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A structured analysis of operations and supply chain management research in healthcare (1982–2011)

David Dobrzykowski [a,1], Vafa Saboori Deilami [b,2], Paul Hong [b,*], Seung-Chul Kim [c,3]

[a] Supply Chain Management and Marketing Science Department, Rutgers Business School, 1 Washington Park, Newark, NJ 07102, United States
[b] College of Business and Innovation, University of Toledo, 2801 West Bancroft St, Toledo OH 43606, United States
[c] School of Business, Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul 133-791, South Korea

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ABSTRACT

As the operations management (OM) and supply chain management (SCM) field has evolved, a greater emphasis on services has emerged. The healthcare industry represents an important sector within services, however, little is known about the current state of research into healthcare OM and SCM. The purpose of this research is to conduct a structured analysis of OM and SCM studies conducted in healthcare and inform three key questions: (1) *what are the primary topics or themes in the extant healthcare OM and SCM literature,* (2) *what are the prevalent methodological approaches employed in healthcare OM and SCM,* and (3) *what does the future of OM and SCM research in healthcare hold?*

The questions are informed via a structured analysis of healthcare papers published between 1982 and 2011 in seven esteemed scholarly journal outlets in the OM and SCM field—*Decision Sciences Journal*, *International Journal of Operations and Production Management, International Journal of Production Economics, Journal of Operations Management, Journal of Supply Chain Management*, *Production and Operations Management,* and *Supply Chain Management: An International Journal*. Through screening 9979 papers, and carefully analyzing the literature, this study makes at least four important contributions by: (1) using quantitative methods to identify the current investigatory themes, (2) quantifying methodological trends, (3) providing a qualitative narrative description of the top research themes, and 4) qualitatively describing directions for future research.

1. Introduction

Managing operations has evolved substantially over time in response to changing priorities and paradigms (Gunasekaran and Ngai, 2012). One major shift for the operations management (OM) field has been the movement from standardized offerings to customization (Vonderembse et al., 2006), following the more macro-level evolution from agriculture to manufacturing to services (Karmarkar and Apte, 2007). This new view places greater emphasis on (1) the provision of individualized offerings, and (2) a more decentralized, but highly collaborative view of value creation achieved through coordinated approaches such as supply chain management (SCM) (Gunasekaran and Ngai, 2012; Schmenner et al., 2009). Increased focus on the customer and collaboration can be linked to growing interest into services among OM and SCM researchers, with some suggesting that manufacturing has become something of a service (Gunasekaran and Ngai, 2012). Thus, as the OM and SCM field continues to evolve, it would seem as though much could be learned – and perhaps increasingly generalized – from research into service OM and SCM; however, little is known about these issues in services (Sengupta et al., 2006; Machuca et al., 2007).

The healthcare industry represents an important and growing research context that can be characterized by an intense focus on providing individualized offerings and a recognized need for collaboration among a number of decentralized supply chain actors (de Blok et al., 2012; Boyer and Pronovost, 2010). Healthcare is a particularly important service industry given not only the criticality of quality and safety in delivering patient care (McFadden et al., 2009), but also the associated cost involved as it is expected to account for 20% of GDP or $4 trillion in the USA in 2015 (Dobrzykowski, 2012). These concerns extend beyond the USA, leading to increasing research interest in global healthcare OM and SCM issues (Sinha and Kohnke, 2009). Today, high quality research in this field is underway, but this work is nascent and a deeper understanding of OM and SCM phenomena in the healthcare field is necessary to improve performance (see McKone-Sweet et al., 2005; Shah et al., 2008). Plainly stated, considering an OM and SCM perspective, the body of knowledge concerning healthcare delivery seems to be rather fragmented (de Vries and Huijsman, 2011), and may possess increased relevance

* Corresponding author. Tel.: +1 419 530 2054; fax: +1 419 530 2290.
E-mail addresses: david.dobrzykowski@utoledo.edu (D. Dobrzykowski), vafa.saboorideilami@rockets.utoledo.edu (V. Saboori Deilami), paul.hong@utoledo.edu, PaulHong1200@Gmail.Com (P. Hong), sckim888@hanyang.ac.kr (S.-C. Kim).
[1] Tel.: +1 419 530 2342.
[2] Tel.: +1 419 329 0408.
[3] Tel.: +82 2 2220 1069.

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given the current state of evolution of OM and SCM (Gunasekaran and Ngai, 2012).

The purpose of this study is to conduct a structured, analytical review exploring important trends and reporting on the current knowledge extant in healthcare OM and SCM based on previously published studies. Under this overarching aim, three key questions facing researchers will be informed (Machuca et al., 2007): (1) *what are the primary topics or themes in the extant healthcare OM and SCM literature,* (2) *what are the prevalent methodological approaches employed in healthcare OM and SCM,* and (3) *what does the future of OM and SCM research in healthcare hold?*

The questions are informed via a structured analysis of healthcare papers published between 1982 and 2011 in seven esteemed scholarly journal outlets in the OM and SCM field—*Decision Sciences Journal*, *International Journal of Operations and Production Management, International Journal of Production Economics, Journal of Operations Management, Journal of Supply Chain Management*: *Production and Operations Management,* and *Supply Chain Management: An International Journal*. Through carefully analyzing the literature, this study makes at least four important contributions by: (1) using quantitative methods to identify the current investigatory themes, (2) quantifying methodological trends, (3) providing a qualitative narrative description of the top research themes, and (4) qualitatively describing directions for future research.

2. Methodology—a structured analysis

Irani et al. (2010) point out a number of different methodological approaches for examining previous work, reporting on the state of a particular field, and prognosticating future research directions. These include literature review, bibliometric analysis, historical analysis, meta-analysis, and structured analysis; all of which were considered herein (Machuca et al., 2007; Ngai et al., 2008; Gunasekaran and Ngai, 2012). For example, Ngai et al. (2008) and Irani et al. (2010) employed a blend of qualitative and quantitative methods reporting on trends using descriptive statistics and providing brief descriptions themes regarding RFID. Gunasekaran and Ngai (2012) followed a qualitative approach in assessing and describing the future of OM research. Machuca et al. (2007) employed a structured analysis of the service operations literature and reported on topic trends, methodological trends, future research directions largely using a quantitative non-parametric (chi-square testing) approach. This study incorporates a blend of quantitative (Machuca et al., 2007) and qualitative (Ngai et al., 2008; Gunasekaran and Ngai, 2012) methods to analyze and report on the state of healthcare OM and SCM research.

Previous research indicates that literature reviews can be understood through content analysis, involving the mixing of quantitative and qualitative approaches to assess structural (descriptive) and content criteria (Brewerton and Millward, 2001; see also Seuring and Müller, 2008). Given the aims of the current study to employ a rigorous approach to understanding the current state of healthcare operations and supply chain research, the four stage process of Mayring (2003) was employed. The four stages are as follows:

1. *Material collection* whereby the material to be collected and unit of analysis is defined and delineated.
2. *Descriptive analysis* whereby formal dimensions of the material are assessed such as the number of publications per year, and other background for subsequent analysis.
3. *Category selection* whereby structural aspects and related analytic categories are selected via a filtering or review of the collected material. These structural dimensions comprise the major topics of analysis which lead to single analytic categories.
4. *Material evaluation* whereby the collected material is analyzed according to the structural dimensions. This underpins the identification and interpretation of relevant issues and results.

3. Material collection

The material collection stage of the structured literature review process involves the specification and definition of the material to be collected as well as the unit of analysis (Mayring, 2003). This begins with the selection of journal outlets which will serve as the target of the researchers' survey. The primary filter employed in journal selection centered on the focus of this structured analysis on healthcare research published in high quality OM and SCM journals. Therefore, journals dealing with operations research and management science were excluded from further consideration. There are several studies which examine the importance of the journals in the field of OM and related fields. A common theme among journal ranking studies is the assessment of a journal's quality and relevance (e.g., Barman et al., 1991, 2001; Young et al., 1996; Soteriou et al., 1999). Literature reviews in OM or its subdimensions, such as the present study, often rely upon one (e.g., Amoako-Gyampah and Meredith, 1989) or two (e.g., Pannirselvam et al., 1999; Prasad and Babbar, 2000) of the aforementioned lists as the basis for journal selection and analysis. One notable exception is Machuca et al. (2007) who expanded their basis for selection to include multiple lists. Such an approach can be useful given that journal rankings can be inexact and the esteem held for journals can vary by region (Theoharakis et al., 2007). Thus, in an attempt to ensure the quality and relevance of the present study, this research employed multiple studies to identify the targeted OM journal outlets for review. These studies include Barman et al. (1991, 2001) and Soteriou et al. (1999). In synthesizing these studies, five relevant journals emerged and served as the foundation for the present literature survey. In alphabetical order, these journals are *Decision Sciences Journal* (DSJ), *International Journal of Operations and Production Management* (IJOPM), *International Journal of Production Economics* (IJPE), *Journal of Operations Management* (JOM), and *Production and Operations Management* (POM) were collected and analyzed. The scope of this study also includes SCM. Journal ranking for SCM outlets is less clear than OM given the relative youth of the SCM field. However, two prominent SCM journals were identified for inclusion; *Journal of Supply Chain Management (JSCM),* and *Supply Chain Management: An International Journal (SCMIJ).*

The unit of analysis for this literature review study falls at the level of individual papers published in the seven target journals between the years of 1982 and 2011 (Mayring, 2003; Seuring and Müller, 2008). This approach (the review of top OM and SCM journals over the past 30 years) ensures the inclusion of high quality and highly relevant papers in this study. The filtering process began with a general review of the seven target journals which produced an initial sample of 9979 papers. Given that a physical review of each paper would be a daunting undertaking, the authors employed technology to assist in the initial screening process. The selection of journal articles for the analysis sample proceeded with a literature search in the scholarly database, EBSCO. Ten individual rounds of keyword searches were employed using the following filters: hospital, healthcare, health care (two words), medical, outpatient, doctors, appointment scheduling, clinic, pharmacy, and laboratory. This procedure reduced the sample to 136 scholarly papers.

