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Conducting systematic literature review in operations management

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ABSTRACT

Systematic literature review (SLR) is a well-known research method. However, there is a paucity of detailed SLR guidelines in operations management (OM). The recent interest in SLR in OM has not been followed by the same rigour observed in disciplines as medical sciences and public policy. There are no OM-specific SLR protocols, detailed step-by-step methods and reporting procedures. Therefore, this paper provides a step-by-step approach to SLR for OM scholars and an overview of SLR's evolution as a research method in OM and the resulting progression of themes. The step-by-step approach aims to serve as a guideline sufficiently broad to avoid skipping any significant step, but still being easy to be understood and applied. The paper describes procedures for rigourous SLR, reveals a growing use of literature review in OM, specially for qualitative SLR and traditional narrative reviews, assesses contemporary and emerging themes in OM, and provides a research agenda.

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Research synthesis; narrative review; meta-analysis; aggregative synthesis; bibliometric analysis

1. Introduction

Literature review (LR) improved significantly over the years, from traditional narrative review to systematic reviews (Cook, Mulrow, and Haynes 1997; Petticrew and Roberts 2006; Fahimnia et al., 2015). A systematic literature review (SLR) is an important research endeavour by itself and not merely a review of previous writings. It responds to specific research questions (RQs) and is a 'methodology that locates existing studies, selects and evaluates contributions, analyses and synthesizes data, and reports the evidence in such a way that allows reasonably clear conclusions to be reached about what is and is not known' (Denyer and Tranfield 2009, 671). SLR differs from narrative reviews by adopting a more rigorous and well-defined review process (Cronin, Ryan, and Coughlan 2008), by following protocols that include comprehensive searches for all potentially significant studies (Cook, Mulrow, and Haynes 1997), and by its replicability, offering an audit trail of all the reviewers research steps in a scientific and transparent manner (Tranfield, Denyer, and Smart 2003).

SLR has been frequently applied in psychology, medical and social sciences research for many decades to provide in-depth answers to specific questions, in support of practice and policy-making (Mulrow 1994; Cook, Mulrow, and Haynes 1997; Hart 1998; Campbell et al. 2003; Petticrew and Roberts 2006; Hunter and Schmidt 2015). The successful applications in these sciences pave the way to disseminate this research method to other fields, such as operations management (OM). Scholars in the management sciences still have little training and know-how in conducting research reviews of the literature, which often result in the production of narrative reviews that lack critical assessments (Tranfield, Denyer, and Smart 2003; Rousseau, Manning, and Denyer 2008; Denyer and Tranfield 2009). Furthermore, recent interest in SLR in OM was not followed by the same rigour observed in medical sciences and public policy, where well-established SLR repositories and clearing houses such as the Cochrane Collaboration and the Campbell Collaboration exist for decades. In addition, despite the existence of guidelines for SLR in general management (Tranfield, Denyer, and Smart 2003; Rousseau, Manning, and Denyer 2008; Denyer and Tranfield 2009), there are no detailed step-by-step guidelines to conduct SLRs in OM. The OM literature does offer detailed guidelines for other research methods widely adopted within this research field, such as surveys (e.g. Forza 2002), case studies (e.g. McCutcheon and Meredith 1993; Voss, Tsikriktsis, and Frohlich 2002) and action research (e.g. Coughlan and Coghlan 2002), but not for SLR in OM. One may notice the existence of the term 'survey of the literature'. Following Forza (2002), the term survey 'involves the collection of information from individuals (…) about themselves or about the social units to which they belong'. When the collection of the information is from the literature, the term LR applies, while some authors may call it 'survey of the literature', usually denoting narrative reviews based on purposeful sampling of the literature (e.g. Pandey and Hasin 1998). General guidelines of SLR in management and in OM are described elsewhere and are taken into account in this paper. In particular, Tranfield, Denyer, and Smart (2003) define the terminology and delineate the major phases of a SLR in management. Seuring and Gold (2012) present guidance for qualitative content analysis and review the process of a number of SLR in the field of Supply Chain Management (SCM). Colicchia and Strozzi (2012) describe SLR techniques in combination with citation network analysis (CNA) and apply it to

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risk analysis in SCM. Cobo et al. (2011, 2012) devolp quantitative techniques for content analysis of co-occurrences of citations and keywords, retracing the evolution of research themes, or thematic areas, and apply it to the field of intelligent transportation systems, among others. However, none of the authors intended to provide a detailed step-by-step approach as the one proposed in this paper and to apply it to a comprehensive review of SLR in the OM field. Within this context, the following RQs are put forward:

RQ-1: How should a SLR be conducted in OM?

