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The evolution of the intellectual structure of operations management—1980–2006: A citation/co-citation analysis

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ABSTRACT

Citation analysis combined with a network analysis of co-citation data from three major operations management (OM) journals is used to reveal the evolution of the intellectual structure of the OM field between 1980 and 2006. This spans the entire time since the beginning of research journals specific to the field. Employing a bibliometric citation/co-citation analysis to investigate the foundations of the discipline enables a robust, quantitative approach to uncovering the evolution of research in OM. The study finds that the intellectual structure of the field made statistically significant changes between the 1980s, the 1990s, and the 2000s and evolved from a pre-occupation with narrow, tactical topics toward more strategic, macrotopics, including new research methods and techniques. A factor analysis identifies the 12 top knowledge groups in the field and how they change over the decades. Illustrations of the structure of the co-citations representing the field are generated from a spring-embedded algorithm that is an improvement over the standard multi-dimensional scaling (MDS) approach to illustrating the knowledge groups.

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1. Introduction

On the opening page of the first issue of the *Journal of Operations Management (JOM)*, Buffa (1980, p. 1) declared that “The field of Operations Management has evolved from a purely descriptive origin through the Management Science/Operations Research phase, and is now in the process of finding itself as a functional field of management.” Later in the article, Buffa estimated the death of the descriptive phase as being 1961, and the end of the MS/OR phase as 20 years later, saying (1980, p. 2) “MS/OR methodology does not define the OM field nor point the way of the future.” and that now “we are emerging from the MS/OR phase into a

clear recognition of OM as a functional field of management.”

OM finally appears to be gaining momentum as a respected academic discipline (Ketokivi and Schroeder, 2004; Pagell and Krause, 2004), largely through the availability of strong and respected OM-specific publication outlets. Thus, this may be a good time to re-evaluate the evolution of the field and its intellectual structure since Buffa's (1980) evaluation almost three decades ago. To achieve this, we set three goals for our research:

1. To identify the major publications/citations in our field and their evolving research utility over the decades. As other fields have found, we expect the citations to include books as well as articles from journals outside the field.
2. To identify and illustrate the major knowledge groups in the field and the general relationships between them.
3. To determine and illustrate the evolution of these knowledge groups over the decades in terms of their

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research popularity and the general relationships between them.

The data source for the study is the set of approximately 75,000 citations listed in the three oldest primary journals in operations management: *JOM*, the *International Journal of Operations and Production Management (IJOPM)*, and *Production and Operations Management (POM)*. To determine the underlying intellectual structure of OM and its evolution, we apply quantitative citation and network co-citation analysis to this data set.

The paper starts with a brief review of the bibliometric methodology employed here, using earlier bibliometric studies, primarily in other fields, to exemplify the approach and its results. We then describe and justify our data source for the study. Next, we present the results of our analysis and describe the evolution of the intellectual structure of the field. Last, we offer our conclusions, discuss the limitations of the study, identify implications for research and practice, and recommend avenues for future research.

2. Literature review

Over the decades, there have been many qualitative studies that attempted to identify the major knowledge groups in OM (Meredith, 1979; Buffa, 1980; Chase, 1980; Miller et al., 1981; Mabert, 1982; Hill et al., 1988–1989; Amoako-Gyampah and Meredith, 1989; Meredith and Amoako-Gyampah, 1990; Neely, 1993; Voss, 1984; Scudder and Hill, 1998; Pannirselvan et al., 1999; Gupta et al., 2006). Most of them, however, were focused on a particular journal, setting (manufacturing, services, practice), research method, or type of outlet (e.g., dissertations). The usual method of determining these knowledge groups was to examine the selected outlets and manually categorize the citations into groups, often pre-selected. More relevant to revealing OM's intellectual structure might be studies that identified the most influential and important publications in the field and their relationship to each other. Sower et al. (1997) in their survey of OM professionals attempted to get at one aspect of this by identifying the "classics" in the OM field. First, they identified the factors that would indicate what works would be considered "classics" and then they identified authors and publications (books and journal articles) for respondents to consider and rate. Although the results are interesting, the authors describe the many problems with their findings resulting from the nature of the study methodology (e.g., classics that few have ever read, or are out of print, or recent articles or books on "hot" subjects). And while an identification of these classics may give us some historical insight into how OM is perceived and thus communicated to students, it does not provide us with those works that are *directly* influencing current research, nor does it give us a contemporary view of the subject or its theoretical structure.

Another, more objective, way to get at the intellectual structure of the field is through bibliographic studies, such as citation and co-citation analyses. That is, what articles are *actually cited* in research studies? And to reveal the

structure of the interrelationships among articles, what works are commonly cited together (co-cited)? Using citation analysis, we can examine the growth in citations over the time period of interest to get a sense of when the major articles in the field were written, how their popularity fared over the time period, and if an article is still useful today for current researchers. If it continues to be cited, that indicates its historic value over time as well as its role in spawning follow-on studies. We can also use the citation rates to determine when the field made major changes in direction.

In contrast to citation analysis, Leydesdorff and Vaughan (2006) discuss the information we can obtain through co-citation analysis, where they speak of publications as "texts:" "Co-citation data can be considered as such linkage data *among* texts, while cited references are variables attributed to texts. ... one should realize that network data are different from attributes as data. From a network perspective, for example, one may wish to focus on how the network develops structurally over time." Identifying co-citations can tell us, through factor analysis for example, what the major factors and groups are within the field and how they vary across journals and over time. We can also graphically illustrate what the most influential citations are for each of the factors, how they are related, how strong their relationships are, and how far removed from, or central to, the factor groups they are—in other words, the relationships inherent in the intellectual structure of the field. And the co-citation studies can show us what topics, authors, journals, and research methods were central, and peripheral, to the field, and how they may have changed over time.

A variety of bibliometric analyses have been performed on the literatures of fields adjacent to OM. For example, Culnan (1986) used co-citation analysis to investigate the founding pillars of management information systems and found the subject to have more affinity with information science than organization studies. Similarly, Karki (1996) examined the sociology of science literature and found that information scientists and sociologists exchange ideas only when they are discussing "scholarly communication" as a subject. Cottrill et al. (1989) investigated the traditions of innovation research and the links between its sub-fields of "diffusion theory" and "technology transfer." Somewhat surprisingly, they found the use of distinct approaches within each sub-field that rarely interacted with each other. And Nerur et al. (2008) used an author co-citation analysis to reveal the intellectual structure of the strategic management field by author, updating an earlier citation/co-citation study (Ramos-Rodriguez and Ruiz-Navarro, 2004) that identified changes in the intellectual structure of the strategic management field. Similarly, Hoffman and Holbrook (1993) conducted a co-citation study of authors to identify the intellectual structure of consumer research based on the first 15 years of publication of the *Journal of Consumer Research*.

There appear to be only two co-citation studies of the field of OM. In an early study covering 1994–1997, Pilkington and Liston-Heyes (1999) explored *IJOPM* citations to plot OM's sub-fields and found five main categories which they termed: Manufacturing Strategy Proposers,

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