Given that the focus of this study is on healthcare operations and supply chain management in the strictest sense, each of these papers was reviewed by four independent judges and deemed to

be appropriate for inclusion in the study. This procedure followed Machuca et al. (2007, p. 589), whereby "in cases where it was not possible to clearly determine the true focus of the article, a consensus amongst the authors determined whether it should be accepted or rejected." The primary criteria used to determine the appropriateness of a study for inclusion centered on the answer to the question; *would this paper be relevant to healthcare (providers) executives and healthcare OM and SCM scholars?* For example, a study by Van den broecke et al. (2008) dealing with a production-scheduling model suited for the manufacturing process of a photographic film-producing company that serves the medical industry was excluded by the judges as irrelevant to healthcare executives and healthcare OM and SCM scholars. This purification process further reduced the size of the final analysis sample to $n=117$ papers dealing squarely with issues of concern to healthcare executives and healthcare operations and supply chain management scholars. See Appendix A for a reading list containing the 117 studies analyzed herein. These parameters and results compare favorably to similar studies such as Ngai et al. (2008) who examined RFID research from 1995 to 2005 and analyzed 85 papers.

4. Descriptive analysis

The descriptive analysis stage of the structured literature review process involves an assessment of the formal dimensions of the material such as the number of publications per year, and also provides important background for subsequent analysis (Mayring, 2003). Such an analysis begins to inform the overarching research aim of this study; the identification of general trends in the HOM literature.

As mentioned in the preceding section, 117 scholarly studies were published in the seven target journals between 1982 and 2011. The first manuscript, titled 'Requirements planning systems in the healthcare environment' by Earle Steinberg, Basheer Khumawala, and Richard Scamell appeared in JOM in 1982 (Steinberg et al., 1982). Since 1982, healthcare OM and SCM studies have increased in frequency with the most notable punctuations occurring in the 1990s and 2000s. A chronological distribution of the HOM studies included in our analysis is provided in Table 1 along with the respective journal outlet. Following Machuca et al. (2007), chi-square testing has been employed to statistically test for trends with regard to the number of healthcare OM and SCM publications appearing in the target journals.

Table 1
Healthcare OM and SCM publications by five-year period and journal.

Five-year group	Journal							Total
	JOM	IJPE	POM	DSJ	IJOPM	SCMIJ	JSCM	
1980–1984	2	0	0	0	0	0	0	2
1985–1989	0	0	0	2	0	0	0	2
1990–1994	0	0	0	2	2	0	0	4
1995–1999	3	3	0	2	5[a]	0	0	13[b]
2000–2004	5	4	3	5	9	1	0	27[b]
2005–2009	5	10[c]	4	9	6	3	1	38
2010–2011	4	1	14[d]	1	6	5	0	31
Totals	19[e]	18[e]	21[e,f]	21[e,f]	28[e,f]	9[e]	1	117

[a] Proportion is statistically significant (different) compared to POM.
[b] Statistically significant change from the previous period.
[c] Proportion is statistically significant (different) compared to POM and IJOPM.
[d] Proportion is statistically significant (different) compared to JOM, IJPE, DSJ, and IJOPM.
[e] Proportion is statistically significant (different) compared to JSCM.
[f] Proportion is statistically significant (different) compared to SCMIJ and JSCM.

Two noteworthy punctuations appear in the data. First, the period between 1995 and 1999 produced 13 publications, which is a statistically significant increase over the four publications which appeared from 1990 to 1994 ($X^2=4.77$, $p=0.03$). A second punctuation occurred during the next period as well, as the period between 2000 and 2004 produced 27 publications compared to 13 in the prior period ($X^2=4.90$, $p=0.03$). While not statistically different from the 2000 to 2004 period, the 2005–2009 period again produced a higher number of studies, with 38 publications appearing in print. Likewise, while the 2010–2011 category represents a shorter, incomplete collection period for proper comparison, it too has produced a high number of studies (31) which is not statistically different from the preceding period. Taken together, these results suggest that the number of healthcare OM and SCM studies grew significantly starting in 1995 and again in 2000 and have remained at these peak levels.

Next, the individual journals were assessed for publication trends. A crosstabs chi-square test comparing the volume of publications in the seven journals was significant ($X^2=28.56$, $p=0.00$), indicating that there is a difference in the aggregate number of papers published by each journal. Chi-square tests indicate that POM, DSJ, and IJOPM published a higher number of papers than SCMIJ and JSCM ($X^2=4.80$, $p=0.03$ for the nearest pair). All the journals are shown to have published more papers than JSCM ($X^2=6.40$, $p=0.01$ for the nearest pair). Finally, in comparing the OM and SCM journals, the OM outlets produced a higher number of studies (107 papers, compared to 10 respectively) ($X^2=80.42$, $p=0.00$).

An analysis of the proportion of papers published by each journal during each five-year period was then conducted. A crosstabs chi-square test was statistically significant ($X^2=63.93$, $p=0.00$) indicating that a relationship exists between five-year grouping and the proportion of each journal's publications. No notable differences appeared until the 2005–2009 period. IJPE published its highest proportion of papers (10 of its 18 or 55.6%) which is higher than POM and IJOPM (significant at $p<0.05$). While statistically the same, on the face IJPE's proportion during this period is also higher than JOM, DSJ, and SCMIJ. This suggests that IJPE participated in the growth of the healthcare OM and SCM literature, publishing the majority of its papers in the most recent full collection period (2005–2009). Next, POM has published the highest proportion of its papers (14 of its 21 or 66.7%) during the most recent 2010–2011 period (significant at $p<0.05$). This is statistically significant (higher) than any of the other four OM journals under consideration, but is statistically the same as JSCM and SCMIJ. Taken together, these results appear to suggest that IJPE and POM have experienced increases in the proportion of their studies during the previous two periods, while JOM and IJOPM have remained consistent.

5. Category selection

The category selection stage of the structured literature review process involves an assessment of the structural aspects and related analytic categories of each data point or paper in the sample (Mayring, 2003). These structural dimensions fall into two categories given the aim of this study: (1) topics and (2) methodologies. These dimensions rest at the heart of two of the research questions under study, namely: (1) *what are the primary topics or themes in the extant healthcare OM and SCM literature,* (2) *what are the prevalent methodological approaches employed in healthcare OM and SCM?* A classification scheme is required in order to inform these questions which involve an analysis of the *content* of each study. Thus, this study adopts the classification

Table 2
Classification scheme of HOM topics (adapted from Aguilar Escobar and Machuca (2000); Machuca et al., 2007).

No.	Topic/ section	Category description
	Topic 1	Introduction and key issues of management in services
1	1.1	Introduction and key issues of management in services
	Topic 2	Service operations strategies and objectives
2	2.1	Service management
3	2.2	General aspects of strategy and objectives of operations in services
4	2.3	Strategic quality issues in services
5	2.4	Service productivity
6	2.5	Information Technology and new technology in services
7	2.6	Supply chain strategies and objectives
	Topic 3	Service operations design
8	3.1	Selection and design of the service delivery system
9	3.2	Capacity design/long-term capacity and demand decisions
10	3.3	Service operations design in supply chains
	Topic 4	Planning, scheduling, and control of service operations
11	4.1	Planning, scheduling, and control of service operations
12	4.2	Capacity planning, scheduling, and control
13	4.3	Short-term scheduling and control
14	4.4	Inventory management and control
15	4.5	Design, measurement, and compensation of service work
16	4.6	Planning, scheduling, and control in supply chains

Note: Strategic issues group: topics 2 and 3. Tactical/operational issues group: topic 4.

scheme of Aguilar Escobar and Machuca (2000) (see also Machuca et al., 2007).

Given its roots in service operations management, the authors found this framework useful in categorizing the healthcare OM and SCM papers under study herein. The framework features four levels of aggregation, with each level encompassing the next. The levels are: groups, topics, sections, and subsections in descending level of abstraction. This hierarchical scheme distinguishes among strategic, tactical and operational issues as well as provides topic granularity, both of which are useful given the aim of the present study. Thus, the classification scheme adapted herein has two groups (strategic and tactical/operational) which are divided into four HOM topics and consequently further subdivided into 16 sections displayed in Table 2.

The categorization of each paper came as the result of an independent review of four judges.[4] In few cases when the categorization of a paper was unclear, the authors conferred until consensus was achieved. This process, following Machuca et al. (2007), increases the probability of correct placement given that consensus was required from all four judges. This was a critical step given that each paper was placed in only a single analytic category in support of the exacting nature of the insights provided by the study (Mayring, 2003). While other authors such as Machuca et al. (2007) and Pannirselvam et al. (1999) have chosen to place single papers in multiple categories, given the nascent status of the healthcare OM and SCM literature, a greater contribution can be made in this case by following a more exacting approach (Mayring, 2003). Like Machuca et al. (2007), this study found that the classification scheme adequately enabled the various aspects of healthcare OM and SCM research to be aptly assigned within the topic structure, thus making the framework suitable for examining the state-of-affairs of this field of research. However, should the authors have found that this adapted categorization scheme was inappropriate, in other words, if the authors were unable to rationally place the papers into the categorical scheme, the existing categories would have been expanded or new categories created to accommodate discrepancies. Such refinements proved to be unnecessary.

The second research question requires the analysis of methods employed in the studies. Authors including Meredith et al. (1989), Swamidass (1991), Claver Cortés et al. (1999), Scandura and Williams (2000), Prasad et al. (2000), Van Hoek (2001), and Alfaro et al. (2002) among many of those mentioned in Section 3 earlier have dealt with this issue. One clear learning that emerges upon review of this literature is that no full consensus has been made relative to the appropriate criteria for categorizing the literature by method (Machuca et al., 2007). Thus, this analysis motivated the use of a classification scheme similar to that employed by Machuca et al. (2007) which include the following methods; theoretical/conceptual (T/C), literature review (LR), mathematical models and simulations (MMS), empirical (E), and ethnographies/cases studies (CS). Again, the papers were reviewed independently by the four judges, consensus was reached, and papers were assigned to single categories (Mayring, 2003).

