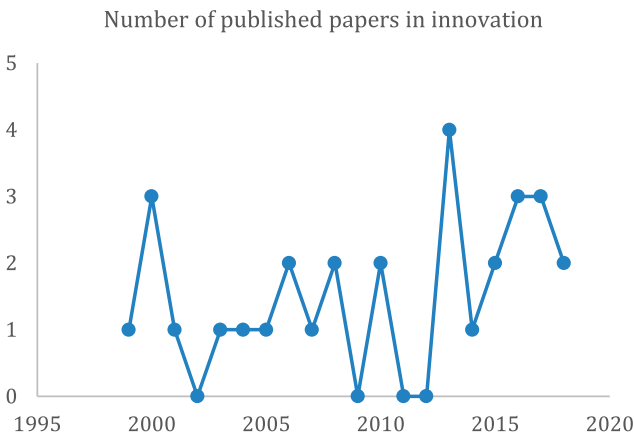
- *Entrepreneurship.* Very recently, two studies explored the operational challenges faced by entrepreneurial ventures, a contextual domain that has seen very little work within OM.

In the third step, we calculated basic statistics regarding the innovation publications at *M&SOM* so that we could compare with similar statistics in other premier OM journals. To date, 4.6% of the papers published in *M&SOM* fall into the category of innovation. *POM* has published 51 innovation papers in its first 20 years (data are compiled based on Krishnan and Loch 2005 and Kavadias 2014), having founded a department on the topic in 2005. If we include the papers from the sister department, Management of Technology, then the innovation papers get to a total of 80, which comprises 12% of 668 original research papers that have appeared in the journal. From 2007

to 2017, *Management Science* published 98 innovation papers out of a total of 1,320 papers, an appearance rate of 7.4%. However, just 46 of those papers on innovation management originated from and used methodologies from the same community as the one that publishes in *M&SOM*, an appearance rate of 3.5% during that decade.¹ Thus, *POM* published a significantly higher fraction of papers related to innovation than did *M&SOM*. Although *Management Science* published a higher fraction of papers on innovation overall, if we focus on comparable communities of scholars, *Management Science* published papers on innovation management at a lower rate, similar to that of *M&SOM*.

From a time-series standpoint, we see that in the case of *M&SOM*, although the number of papers is still small, publication rates may be trending upward (Figure 1). From a topical standpoint, it seems that most of the papers that appeared in *M&SOM* have focused on three major themes: product design and positioning, resource allocation problems, and contractual relationships between different parties during projects and innovation activities.

Figure 1. (Color online) Number of Papers Published in Innovation in Each *M&SOM* Issue



Whereas the resource allocation analyses and the optimal contractual studies point directly to topics that have deep roots in OM, the large number of studies in competitive positioning and design suggest a different story. Within the broader OM community (as expressed through the selection of which papers get published), the topic of innovation might be equated with product positioning as represented by performance quality. In fact, this particular type of product positioning model emerged primarily from the marketing literature (Moorthy 1988) and therefore aligned more closely with the marketing strategy literature than with the topic of innovation. This limited view suggests the need to cultivate further understanding about other operational challenges within innovation. Notwithstanding the historical focus, a positive sign is that more recent publications seem to address more far-ranging topics: for example, service design (Roels 2014), entrepreneurship (Yoo et al. 2016a, 2016b), and R&D intensity (Pennetier et al. 2019).

M&SOM: Past Performance and Open Questions

These insights give rise to several questions that both *M&SOM* and the innovation and product development community within OM should ponder as the journal enters into its next stage of expansion and growth. We pose a few of them here in an attempt to fuel the discussion about the future.

- What is the argument for including innovation and new product development within the domain of service and operations management? Is innovation an “operational” topic of interest?
- Is the rate of publication sufficient to support the argument for a continuous presence of innovation and product development papers in *M&SOM*? Or does the relatively low rate of publication point to a challenge?

- If indeed a challenge is too few papers, how might the publication rate be increased?

We explore these questions in the next sections.

Should Innovation and New Product Development Be Within the Scope of *M&SOM*?

We start with the existential question: should the study of innovation and product development be part of the operations management research community? We answer yes for two reasons. First, the mere reality that improving firm performance typically benefits from joint solutions across the functions of product development and operations. Therefore, the study of operations must include an understanding of product development. Second, innovation and new product development are processes themselves (Cooper 1994, Eppinger and Ulrich 1995). Therefore, OM tools and methodologies could offer insights into the improvement of new product development and innovation processes.

Is the Rate of Innovation Publications in *M&SOM* Appropriate?