6. Material evaluation

The material evaluation stage of the structured literature review process involves an analysis of the collected material according to the structural dimensions of topic and methodology (Mayring, 2003). This will underpin the identification and interpretation of relevant issues and results aimed at informing research questions 1 and 2 under investigation.

6.1. Research content

The investigation into research question 1, *what are the primary topics or themes in the extant healthcare OM and SCM literature,* requires an analysis of topic trends over the past 30 years. Table 3 displays the results of the content analysis of topics. This is a useful first step in informing the first research question.

6.1.1. Topics

The topics and sections listed earlier are now presented in Table 3 with the corresponding frequency of the papers under study. Topic 2, Service operations strategies and objectives, is the largest topic containing 53 papers (45.4% of the sample). This is followed by topic 4, Planning, scheduling, and control of service operations with 36 papers (30.8% of the sample), topic 3, Service operations design with 22 papers (18.8% of the sample) and finally, topic 1, Introduction and key issues of management in services with six papers (5.1% of the sample). Chi-square tests reveal differences among the topics. Topic 2 ($n=53$) is the most popular topic among authors, statistically greater than all other topics with the marginal exception of topic 4 ($n=36$) ($X^2=3.25$, $p=0.07$). Topic 4 (n=36) is marginally more popular than topic 3 ($n=22$) ($X^2=3.38$, $p=0.07$), and substantially more popular than topic 1 ($n=6$) ($X^2=21.43$, $p=0.00$). Topic 1 is the least popular of all the topics ($X^2=9.14$, $p=0.00$ for the nearest pair). Therefore, topics 2 and 4 are trailed by topic 3 and finally all topics are trailed by topic 1 in terms of publication volume. See Table 4.

These four topics were analyzed by five-year period (similar to the testing performed in Section 4, Table 1). No meaningful trends emerged from crosstabs chi-square testing. This suggests that the four topics have been relatively stable during the past 30 years. Further, the four topics were analyzed by journal using a crosstabs chi-square test which was significant ($X^2=38.04$, $p=0.00$). Results reveal that POM publishes a higher proportion of papers in topic 3,

[4] The four authors of this study served as judges and evaluated each paper individually *a prior* group discussion following Machuca et al. (2007).

Table 3
HOM topics and frequency (adapted from Aguilar Escobar and Machuca (2000); Machuca et al., 2007).

Topic	Category description	Count	%
Topic 1	Introduction and key issues of management in services	**6**	**5.1**
1.1	Introduction and key issues of management in services	6	5.1
Topic 2	Service operations strategies and objectives	**53**	**45.4**
2.1	Service management	4	3.4
2.2	General aspects of strategy and objectives of operations in services	12	10.3
2.3	Strategic quality issues in services	11	9.4
2.4	Service productivity	3	2.6
2.5	Information technology and new technology in services	16	13.7
2.6	Supply chain strategies and objectives	7	6.0
Topic 3	Service operations design	**22**	**18.8**
3.1	Selection and design of the service delivery system	12	10.3
3.2	Capacity design/long-term capacity and demand decisions	4	3.4
3.3	Service operations design in supply chains	6	5.1
Topic 4	Planning, scheduling, and control of service operations	**36**	**30.8**
4.1	Planning, scheduling, and control of service operations	7	6.0
4.2	Capacity planning, scheduling, and control	11	9.4
4.3	Short-term scheduling and control	6	5.1
4.4	Inventory management and control	6	5.1
4.5	Design, measurement, and compensation of service work	5	4.3
4.6	Planning, scheduling, and control in supply chains	1	0.9
	Totals	117	100.1%

Note: Strategic issues group=topics 2 and 3. Tactical issues group=topic 4.

Table 4
Results of chi-square tests of topics (topics 1, 2, 3, & 4).

Pairings	X^2	p-value
Topic 1: Introduction and key issues of management in services ($n=6$) Topic 2: Service operations strategies and objectives ($n=53$)	37.44	$p=0.00$
Topic 1: Introduction and key issues of management in services ($n=6$) Topic 3: Service operations design ($n=22$)	9.14	$p=0.00$
Topic 1: Introduction and key issues of management in services ($n=6$) Topic 4: Planning, scheduling, and control of service operations ($n=36$)	21.43	$p=0.00$
Topic 2: Service operations strategies and objectives ($n=53$) Topic 3: Service operations design ($n=22$)	12.81	$p=0.00$
Topic 2: Service operations strategies and objectives ($n=53$) Topic 4: Planning, scheduling, and control of service operations ($n=36$)	3.25	$p=0.07$
Topic 3: Service operations design ($n=22$) Topic 4: Planning, scheduling, and control of service operations ($n=36$)	3.38	$p=0.07$

Service operations and design (eight out of 22 or 36% of papers) compared to topic 2, Service operations strategies and objectives (five out of 53 or 9% of papers) ($p<0.05$), indicating a preference by POM for topic 3 papers.

6.1.2. Topic sections (subtopics)

It would be useful to unpack trends which may exist beyond the topic level (Machuca et al., 2007). Therefore, a more granular analysis of the topic sections was necessary. To begin, the topic sections have been sorted by frequency in descending order. See Table 5. Chi-square tests were employed to examine differences among individual sections (e.g., Section 2.2, General aspects of strategy and objectives of operations in services compared to Section 4.3, Short-term scheduling and control). Chi-square tests revealed no statistical differences when testing the first seven pairings. The eighth pairing testing the most frequent topic section (Section 2.5, Information technology and new technology in services) and the eighth most frequent topic (Section 1.1, Introduction and key issues of management in services) produced a statistically significant difference ($X^2=4.55$, $p=0.03$). Given that such comparisons of the leading topic sections to mid-range topic sections seem to provide limited value to scholars, the researchers explored topic section groupings capable of providing rich insights for scholars.[5]

Two natural cut points appear in the distribution; one between frequency counts of 11 and seven studies and another between frequency counts of six and five studies. These cut points produce three groups containing similar numbers of topic sections. These groups are displayed in Table 5. Group A represents the most researched topic sections containing the top five topic sections, while group B represents the moderately researched topics sections containing the middle six topic sections, and group C represents the least researched topic sections containing the bottom five topic sections.

Chi-square testing reveals that these groupings are indeed different. Group A is statistically significantly larger than group B ($X^2=5.76$, $p=0.02$). Group B is statistically significantly larger than group C ($X^2=8.02$, $p=0.01$). Finally, group A is statistically significantly larger than group C ($X^2=25.63$, $p=0.00$). These results provide statistical support for the notion that Group A contains the most researched topic sections of the three groups, and thus these topic sections are of particular interest to researchers. See Table 6. A content analysis of the papers in the top five most research topic sections is provided later in Section 7.

6.1.3. Strategic versus tactical/operational issues

Many service operations scholars have long described greater research needs in strategic issues (see Buffa, 1980; Chase, 1980; Samson and Whybark, 1998). However, other studies have found that tactical/operational concerns have dominated OM research

[5] It is worth noting that a chi-square test comparing the eighth topic section (1.1) to the least frequent topic section (4.6) produced non-significant findings ($X^2=3.57$, $p=0.06$).

Table 5
Healthcare OM and SCM topic sections sorted in descending frequency and reorganized by frequency group.

No.	Section	Description	Count
	Group A: most researched topics (top five topic sections)		***62***
1	2.5	Information Technology and new technology in services	16
2	2.2	General aspects of strategy and objectives of operations in services	12
3	3.1	Selection and design of the service delivery system	12
4	2.3	Strategic quality issues in services	11
5	4.2	Capacity planning, scheduling, and control	11
	Group B: moderately researched topics (middle six topic sections)		***38***
6	2.6	Supply chain strategies and objectives	7
7	4.1	Planning, scheduling, and control of service operations	7
8	1.1	Introduction and key issues of management in services	6
9	3.3	Service operations design in supply chains	6
10	4.3	Short-term scheduling and control	6
11	4.4	Inventory management and control	6
	Group C: least researched topics (bottom five topic sections)		***17***
12	4.5	Design, measurement, and compensation of service work	5
13	2.1	Service management	4
14	3.2	Capacity design/long-term capacity and demand decisions	4
14	2.4	Service productivity	3
15	4.6	Planning, scheduling, and control in supply chains	1

Table 6
Results of chi-square tests of frequency groupings.

Pairings	X^2	*p*-value
Group A: most researched topics (top five topic sections) ($n=62$) Group B: moderately researched topics (middle six topic sections) ($n=38$)	5.76	$p=0.02$
Group B: moderately researched topics (middle six topic sections) ($n=38$) Group C: least researched topics (bottom four topic sections) ($n=17$)	8.02	$P=0.01$
Group A: most researched topics (top five topic sections) ($n=62$) Group C: least researched topics (bottom five topic sections) ($n=17$)	25.63	$p=0.00$

Table 7
Frequency distribution of research methodologies.

Research method	Count	Percentage
Literature review	5	4.3
Theory/conceptual	5	4.3
Ethnographic/case study	29	24.8
Empirical	32	27.4
Mathematical modeling and simulation	46	39.3
Totals	117	100.1

(Meredith, et al., 1999; Pannirselvam et al., 1999). Mabert (1982) found that strategic issues comprised only 17.4% of studies in his review, while 82.6% investigated tactical/operational concerns. More recently, in their review of the SOM literature, Machuca et al. (2007) found that 53.9% of studies fell into the strategic category, while 44.8% were of the tactical/operational variety. With regard to healthcare OM and SCM, the authors are unaware of any study that has examined publication differences of this variety. Given the mixed results from the service operations literature and the nascent nature of healthcare OM and SCM research, the examination of strategic and tactical/operational publications warrants investigation.

The classification scheme employed in the present study allows for an analysis of papers dealing with strategic issues versus those addressing tactical/operational concerns. Topic 2, service operations strategies and objectives, and topic 3, service operations design, comprise the strategic group. Topic 4, planning, scheduling, and control of service operations comprises the tactical/operational group. A chi-square test was conducted to assess differences between the strategic and tactical/operational groups, and the results reveal that strategic papers ($n=75$ or 64.1%) are significantly more prevalent than tactical/operational studies ($n=36$ or 30.8%) ($X^2=13.70$, $p=0.00$).

Next, a crosstabs chi-square tests was performed to investigate the relationship between a paper's status as strategic or tactical/operation and five-year period. No statistical relationship was found indicating that this breakout of strategic and tactical/operational papers has been stable over the 30-year collection period. Likewise, chi-square testing examining the relationship between a paper's status as strategic or tactical/operational and journal outlet failed to produce statistically significant results. This suggests that all seven journals are equally likely to publish strategic and tactical/operational studies.

6.2. Research methodologies

The investigation into research question 2, *what are the prevalent methodological approaches employed in healthcare OM and SCM,* requires an analysis of methodological trends over the past 30 years. Table 7 displays the results of our methodological analysis.

6.2.1. Methodological comparisons

A review of the descriptive statistics infers that mathematical modeling and simulation (MMS) appears to be the most prevalent method as it is featured in 46 papers (39.3%), while empirical studies (E) are second employed in 32 papers (27.4%). Ethnographies/case studies (CS) are third with 29 appearances (24.8%), followed by theory/conceptual methods (T/C) featured in five papers (4.3%), and literature reviews (LR) with five papers (4.3%). Chi-square tests reveal that important differences emerge among the methodological frequencies under study ($X^2=55.27$, $p=0.00$). While theory/conceptual papers and literature reviews are the same, an analysis comparing theory/conceptual papers and ethnographies does produce significant findings ($X^2=16.94$, $p=0.00$). The next appropriate test examines ethnographies and empirical studies. This test is not significant.

However, when comparing ethnographies and mathematical modeling and simulation papers, a statistically significant difference does emerge ($X^2=3.85$, $p=0.05$). Finally, a comparison of empirical studies and mathematical modeling and simulation papers does not produce a statistically significant difference ($X^2=2.51$, $p=0.11$). These results reveal that mathematical modeling and simulation papers and empirical papers have emerged as dominant methods in the healthcare OM and SCM.

6.2.2. Methodologies and time

The methodologies were next analyzed by five-year period to investigate potential trends. A crosstabs chi-square test was not statistically significant indicating that a methodologies have been fairly stable over time. However, it is worth mentioning that 27 out of the 32 empirical studies appearing in the analysis sample have been published since 2000, indicating that while empirical research lags behind mathematical modeling and simulation, this method may be rapidly gaining popularity.

6.2.3. Methodologies and journals

'Fit' between papers and journals, with regard to topical and methodological preferences, is an important consideration for authors when submitting papers for review and potential publication. As such, it is worthwhile to investigate potential relationships among methodologies and journal outlets. A crosstabs chi-square test produced statistically significant results ($X^2=84.03$, $p=0.00$) indicating that a relationship exists between methodology and journal outlet. Results reveal that publications are unremarkable (stable) across journals for theoretical/conceptual papers and literature reviews. However, statistically significant differences appear when considering ethnographies, empirical studies, and mathematical modeling and simulation papers.

With regard to ethnographies, this method represents the lowest proportion of studies in POM (0%) during the collection period (1982–2011) ($X^2=38.23$, $p=0.00$). This is statistically significant (different) at $p<0.05$ when compared to JOM (21.1%), IJPE (27.8%), IJOPM (32.1%), and SCMIJ (100.0%). SCMIJ (100.0%) published a higher percentage of ethnographies than any of the other journals in this study at $p<0.05$. Considering empirical studies, JOM and DSJ published a higher proportion these studies (52.6% and 42.9% respectively); higher than POM (14.3%), IJPE (11.1%), and SCMIJ (0%) ($X^2=16.63$, $p=0.01$). There was no statistically significant difference among JOM, DSJ, and IJOPM with regard to empirical studies. Finally, POM published the highest proportion of mathematical modeling and simulation studies (76.2%). This is statistically significant when compared to DSJ (38.1%), IJOPM (32.1%), JOM (15.8%), and SCMIJ (0%), but it is not statistically different from IJPE (55.6%). These results may serve to guide ethnographers away from POM and toward SCMIJ, empiricists toward JOM and to a lesser extent yet still attractive DSJ and IJOPM, and mathematical modelers toward POM and IJPE.

6.2.4. Methodologies and topics

The previous analysis has highlighted the popularity of particular topics among healthcare OM and SCM researchers. Given this, understanding prevalent research methodologies in each of the four topic areas, particularly topics 2 and 4, ought to be of interest to researchers. Thus, it is sensible to explore the potential relationship among research methodologies and research topic.

A crosstabs chi-square test produced statistically significant results ($X^2=129.77$, $p=0.00$) indicating that a relationship exists between research methodology and research topic. As would be expected, theoretical/conceptual papers (66.7%) and literature reviews (33.0%) are more prevalent for studies in topic 1, introduction and key issues of management in services (significant at $p<0.05$). Mathematical modeling and simulation studies most prevalent for topic 4, planning, scheduling, and control of service operations (77.8%), followed by topic 3, service operations design (40.9%), and finally, topic 2, service operations strategies and objectives (17.0%) (all significant at $p<0.05$). Empirical studies dominate all other methods for topic 2, service operations strategies and objectives (54.7%) (significant at $p<0.05$), while the other topics are statistically the same for empirical methods. Ethnographies dominate all other methods for topic 3, service operations design (50.0%) (significant at $p<0.05$), while the other topics are the statistically the same for ethnographic methods. These findings draw stark contrast when considering appropriate methodologies for the four topics areas identified herein. Theory development and literature review methods dominate topic 1, while empirical methods appear to dominate topic 2, with ethnographies dominant for topic 3, and mathematical modeling and simulation methods most popular in topic 4, followed by topic 3, and finally topic 2.

6.2.5. Methodologies and strategic or tactical/operational orientation

As discussed in Section 6.1.3 understanding the call for strategic and tactical/operational investigations is key as researchers attempt to address research gaps (Meredith et al., 1989; Pannirselvam et al., 1999; Machuca et al., 2007). This may be even more important in healthcare OM and SCM, given the earlier discussion and evidence that strategic issues appear to dominate the healthcare OM and SCM literature in a way that may be uncommon in other fields (see Mabert, 1982). Therefore, it is worthwhile to investigate the potential relationship among research methodologies and a paper's focus on strategic or tactical/operational issues.

A crosstabs chi-square test produced statistically significant results ($X^2=34.66$, $p=0.00$) indicating that a relationship exists between methodology and a paper's focus on strategic or tactical/operational issues. These findings reveal that no statistical difference exists among theoretical/conceptual papers, nor literature reviews. However, 77.8% of tactical/operational studies employed mathematical modeling and simulation techniques compared with only 24.0% of the studies investigating strategic issues (significant at $p<0.05$). On the other hand, 41.3% of strategic studies employed empirical methods compared with only 2.8% of tactical/operational studies (significant at $p<0.05$). Finally, 32.0% of strategic studies employed ethnographic methods compared with only 13.9% of tactical/operational studies (significant at $p<0.05$). These findings appear to encourage researchers investigating strategic issues to employ empirical and ethnographic methods, while researchers examining tactical/operational issue are better served by mathematical modeling and simulation approaches.

7. Content analysis of the most researched topics (top five sections)

Given the unit of analysis under study – individual journal papers – it is important to augment this quantitative analysis with a qualitative summary of some key individual data points (papers) collected for this study (Brewerton and Millward, 2001). As such, in this section, a narrative is provided for the most researched topics identified earlier in Section 6.1.2, Table 5. This section describes 62 studies and highlights opportunities for future research. The five most researched topic sections were: 2.5—information technology and new technology in services, 2.2—general aspects of strategy and objectives of operations in services, 3.1—selection and design of the service delivery system, 2.3—strategic quality issues in services, and 4.2—capacity planning, scheduling, and control. This narrative extends the findings previously presented regarding research question (1) *what are the primary topics or themes in the extant healthcare OM and SCM*

literature, and informs research question (3) *what does the future of OM and SCM research in healthcare hold?*

7.1. Information technology and new technology in services (Topic section 2.5)

Topic section 2.5, Information technology and new technology in services, is the leading section representing 16 studies in this review. The prevalence of research in this area may be owing in part to the substantial investments in the new medical technology and specifically information technology that are afoot in the healthcare industry (Bourgeois et al., 2009; Angst et al., 2011; Dobrzykowski, 2012). Medical technology is broadly defined as procedures, equipment and processes by which medical care is delivered. Information technologies utilized in the healthcare context are usually referred to as health information technology (HIT) (Dobrzykowski, 2012). HIT generally refers to "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of healthcare information, data, and knowledge for communication and decision making" (Thompson and Brailer, 2004, p. 38). Given the pressure for adoption as well as the nascent status of the literature, studies have arisen at both the organizational and individual levels (see Ilie et al., 2009; Angst et al., 2011).

At the organizational level (unit of analysis), researchers have placed an emphasis on investigating how the use of IT in healthcare can influence performance. Li and Benton (2006), in an empirical study, examined the effect of technology management decisions on the hospital performance. They showed that implementation of technology mandates hospitals to provide on-the-job technological training for their staff, and especially for their nurses. The study supports a causal relationship between technology, nurse management decisions, and performance. Their study also shows that large hospitals as well as urban hospitals have a greater tendency towards technology implementation in comparison with smaller and rural hospitals. Lastly, the authors mentioned that including other factors, such as hospital location, or the type of technology, and their potential effect on hospital performance could be considered future research opportunities. In another study, Angst et al. (2011) investigated the effect of the sequence of technology integration on hospital performance. The authors studied 555 hospitals to examine the order of transforming medical technology into information technology via certain processes that convert isolated technologies into interoperable and integrated information systems. The study also examined the effect of different arrangements of sequence on performance, finding support for the notion that hospitals which integrate foundational technologies sooner, tend to perform better. The authors advocate for more detailed studies into the reasons why certain sequences of technology integration yields better results.