A thorough consideration of supply and demand informs the question of what the appropriate publication rate is. On the supply side, are there interesting and relevant papers being submitted to *M&SOM*? Table 1 is a positive sign. The topics explored seem to be diverging toward a broader and more diverse sets of problems (e.g., entrepreneurship). On the demand side, are there open problems for innovation researchers and, more specifically, for innovation researchers with an OM perspective? On that dimension, the answer seems to be more emphatically positive. Innovation seems to be more relevant than ever as the post-financial crisis economies seek to establish new sources of value creation at a macroeconomic level (Hausman and Johnston 2014) and as technological developments seem to be resetting business models across various industries (Kavadias et al. 2016). Moreover, because of technological changes in business models, the “details” of operational execution have become extremely important. We therefore posit that a lot of value to managers could be brought through innovation research conducted by the *M&SOM*² community. Of course, the appropriate level of publications in any period also depends directly on the size of the subcommunity that seeks to answer the key research questions. Given how headcount is established in universities and the time lags associated with training new scholars, the size of the academic community does limit the rate at which research is completed. Furthermore, because of the finite set of elite academic journals in a given field and the long period required to establish new prestigious journals, the total number of articles

published is to a large extent a constant sum across fields and across journals.

How Might the Rate of Publication Be Increased?

As a final point in this reflection of the published innovation studies in the first 20 years of *M&SOM*, we explore structural ways by which the rate of good publications could be enhanced. We draw an analogy between innovation processes and the publication process.

Publications as Research Projects. Research papers (candidate products or services in our analogy) come from ideas generated by different scholars (entrepreneurs and innovators). Then they are subjected to the scrutiny of topical fit (strategic fit) and academic quality (performance) by the editorial board (executives or investors). A positive selection decision from the editors (executives or venture capitalists) enters the papers into the review process (design-build-test iterative development) with the objective to converge into new published papers (launched innovations). The eventual success or failure of the products depends on market adoption in the same way that the success or failure of papers manifests itself through their eventual citation count and influence on scholarship and practice over time. Given this analogy as a framework, we can now explore how interventions in each phase of innovation could enhance the numbers and quality of the papers published.

Ideation. Ideation challenges always happen around the number and diversity of the idea pool (Kornish and Ulrich 2011, Erat 2017, Kornish and Hutchison-Krupat 2017). This translates into the question of how the number and diversity of innovation papers could be increased. The current relatively low rate of publications could derive from the journal's editorial statement, which recently added further clarity that innovation and product development papers are welcome (and often there is a lag for such messages to reach the ideator audience). Low rates could also stem from the journal's past performance in publishing innovation research, a signal to researchers about the receptivity of the journal to their work. Given such challenges, we can draw on the managerial insights about improving the organizational culture of innovation, starting with an explicit executive-level statement about the importance of innovation in general (Hutchison-Krupat 2017) and the direction of focused efforts toward particular problem areas (Terwiesch and Ulrich 2009); the editorial equivalent of the former is this essay for the celebration issue of *M&SOM*, whereas the latter could happen through a special issue on innovation topical interests.

Selection. Paper publications depend heavily on the selection criteria applied by the editorial boards. Whereas some of these criteria might be relatively clear and objective (e.g., "Is the research methodology applied correctly?"), certain other criteria represent more subjective dimensions (e.g., "Does the study contribute to the operations management field?"). Effective selection implies a balance across these different dimensions (Kavadias and Chao 2008), and the challenge echoes similar difficulties in corporations, where innovation projects need to achieve short-term returns but also offer good strategic fit or long-term growth. As in corporations, very few truly novel research projects will clearly match the editorial objectives of the journal. This may lead to few such papers succeeding in the review process or, even worse, papers not even being submitted in the first place; authors foresee rejection given the challenge to satisfy the selection criteria (what Chao et al. (2014, p. 1286) call "idea risk"). A key insight for innovation and product development researchers is to appeal to *M&SOM*'s editorial objectives through a clear articulation of the operational relevance of their work, possibly accepting that not all research studies might admit an operations interpretation. On the *M&SOM* editorial board side, signaling the selection capability through expert associate editors can offer the assurance to authors for directing more of their work to the journal.

Execution. New ventures or new products need to undergo several iterations in order to converge to excellent outcomes (i.e., well-performing businesses or products; Thomke 2003). Similarly, research ideas necessitate feedback and iterative refinement to converge to robust and rigorous scientific findings. The eventual outcome depends crucially on two distinct factors: the capability of researchers (project managers or entrepreneurs) to navigate the demands and requirements identified during these iterative cycles and the capacity of the editorial teams (management boards/venture fund committees) to understand the underlying value and potential of the new ideas (products/ventures) and therefore provide useful feedback. Especially when the upfront idea is relatively novel, which means different from the current conceptual paradigms but also bearing high citation potential, the previous two factors become crucial. Failure modes reflect risks on both dimensions: new product development and innovation researchers may not be familiar enough with the demands of an OM journal; equally, the editorial board lacks the presence of reviewers who can comprehend the topical issues and contributions of the innovation papers. Moreover, for new paradigms on the topic, the editors need to navigate the opposing forces between evaluation

and incubation (similar to what angel investors and venture capitalists do for early-stage ventures). Often enough, this requires notching up the “tolerance for failure” and setting protection barriers up against traditional evaluation criteria that kill ideas (Manso 2011, Hutchison-Krupat and Kavadias 2015).