Investigating the implementation of specific technologies and particularly information technologies in healthcare context is another stream in the healthcare operations management literature. Botta-Genoulaz and Millet (2006) in a series of case studies examined the use of ERP system in the service industry as opposed to manufacturing industry. One of their case studies focused on the hospital setting. Tzeng et al. (2008), through five different cases studies in Taiwan, demonstrated the commercial value of RFID technology integration and implementation in the healthcare service. In a similar study Amini et al. (2007) showed that the use of RFID technology in healthcare can generate high quality data that can be utilized in simulation modeling which enables healthcare professionals to optimize and improve their processes.

At the individual level (unit of analysis), researchers have investigated technology acceptance in healthcare setting. For instance Chau and Hu (2001) in an empirical study examined the results of a survey from 400 physicians, to test whether the extant technology acceptance models like the technology acceptance model (TAM) and the theory of planned behavior (TPB) are applicable in healthcare context. They found several limitations of these theories in explaining technology acceptance by healthcare professionals. The study also concluded that current technology acceptance instruments developed in the business setting may not have the same validity in the healthcare setting. Similarly, Yi et al. (2006) investigated the role of individual characteristics, like innovativeness, in the acceptance of new information technologies. Based on the results of a survey from 222 healthcare professionals, their study showed that individual innovativeness has direct effect on the behavioral intention of individuals in adoption of technology. As avenues for future research, they propose the exploration of potential mediating variables in the causal relationship. Although the main focus of this study is not the behavioral traits of healthcare professionals, it ought to be of interest to healthcare researchers and managers and thus, we included it in the analysis sample. In a similar study, Ilie et al. (2009) used the technology acceptance model (TAM) to examine the behavior of physicians in accepting electronic medical records (EMR) technology. They showed that accessibility is a major determinant of perceived usefulness and ease of use of EMR technology among physicians.

7.2. General aspects of strategy and objectives of operations in services (Topic section 2.2)

Topic section 2.2, General aspects of strategy and objectives of operations in services, is tied as the second leading section representing 12 studies in this review. Strategic decision making and its effects on performance in the healthcare setting have gained the attention of researchers. For example, Heineke (1995) examined the relationship between operations management decisions and clinical performance in health maintenance organizations (HMOs). These decisions include choices about organization, workforce, quality, planning, and control. The author's empirical analysis of survey data from HMO managers showed that managerial decisions have a significant effect on clinical performance. This study also suggests that other factors such as characteristics of customers, environment, and individual professionals also affect performance. As an avenue for future research, this study proposes to apply this framework in different settings. Butler et al. (1996) investigate links between operations management and hospital strategy. Through a literature review, his study identifies different patterns in clinical and business strategies in hospitals. This study provides 13 suggestions for future research into the applicability of traditional OM concepts (e.g., order winner and order qualifiers) in healthcare.

Many of these studies have been performed using empirical methods. For instance, Goldstein et al. (2002) investigated the effect of location, strategy, and technology on hospital performance. Analysis of the data from survey and secondary sources shows that technology and location is significantly associated with performance. However, strategy could moderate the association between location and performance. As an avenue for future research, this study proposes to perform this study in different geographical locations with different rural and urban configurations. In a subsequent study, Goldstein (2003) investigated the significance of employee development in strategy design in high contact service contexts. Results of empirical analysis reveal that service strategies related to employee development, drive employee outcomes (e.g., productivity and satisfaction). Employee outcomes lead to customer satisfaction, however, only some links to financial performance are significant. As an area for future research, this study proposes to investigate other dimensions of employee development. In another study, Li et al. (2002) examined

the effects of strategic operations management on hospital performance. Results of the analysis of the survey data from community hospitals show that infrastructural operation decisions influence hospital cost, quality, and financial performance once structural decisions of location and size have set the stage. As an opportunity for future research, this study proposes to conduct similar studies in different geographical locations.

McDermott and Stock (2007) examined the relationship between different strategic variables and the performance of the hospital. Results of the analysis of data gathered from a metropolitan hospital support the hypothesized association between location, teaching status, and capacity on the performance of the hospital. This study asserts that there is a trade-off between capital spending and staff decisions. Four years later, McDermott and Stock (2011) investigated the concept of focus in hospitals. This study argues that there is a lack of empirical work to support the effect of focus in hospital performance. Analysis of the secondary data from a large number of patients in a metropolitan area supports the idea that focus is associated with lower cost.

Some studies used ethnographic methods to investigate the implications of strategic decisions. For example, Eastman and Fulop (1997) investigated the causes of resistance against certain innovative regulatory programs for clinicians in an Australian hospital. The results of a case study identified the professional and political problems facing healthcare reform programs, especially those which address management education initiatives for clinicians.

Many of the studies in this group have been conducted through mathematical modeling or simulation. For example, in a mathematical modeling study, Zhang et al. (2011) examined the optimal design of price–volume agreements. The results of this study indicate that price–volume agreements with a 100% rebate rate are suboptimal if payers have the ability to negotiate prices as a provision in the agreement. As a direction for future research, this study proposes to extend the model to include marketing decisions made by manufacturers. This study asserts that marketing decisions might have an impact on the performance. In another study, Ashmos and McDaniel (1996) explored the critical role of specialists in strategic decision making. Specifically this study examined the participation of physicians in decision making in hospitals and found that a more complex model should be utilized to study the participation issue. From a managerial standpoint, this study suggests that executives should pay more attention to physician participation while making strategic decisions. The results also demonstrate that specialists play different roles in different strategic decision making contexts. In another study Specht (1993) investigated a goal programming model that allows for analyzing the trade-off between different healthcare objectives. This model also enables the decision makers to evaluate the budgetary and staff consequences of their decisions. This study is helpful for resource allocation and in predicting future budgeting requirements. McFadden (1996) investigated the role of policy modifications on hospital efficiency. Results from a simulation analysis on data gathered from a large metropolitan hospital shows that policy changes can improve overall efficiency. As an area for future research, this study proposes to extend this model to other hospitals.

7.3. Selection and design of the service delivery system (Topic section 3.1)

Topic section 3.1, Selection and design of the service delivery system, is tied as the second important section representing 12 studies in this review. In a simulation study Cayirli et al. (2008) investigates different approaches to patient classification. The findings of this study have been used to identify best performing appointment systems for different clinic environments. Authors propose that future studies may address the issue of finding a new appointment system that performs well across different clinical conditions. In another study, Gupta (2007) examined the scheduling problems occurring in the surgical suites. Using a mathematical modeling approach, this study shows that adding urgent cases to the daily schedule, as well as mixing different surgeries leads to higher variability and in turn more cancellations and delay. Another study by Helm et al. (2011) proposes an alternative method of admission to hospitals. Conventional admission methods include emergency department and scheduled admissions. Through mathematical modeling using historical data, this study analyzes the new admission method, i.e. the zone-based admission policy, and finds that this policy can enhance admission performance. Kucukyazici et al. (2011) modeled multiple visit patterns of patients categorized by chronic illness. Using data from an acute care hospital, this study identified the optimal care management model and its respective patient and care provider characteristics. This study could be used as a foundation for designing community-based care initiatives. This study could be applied to other healthcare settings as an opening for future research. Another simulation study by Salzarulo et al. (2011) investigated the effects of variability of patient arrival and service process on performance of a healthcare facility. Findings of a discrete event simulation model show that unscheduled visits have the largest impact on performance. Results of the analysis also show that implementing policies that sequence patients according to their classification will enhance the performance.

The concept of focused factory has been investigated in some studies in this group. For instance Hyer et al. (2009) investigated the concept of the focused factory and its application in healthcare setting. Specifically, this study examines how a focus-based approach to organizational redesign can affect practices and processes, and the resulting operational, clinical, and financial outcomes. This study has been performed in a medical center in which the focused hospital unit (FHU) has been established. The analysis of performance before and after this implementation covered a three year period. Results show no variation in morality, moderate enhancement in length of stay, and an improvement in profitability. These results confirm that focus could be an attractive concept in healthcare. In contradiction, (Pieters et al., 2010) investigated the application of the concept of focused factory in healthcare context. Results from analysis of one year of data collected from a hospital department and a clinic practice in its proximity showed that although the studied care sector has been designed in line with the focused factory concept, it does not operate appropriately. This study argues that the origins of this misalignment could be rooted in the specific conditions of the studied healthcare sector. This study suggests that more research be done on the effects of medical conditions on the operational processes and the organization design.

Literature review, case study, and conceptual studies are also represented in this section. Bamford and Griffin (2008), in a case study, investigated human resource management in an OM setting. They specifically studied teamwork among hospital health care workers. Results from survey and group discussions, in a UK national hospital, show that multiple factors contribute to effective teamwork. Among these factors, they refer to leadership, regularity of team meetings, and an atmosphere of trust. The study found limited evidence of multi-disciplinary teams as well as organizational support for teamwork. A new model is proposed for effective team work. Jack and Powers (2004) investigated the effect of volume flexibility to offset the negative outcomes of fluctuating demand in the health services industry. Based on literature review and interviews, this study proposes a framework that encompasses four volume flexibility strategies. This study could guide future research in examining the relationship between different volume flexibility strategies and performance. Lillrank et al. (2011) explored different units of analysis in healthcare

service supply chain. Based on literature review and case studies, this study found that process management is effective when there is structured flow and a sufficient volume of similar repetitions. However, when a substantial level of exceptions exists, a process can be decomposed into service events managed as part of a supply chain. In another study, Van der Vaart et al. (2011) investigated the performance measures of a hospital emergency room (ER), and different factors affecting its operational performance. This study utilizes a combination of time measurement and interviews, and via exploratory data analysis, examines the effect of different practices on the performance of the ER. It finally proposes techniques to streamline the patient flow in the ER.

In terms of empirical studies, Buchanan (1998) investigated business process re-engineering in an acute care teaching hospital. Researchers conducted a process-mapping project on one of the core surgical processes of the hospital. Results from a combination of survey, interviews, and informal discussions used to develop recommendations for process re-engineering to reduce the surgical process delays. This study concludes that a process orientation should be considered as a conceptual device to shape the definition of organization problems. In another study Silvestro (2003) examined telephone health advice service system in UK during the first three years of operation. Results show that the system lacks a central design specification, and this has caused extensive dissimilarity in how different call centers are being operated. This study argues that this variability has strongly diminished the ability of this system to meet its strategic goals.

7.4. Strategic quality issues are services (Topic section 2.3)

Topic section 2.3, Strategic quality issues are services, is tied for the fourth researched topic representing 11 papers in this study. Most of these studies are empirical studies in which the antecedents of a successful quality management project have been the focus. For instance, Meyer and Collier (2001) tested the proposed relationships in the Malcolm Baldrige National Quality Award. The results of the analysis of data from 220 USA hospitals showed significant support for many of the relationships in the Baldrige model. Leadership (Baldrige Category 1.0) a driver of all components in the Baldrige System, including Strategic Planning, Human Resource Development and Management, Information and Analysis, and Process Management. As an avenue for future research, this study proposes to conduct this study in other hospital settings in order to increase generalizable. In another study, Goldstein and Naor (2005) drawing on the organizational publicness theory, examined the association between publicness dimensions and quality practices related to operations. Results from this empirical study analyzing survey data reveal that some dimensions of publicness are associated with some quality management practices. As an opportunity for future research, this study proposes that other dimensions of publicness should be investigated. In a similar study Theokary and Ren (2011) investigated drivers of quality in healthcare. Results of an empirical analysis show that in hospitals with a high teaching orientation, patient volume is associated with diminished quality. As an area for future research, this study proposes an extension to specialty hospitals, which are more focused on specific diseases.

Other studies have looked into human factors in quality management projects. For example, Gowen III et al. (2006) investigated healthcare quality programs, and the value of employee commitment and control plans in such programs. Results from an empirical analysis of survey data from a large number of USA hospitals show that employee commitment and control initiatives are highly related to the performance of quality programs. This study proposes that for future studies similar research could be conducted in other countries for comparative purposes. In a related study, Stock et al. (2007) examine how the culture of organizations and management techniques lead to decreasing medical errors. The results of regression analysis on survey data from a large number of USA hospitals show that some characteristics of organizational culture and certain management techniques are associated with reduction of medical errors. As an avenue for future research, this study proposes that the scope of this paper could be extended to the national level to study the effect of different national cultures on the reduction of medical errors. Marley et al. (2004) investigated the effect of leadership, as well as clinical and process quality on the patient satisfaction in hospital. Results of an empirical analysis on survey data from a large number of USA hospitals show support for the proposed hypotheses. As an avenue for future research, this study proposes that size and type of ownership of the hospitals should be included in the model. Papadopoulos et al. (2011) drawing on the actor-network theory (ANT) explored the dynamics of the implementation of a process improvement project in a UK healthcare organization. Results of a qualitative analysis of the formation and transformation of networks show how different players shift their positions and affiliations over time. This study also shows the importance of interventions to assist actors in shifting their position toward the improved results.

Safety also has been in the center of attention of researchers. McFadden et al. (2006) explored the use of patient safety initiatives (PSI), factors that influence their implementation, and benefits that result from their implementation in the USA hospitals. Results from analysis of survey data shows that barriers such as a lack of top management support, lack of incentives, lack of resources, and lack of knowledge impede implementation while other factors such as the perceived importance of PSIs facilitated implementation. For future research, this study proposes to explore the relationship between organizational culture and patient safety. In a subsequent study, McFadden et al. (2009) investigated the patient safety chain in hospitals. This study asserts that enhancing patient safety starts with a transformational leadership, which in turn leads to forming a culture of safety, adoption of patient safety plans, and finally development in patient safety outcomes. Results of an empirical analysis of survey data from USA hospitals show support for the hypothesized relationships. For future research, this study proposes the exploration of possible factors of patient safety, other than transformational leadership. Tucker (2004, p. 151) investigated the issue of operational failures encountered by hospital nurses. Results of this qualitative study shows that: "(1) most operational failures stem from breakdowns in the supply of materials and information across organizational boundaries and (2) employees quickly compensate for most failures." As an area for future research, this study proposes to extend this research by developing models that can be tested using empirical and mathematical methods.

Some authors have reviewed the applicability of quality initiatives in healthcare. For example, Douglas and Fredendall (2004) examined the applicability of total quality management models in healthcare setting. A combination of survey and secondary data has been used to perform empirical analysis. The results of this analysis shows that total quality management initiatives in hospitals have outcomes similar to those of manufacturing. This study also confirms that leadership has an important role in the success of quality management programs. As an area for future research, this study proposes that considering customer satisfaction as a consequence of continuous improvement could extend this work.

7.5. Capacity planning, scheduling, and control (Topic section 4.2)

Topic section 4.2, Capacity planning, scheduling and control is tied for the fourth researched topic representing 11 papers in this study. This stream begins with Connell et al. (1984) who conducted and developed an optimal heuristic for planning healthcare

food service. By comparing the performance of different planning models, the optimal model significantly reduces costs. As an area for future research, this study proposes the application of this model in other healthcare sectors. In another study Bretthauer and Côté (1998) investigated the efficiency of a general resource planning model in healthcare. This study developed an optimization queuing network to minimize the cost of capacity and enforcing performance constraints. Interestingly, the results show that too much reduction of patient time drives capacity cost increases. Therefore the model identifies a cut-off point for patient time.

Scheduling and optimization are primarily focused on scarce resources such as ICU beds or operating rooms. For instance, Kim et al. (2000) investigated different bed reservation systems in an ICU unit. Using computer simulation, results found no dominant solution for the bed allocation problem. An important result of this study is to establish a specific form of flexible bed allocation system that is shown to enhance performance in terms of cost, utilization, and flexibility. Guinet and Chaabane (2003) investigated a patient planning problem in an operating theater. Mathematical modeling and optimization have been utilized to solve this assignment problem. The results of this analysis optimize the overload and waiting times in the operating theater. Similarly, Marcon et al. (2003) proposed a planning procedure for an operating theatre, through mathematical modeling and simulation. In another study focused on the operating rooms, Jebali et al. (2006) proposed a two-step scheduling approach for operating rooms. In the first step of this approach surgical operations are assigned to operating rooms. In the second step, the assigned operations are sequenced in order to enhance utilization while considering constraints. Mathematical modeling and simulation demonstrated good performance of this scheduling model. In an analogous study, Bretthauer et al. (2011) proposed a solution for the problem of optimal capacity allocation in hospital. Using optimization methods, a new heuristic has been developed and proved to be superior in terms of performance comparing to other approaches in the literature.

Recent studies concentrate on developing creative and innovative scheduling methods. Price et al. (2011) developed an improved surgical scheduling assignment. This study attempted to balance new surgeries and hospital discharges. Through integer programming, a new and improved scheduling system has been developed that matches the patient inflow and outflow. This study shows that this balance could be effective in enhancing utilization. In another study, White et al. (2011) investigate the effect of joint scheduling on performance in an outpatient healthcare facility.

Scarce resources are not limited to ICU beds or operating rooms. Studies have considered other resources such as nurses and medical equipment that need to be utilized in an optimal manner. Wright et al. (2006) examined the nurse scheduling problem and reviewed the effect of healthcare legislation on nursing workforce decisions. This study developed a simulation model to optimize nursing management issues such as reducing the number of shifts without additional cost. In another study Pasin et al. (2002) investigated the effect of equipment pooling on performance. By developing a simulation model, this study quantified the benefits of the pooling process, and evaluated different pooling scenarios.

8. Discussion and contributions

The results of this study provide valuable insights for healthcare practitioners, as well as service operations, and OM and SCM researchers interested in healthcare. In doing so, this research makes a number of important contributions by examining the healthcare OM and SCM literature (1) using quantitative methods to identify the current investigatory themes, (2) quantifying methodological trends, (3) providing a qualitative narrative description of the top research themes, and (4) qualitatively describing directions for future research. These are important contributions which may be of interest to a broad and growing OM and SCM audience given the continuing evolution of the field toward issues of collaboration, customization, and service provision (Gunasekaran and Ngai, 2012). Practitioners ought to be particularly interested in Section 7 of this paper which provides a detailed narrative description of 62 papers organized into five top research themes, and to a lesser extent, the discussion of future research.

In terms of a methodological contribution, this research illustrates the application of an uncommonly structured approach to literature review employed in the healthcare OM and SCM context (following Mayring, 2003). This structured approach, consisting of four well defined stages – (1) material collection, (2) descriptive analysis, (3) category selection, and (4) material evaluation – provides a procedurally rigorous method for collecting and analyzing relevant literature. Mayring's (2003) structured literature review approach was complemented with the sound methods employed to review and analyze the service operations literature from Machuca et al. (2007). This involved the use of four independent judges who screened nearly 10,000 papers, reviewed and assigned 117 papers from seven leading OM and SCM journals (Barman et al., 2001) to topical and methodological categories using a framework based largely on Aguilar Escobar and Machuca (2000). This produced a valuable reading list which can be found in Appendix A. Next, this study followed Machuca et al. (2007) in employing non-parametric statistical testing (chi-square testing) to examine key relationships among important factors such as publication volume, chronology (time), journal outlets, topic groupings, topics, topic sections, and research methods. The consequent findings provide important insights into the state of the healthcare OM and SCM research. Finally, a rich qualitative description of the studies extant in five prominent themes in the literature was provided in Section 7 (Ngai et al., 2008; Irani et al., 2010; Gunasekaran and Ngai, 2012).