Observations for the Future

In our view, given the scope of the journal, the publication of papers on innovation should unquestionably continue, and the journal should aim to achieve higher numbers of accepted manuscripts. The drastic redefinition of industries through new business models (Girotra and Netessine 2014, Kavadias et al. 2016) has opened up new challenges for innovation, and at some level, it has shifted the scope of innovation beyond technologies, products, and services to new “ways of doing business”; a large part of these new ways is their operations.

This implies that future publications probably should further focus on exploring synergies across product/service design and operations and use operations methods applied to innovation processes. Thus, *M&SOM* might question whether to encourage publications of, say, research on improving the interpersonal dynamics in product development teams because the link to operations is just too weak. However, by the same token, the journal may increase its scope to understand further how systematic innovation outputs arise and, in particular, how to design new services effectively (Das Gupta et al. 2015, Bellos and Kavadias 2019) and why novel business models may develop (Agrawal and Bellos 2016). A closer look at the success of concepts such as the lean startup (Ries 2011) and the business model canvas (Osterwalder and Pigneur 2010) points to a potential systematization of business model design and development (i.e., a *process* for designing new business models).

Along similar lines, several additional topics that are consistent with this focus but that have not received significant attention could be considered. Based on these topics, we list below a few recent developments that point to ideas that are in no particular way restrictive or complete. We classify them along the same dimensions of ideation-selection-execution.

- *Ideation*. Recently, a sizable number of studies have sought to understand *innovation tournaments* (Terwiesch and Xu 2008, Terwiesch and Ulrich 2009) as processes that enable more open and collaborative innovation ecosystems (Körpeoğlu and Cho 2017, Wooten and Ulrich 2017, Mihm and Schlapp 2018). Although several questions remain unanswered, the capacity to collect data from such ideation processes offers a unique opportunity to study the evolution of ideas and paradigms/styles (Chan et al. 2017) and the role of feedback as well as the implications of different

processes and incentives on the creative output. At a more micro level, more work—and, in particular, experimental work—could enhance our understanding of the effectiveness of ideation processes and its link to subsequent innovation stages (e.g., Erat and Gneezy 2016, Kagan et al. 2017, Sommer et al. 2019).

- *Selection*. In a similar context to this essay, while celebrating the 50th anniversary of *Management Science*, Shane and Ulrich (2004) called for additional work in the area of new product portfolio decision making. Additional work is still needed in that domain because the project selection decisions tend to be crucial for the future success of any company. Recent work recognized the organizational nature of these decisions, delivering a lot of novel insights (Hutchison-Krupat and Kavadias 2015, Schlapp et al. 2015, Oraiopoulou and Kavadias 2019). Although OM researchers have explored the possible decisions from a normative modeling viewpoint, more work could benefit our understanding of the selection processes at an empirical level (i.e., how are senior managers *actually* making project choices?). Again, at a more micro level, additional work could benefit our understanding of how decision makers balance the different conflicting selection dimensions (Cui et al. 2019). For example, the infamous knapsack problems have consumed a lot of ink in the OM community. However, do decision makers even make the same trade-offs as the knapsack framework when facing the challenge of selection?

- *Execution*. Experimentation and testing have emerged early on as core topics for the effective management of innovation processes and projects (Thomke 1998, 2003; Loch et al. 2001; Sommer and Loch 2004). Yet it seems as if the literature has gone quiet, with some exceptions recognizing the distributed nature of the innovation tasks and projects (Mihm et al. 2003, Sosa et al. 2004, Bhaskaran and Krishnan 2009, Gokpinar et al. 2010, Mihm 2010, Erat and Krishnan 2012, Hutchison-Krupat and Chao 2014). Recent studies have attempted to look into the behavioral dimension of managing innovation projects (Wu et al. 2014, Rahmani et al. 2017, Crama et al. 2018, Long et al. 2019). Still, core questions remain about effective collaboration during innovation projects and the capacity to ensure timely and on-budget delivery of the intended innovation outcomes.

As a concluding remark, we believe there is a great opportunity for the innovation community to engage with *M&SOM* but also for the journal to engage the innovation community more, possibly involving a somewhat broader set of scholars in editorial decisions. This is not to say that the journal should stray from its roots and focus. Rather, additional experts with interests in innovation and, perhaps, methodological expertise in empirical methods would enhance

the ability of the journal to detect interesting and important work that still resonates with its focus on OM. In any case, *M&SOM* has been and should remain a top destination for research on the operational challenges of the management of innovation.

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Endnotes

¹ Data sourced from an analysis on innovation publications in *Management Science* in the period 2007–2017; the analysis was conducted by J. Schlapp, J. Mihm, and S. Kavadias.

² In the light of our argument, the recent establishment of a department on “innovative operations” from *M&SOM* points in the same direction.

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