These results suggest that the frequency of healthcare OM and SCM studies increased significantly starting in 1995 and again in 2000, and has remained at peak levels since that time. It is noteworthy to observe that the most recent collection period in this study (2010–2011) is incomplete with three more years of publication potential, and already the number of publications during this period is statistically the same as the preceding period (2005–2009). As such, it may be that another punctuation in the growth of healthcare OM and SCM research is underway at present. This trend indicates that leading OM and SCM journals are attempting to address the need for research into healthcare OM and SCM identified by a plethora of scholars such as McKone-Sweet et al. (2005), Shah et al. (2008), and Boyer and Pronovost (2010) among others.

The volume of healthcare OM and SCM research has trended upward since 1995. This is important to researchers as it signals that the leading OM outlets appear to have an appetite for healthcare OM and SCM studies. That said, differences have emerged in the pace of publication in recent years. IJPE published a significantly higher proportion of its healthcare OM and SCM studies in the most recent complete collection period (2005–2009). This is significantly higher than IJOPM and POM. While not statistically significant, on the face, this is higher than JOM, DSJ, and SCMIJ. However, when considering the 2010–2011 (incomplete) collection period, POM has led all OM journals in terms of the proportion of their healthcare OM and SCM publications due in part to a special issue in 2011. This is not statistically different from the SCM journals. These findings indicate that IJPE and POM may have the greatest growing appetite for healthcare

OM and SCM studies at present. As a matter of fact, POM has launched an Industry Studies and Public Policy division which seeks research that 'furthers the current understanding of operations by explicitly accounting for industry-specific contextual details that motivate, describe, or improve a firm's, organization's, or industry's operational decisions or outcomes.' However, scholars should be reminded that none of the OM journals differ in terms of their 30-year publication record, indicating that JOM and IJOPM have steadily published healthcare OM and SCM research. It would also appear that there is a growing interest in healthcare OM and SCM among the SCM journals as evidenced by a 2011 special issue of SCMIJ.

In addition to these general trends, this study informs two important research questions related to topic and methodological trends. In examining topic trends (research question 1), the two leading topics appearing in the healthcare OM and SCM literature are (1) service operations strategies and objectives, and (2) planning, scheduling, and control of services. This provides two appealing topics: one for those researchers interested in strategic issues in healthcare OM and SCM involving service operations strategies and objectives, as well as one for those scholars who choose to investigate tactical/operational issues such as planning, scheduling, and control of services. These findings also indicate that these topics have been stable over the 30 years and do not differ by journal. However, when considering journal preferences, these results reveal that POM publishes a higher proportion of papers in topic 3—Service operations and design compared to topic 2—Service operations strategies and objectives indicating a preference by POM for topic 3 papers. The topics appear to be stable for the other journals in the study. This is useful knowledge for researchers and practitioners interested in issues of service operations and design.

Topic sections (or subtopics) were also examined in terms of frequency to provide healthcare executives and scholars with more granularity regarding topic trends. A group of five topic sections emerged as statistically significant (more prevalent) than competing groups of topic sections. The most prevalent topic sections emerged as: (1) Information technology and new technology in services, (2) general aspects of strategy and objectives of operations in services, (3) selection and design of the service delivery system, (4) strategic quality issues in services, and (5) capacity planning, scheduling, and control. This list provides healthcare executives and scholars with a list of 'hot topics,' offering a picture of the state of research in healthcare OM and SCM. The first four of these topic sections highlight strategic level concerns for healthcare executives, while the fifth topic section describes tactical/operational level issues.

Studies investigating strategic issues also proved to dominate tactical/operational research when testing the entire sample of healthcare OM and SCM papers. To the authors' knowledge the present study is the first to provide an examination of strategic and tactical/operational issues in the healthcare OM and SCM literature. While the results run counter to some studies in service operations (e.g., Pannirselvam et al., 1999), these findings are consistent with Machuca et al. (2007) in their analysis of the service operations literature. Further, given the nascent state of the healthcare OM and SCM literature, it is logical to expect that research would begin by identifying and testing phenomena at the strategic level *a priori* conducting tactical studies aimed at the refinement of operational activities.

The final set of findings informs the second research question querying methodological trends in the healthcare OM and SCM literature. Mathematical modeling and simulation and empirical studies are the most frequently employed methods, followed by ethnographies. Theory/conceptual papers and literature reviews are statistically the same and lag behind mathematical modeling, empirical, and ethnographic studies. These results indicate that methodological approaches have been fairly stable over time; however empirical research experienced an increase when comparing the periods 1995–1999 and 2000–2004. This peak in empirical studies held steady in the succeeding 2005–2009 period. This indicates that although empirical and mathematical modeling and simulation studies are statistically the same in terms of frequency, empirical methods may be quickly gaining acceptance in the healthcare OM and SCM literature. The uptake in empirical methods may also be related to the growth in healthcare OM and SCM publications which transpired during roughly the same period, given that empirical methods, particularly survey method, flourished in the 1990s and 2000s.

This study provides insights into the frequency of methodologies published by each of the seven leading journals studied herein. These results indicate that a relationship does exist between journal and methodology. Specifically, POM published the lowest proportion (0%) of ethnographies, steering researchers attempting to publish case studies in the direction of the other outlets, particularly SCMIJ which published 100% ethnographies. JOM and DSJ published the highest proportion of empirical studies, statistically the same as IJOPM, positioning these as appealing outlets for empiricists. Finally, POM published the highest proportion of mathematical modeling and simulation papers, statistically the same as IJPE, positioning both journals as attractive outlets for mathematical modelers. In considering methodologies and topics, this study finds that empirical methods are most prevalent in studies of service operations strategies and objectives (topic 2), while mathematical modeling and simulation is preferred in studies examining planning, scheduling, and control of services (topic 4). Finally, methodological differences were also found when examining research approaches in strategic and tactical/operational studies. Strategic papers tend to employ empirical methods, while tactical/operational studies are more likely to employ mathematical modeling and simulation approaches. These are key findings as researchers consider appropriate methodological approaches to suite their study's target problem.

The final, and perhaps most substantial, contribution of this paper is found in Section 7, a content analysis of the most researched topics. The section provides a detailed description of 62 studies and highlights future research opportunities. The papers are organized in five leading categories, providing a valuable resource for scholars as well as practitioners interested in learning about key topics in healthcare OM and SCM. The five topics are: (1) information technology and new technology in services, (2) general aspects of strategy and objectives of operations in services, (3) selection and design of the service delivery system, (4) strategic quality issues in services, and (5) capacity planning, scheduling, and control.

9. Limitations and future research

While this study made a number of important contributions to the field, it is not without shortcomings. It would be useful to repeat this study in the future as healthcare operations is a dynamic field facing substantial change. This change has been reflected in some of the trends identified in this study. One key issue worthy of future exploration might be data collection methods and sources. As the availability of publically available archival data in the healthcare industry increases, it is likely that authors will pursue research featuring multiple data collection sources and perhaps multiple analysis methods. Next, when repeating this study, it may be beneficial to expand the number of journal outlets included in developing the sample of healthcare OM and SCM papers. While

the focus of this study centered on healthcare OM and SCM studies published in leading OM and SCM journals, it may be interesting to include dedicated healthcare journals for comparative purposes. Likewise, as the SCM field evolves, it is likely that new journals will emerge dedicated to supply chain issues. It would also be useful to extend this literature review by identifying key constructs and relationships in the healthcare OM and SCM field for a meta-analysis. Section seven of this paper could serve as a foundation for such a meta-analysis. A key limitation of this study is the fact that only two SCM journals were surveyed during data collection. The inclusion of additional SCM journals would improve future extensions of this research.

In summary, the healthcare sector faces increasing challenges centered on issues that have historically been studied by OM and SCM researchers, and more generally business researchers, but often in other contexts (e.g., for-profit manufacturing). As such, business scholars have much to contribute that can improve healthcare sector performance if researchers understand and are sensitive to the unique conditions facing providers (Boyer and Pronovost, 2010). For example, basic business practices such as measuring costs and understanding value have rarely been adopted by healthcare providers owing to the prevalent notion that "…costs are too complex to allocate accurately," and greater goals exist such as the mortality of their patients (Kaplan and Porter, 2011, p. 57). Business researchers can make meaningful contributions in healthcare OM and SCM when research is conducted with an open lens to the issues facing healthcare providers. As such, business research is shifting to embrace non-traditional nuances in contexts such as healthcare with the recognition that "business and society have been pitted against each other for too long," and a more holistic understanding of the challenges facing an organization, how an organization operates, and how performance can be improved evolves (Porter and Kramer, 2011, p. 64).

Appendix A. Reading list (117 papers analyzed in this study)

Year	Lead author	Journal	Vol	Issue	Topic category	Methodology category
1996	Ashmos	DS	27	1	General aspects of strategy and objectives of operations in services	Empirical
1998	Bretthauer	DS	29	1	Capacity planning, scheduling and control	Math modeling/ simulation
2001	Chau	DS	32	4	Information technology and new technology in services	Empirical
2004	Douglas	DS	35	3	Strategic quality issues in services	Empirical
2003	Edmondson	DS	34	2	Information technology and new technology in services	Math modeling/ simulation
2009	Fredendall	DS	40	2	Service operations design in supply chains	Case study
2009	Gnanlet	DS	40	2	Capacity design/long-term capacity and demand decisions	Math modeling/ simulation
2009	Ilie	DS	40	2	Information technology and new technology in services	Empirical
2007	Laganga	DS	38	2	Planning, scheduling and control of service operations	Math modeling/ simulation
2004	Marley	DS	35	3	Strategic quality issues in services	Empirical
2000	May	DS	31	1	Design, measurement and compensation of service work	Math modeling/ simulation
2009	Ross	DS	40	2	Supply chain strategies and objectives	Math modeling/ simulation
1989	Safizadeh	DS	20	3	Service management	Empirical
2008	Shah	DS	39	4	Supply chain strategies and objectives	Case study
2009	Sinha	DS	40	2	Supply chain strategies and objectives	Theory/conceptual
1988	Smith-Daniels	DS	19	4	Introduction and key issues of management in services	Theory/conceptual
1992	Umanath	DS	23	4	Information technology and new technology in services	Empirical
1993	Wertheim	DS	24	3	Service management	Empirical
2006	Wright	DS	37	1	Planning, scheduling and control of service operations	Math modeling/ simulation
2010	Wright	DS	41	2	Capacity planning, scheduling and control	Math modeling/ simulation
2006	Yi	DS	37	3	Information technology and new technology in services	Empirical
2002	Adan	IJOPM	22	4	Planning, scheduling and control of service operations	Math modeling/ simulation
1999	Al-Shammari	IJOPM	19	9	Service productivity	Math modeling/ simulation
2011	Ancarani	IJOPM	31	3	Service management	Empirical
1993	Badri	IJOPM	13	3	Planning, scheduling and control of service operations	Math modeling/ simulation
2008	Bakker	IJOPM	28	4	Information technology and new technology in services	Case study
2008	Bamford	IJOPM	28	3	Selection and design of the service delivery system	Case study
2002	Boaden	IJOPM	22	4	Introduction and key issues of management in services	Theory/conceptual
2011	Broekhuis	IJOPM	31	3	Service management	Case study

1998	Buchanan	IJOPM	18	12	Selection and design of the service delivery system	Case study
2006	Dey	IJOPM	26	8	Design, measurement and compensation of service work	Math modeling/ simulation
2001	Fowler	IJOPM	21	3	Design, measurement and compensation of service work	Empirical
1999	Gemmel	IJOPM	19	9	Planning, scheduling and control of service operations	Literature review
2011	Lee	IJOPM	31	11	Supply chain strategies and objectives	Empirical
2002	Longo	IJOPM	22	4	Design, measurement and compensation of service work	Case study
2007	Mcdermott	IJOPM	27	9	General aspects of strategy and objectives of operations in services	Empirical
1996	Mcfadden	IJOPM	16	3	General aspects of strategy and objectives of operations in services	Math modeling/ simulation
2006	Mcfadden	IJOPM	26	3	Strategic quality issues in services	Empirical
2011	Papadopoulos	IJOPM	31	2	Strategic quality issues in services	Case study
2002	Pasin	IJOPM	22	4	Capacity planning, scheduling and control	Math modeling/ simulation
2010	Pieters	IJOPM	30	11	Selection and design of the service delivery system	Case study
1997	Procter	IJOPM	17	8	Information technology and new technology in services	Case study
2005	Ramanathan	IJOPM	25	1	Service productivity	Math modeling/ simulation
2002	Rivard-Royer	IJOPM	22	4	Supply chain strategies and objectives	Empirical
2002	Sarkis	IJOPM	22	3	Design, measurement and compensation of service work	Math modeling/ simulation
2003	Silvestro	IJOPM	23	4	Selection and design of the service delivery system	Empirical
1993	Specht	IJOPM	13	9	General aspects of strategy and objectives of operations in services	Math modeling/ simulation
2002	Waring	IJOPM	22	4	Information technology and new technology in services	Empirical
2005	Amini	IJPE	96	3	Service operations design in supply chains	Math modeling/ simulation
2006	Botta-Genoulaz	IJPE	99	1–2	Information technology and new technology in services	Case study
2008	Chiaramonte	IJPE	114	2	Planning, scheduling and control of service operations	Math modeling/ simulation
2008	Combes	IJPE	112	1	Short-term scheduling and control	Math modeling/ simulation
2011	De Vries	IJPE	133	1	Inventory management and control	Case study
1996	Dellaert	IJPE	46	0	Inventory management and control	Math modeling/ simulation
1997	Eastman	IJPE	52	1–2	General aspects of strategy and objectives of operations in services	Case study
2009	Fei	IJPE	120	2	Short-term scheduling and control	Math modeling/ simulation
2003	Guinet	IJPE	85	1	Capacity planning, scheduling and control	Math modeling/ simulation
2009	Haijema	IJPE	121	2	Inventory management and control	Math modeling/ simulation
2006	Jebali	IJPE	99	1–2	Capacity planning, scheduling and control	Math modeling/ simulation
2002	Lillrank	IJPE	78	1	Information technology and new technology in services	Case study
2003	Marcon	IJPE	85	1	Capacity planning, scheduling and control	Math modeling/ simulation
2008	Reymondon	IJPE	112	1	Inventory management and control	Math modeling/ simulation
1996	Roberta Minifie	IJPE	46–47	0	Introduction and key issues of management in services	Theory/conceptual
2004	RodríGuez-Álvarez	IJPE	92	2	Service productivity	Empirical
2007	Stock	IJPE	106	2	Strategic quality issues in services	Empirical
2008	Tzeng	IJPE	112	2	Information technology and new technology in services	Case study
2011	Van Der Vaart	IJPE	133	1	Selection and design of the service delivery system	Case study
2010	Boyer	JOM	28	5	Introduction and key issues of management in services	Theory/conceptual
1996	Butler	JOM	14	2	General aspects of strategy and objectives of operations in services	Literature review
1984	Connell	JOM	5	1	Capacity planning, scheduling and control	Math modeling/ simulation
2005	Goldstein	JOM	23	2	Strategic quality issues in services	Empirical
2002	Goldstein	JOM	20	1	General aspects of strategy and objectives of operations in services	Empirical

2006	Gowen III	JOM	24	6	Strategic quality issues in services	Empirical
1995	Heineke	JOM	13	4	General aspects of strategy and objectives of operations in services	Empirical
2009	Hyer	JOM	27	3	Selection and design of the service delivery system	Case study
1996	Klassen	JOM	14	2	Short-term scheduling and control	Math modeling/ simulation
2011	Laganga	JOM	29	5	Capacity design/long-term capacity and demand decisions	Case study
2006	Li	JOM	24	5	Information technology and new technology in services	Empirical
2002	Li	JOM	20	4	General aspects of strategy and objectives of operations in services	Empirical
2011	Mcdermott	JOM	29	6	General aspects of strategy and objectives of operations in services	Empirical
2009	Mcfadden	JOM	27	5	Strategic quality issues in services	Empirical
2001	Meyer	JOM	19	4	Strategic quality issues in services	Empirical
2011	Queenan	JOM	29	7–8	Information technology and new technology in services	Empirical
1982	Steinberg	JOM	2	4	Inventory management and control	Case study
2000	Kim	JOM	18	4	Capacity planning, scheduling and control	Math modeling/ simulation
2004	Tucker	JOM	22	2	Strategic quality issues in services	Case study
2005	Mckone-Sweet	JSCM	41	1	Introduction and key issues of management in services	Literature review
2007	Amini	POM	16	5	Information technology and new technology in services	Math modeling/ simulation
2011	Angst	POM	20	3	Information technology and new technology in services	Math modeling/ simulation
2011	Bretthauer	POM	20	3	Capacity planning, scheduling and control	Math modeling/ simulation
2003	Cayirli	POM	12	4	Planning, scheduling and control of service operations	Literature review
2008	Cayirli	POM	17	3	Selection and design of the service delivery system	Math modeling/ simulation
2011	Chow	POM	20	3	Short-term scheduling and control	Math modeling/ simulation
2011	Dobson	POM	20	3	Short-term scheduling and control	Math modeling/ simulation
2003	Goldstein	POM	12	2	General aspects of strategy and objectives of operations in services	Empirical
2007	Green	POM	16	1	Capacity design/long-term capacity and demand decisions	Math modeling/ simulation
2011	Gul	POM	20	3	Short-term scheduling and control	Math modeling/ simulation
2007	Gupta	POM	16	6	Selection and design of the service delivery system	Math modeling/ simulation
2011	Helm	POM	20	3	Selection and design of the service delivery system	Math modeling/ simulation
2004	Jack	POM	13	3	Selection and design of the service delivery system	Empirical
2011	Kucukyazici	POM	20	3	Selection and design of the service delivery system	Math modeling/ simulation
2011	May	POM	20	3	Introduction and key issues of management in services	Literature review
2011	Patrick	POM	20	3	Capacity design/long-term capacity and demand decisions	Math modeling/ simulation
2011	Price	POM	20	3	Capacity planning, scheduling and control	Math modeling/ simulation
2011	Salzarulo	POM	20	6	Selection and design of the service delivery system	Math modeling/ simulation
2011	Theokary	POM	20	3	Strategic quality issues in services	Empirical
2011	White	POM	20	3	Capacity planning, scheduling and control	Math modeling/ simulation
2011	Zhang	POM	20	3	General aspects of strategy and objectives of operations in services	Math modeling/ simulation
2011	Aronsson	SCMIJ	16	3	Supply chain strategies and objectives	Case study
2011	Bhakoo	SCMIJ	16	3	Information technology and new technology in services	Case study
2007	Ford	SCMIJ	12	1	Planning, scheduling and control of service operations	Case study
2008	Kumar	SCMIJ	13	2	Service operations design in supply chains	Case study
2011	Lillrank	SCMIJ	16	3	Service operations design in supply chains	Case study
2011	Meijboom	SCMIJ	16	3	Service operations design in supply chains	Case study
2009	Mustaffa	SCMIJ	14	3	Supply chain strategies and objectives	Case study
2010	Rahimnia	SCMIJ	15	1	Inventory management and control	Case study
2000	Ritchie	SCMIJ	5	5	Service operations design in supply chains	Case study

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