RQ-2: Has SLR been used as a research method in OM and if so how?

The main goal of this paper is twofold: (i) to provide OM scholars with a step-by-step approach to conduct a SLR; and (ii) to provide an overview of the evolution of SLR as a research method and of the progression of themes in OM-LRs. Therefore, the authors aim to contribute to disseminate further this review technique in the OM field, alerting scholars of the research opportunities offered by its correct application.

This paper is organised as follows. First, definitions of different LR techniques are given. A SLR step-by-step approach is proposed in Section 3, addressing RQ-1, and applied in Section 4, addressing RQ-2. The authors' main conclusions and recommendations for future research close the paper.

2. Definitions of LR techniques

A LR summarises and provides a critical assessment of the available literature on a specific subject (Hart 1998). Its application area is broad, embracing knowledge emanated from research- and non-research-related literature. Cooper (2010) proposes the designation of research synthesis for the type of LR focused on research. It is the collective term for a set of approaches used to review different studies on a subject or RQ (Tranfield, Denyer, and Smart 2003). Petticrew and Roberts (2006) identify eight different types of LRs: systematic or evidence synthesis, narrative, conceptual, rapid, realistic, critical, expert and state-of-the-art. This section concentrates in the systematic review subdividing it into meta-synthesis and meta-analysis, as defined next.

A SLR uses well-defined and rigorous criteria to identify, appraise and synthesise the literature, including a list of studies published in peer-reviewed and gray literature. Gray (or grey) literature is defined as any material not easily identifiable by traditional bibliographic index or database, such as newsletters, reports, working papers and thesis (Rothstein and Hopewell 2009). SLR aims to answer a particular RQ, test hypotheses and theories, or build new theories, limiting at the same time systematic error or bias (Petticrew and Roberts 2006; Cronin, Ryan, and Coughlan 2008; Higgins and Green 2008; Campbell Collaboration 2014). In this sense, it is 'less of a discussion of the literature and more of a scientific tool' (Petticrew and Roberts 2006). Mulrow (1994) highlights nine uses of SLR. First, it contributes to reduce large amounts of information. Second, it integrates 'critical pieces' of information for decision-making, research and policy. Third, it is an efficient scientific technique usually less costly than new research, particularly if it is updated continuously. Fourth, it eases the generalisability of findings by regrouping similar results from different populations or interventions. Fifth, it allows a systematic assessment of relationships among variables. Sixth, it puts in evidence and helps explaining data inconsistency and contradictory findings in a given field. Seventh, it increases statistical power in quantitative synthesis. Eighth, it increases the precision in the estimation of statistical risks. Ninth, by systematically reporting procedures and methods, it should improve the accuracy or at least allow verification. Meta-analysis is a quantitative approach for SLR. It applies to the statistical analysis of a large collection of results from individual studies (Glass 1976). Findings on the same subject are averaged or reduced to a common metric through the use of standardised statistical procedures (Cronin, Ryan, and Coughlan 2008; Cooper, Hedges, and Valentine 2009; Hunter and Schmidt 2015). Findings are aggregated (Rousseau, Manning, and Denyer 2008), synthesised into a single quantitative estimate (i.e. a summary effect size) (Petticrew and Roberts 2006). Therefore, the term aggregative synthesis (Rousseau, Manning, and Denyer 2008) is also applied for meta-analysis.

Although SLR is frequently considered synonymous to meta-analysis (Tranfield, Denyer, and Burr 2004), it is not limited to quantitative synthesis (Petticrew and Roberts 2006). The qualitative approach might be particularly relevant for management sciences, as researchers in this field tend to address divergent questions with a diverse range of research designs and often with different definitions for the same constructs (Tranfield, Denyer, and Smart 2003; Tranfield, Denyer, and Burr 2004). Qualitative SLR puts together findings from different studies on a chosen subject aiming to achieve greater understanding and attain a level of conceptual or theoretical development beyond what can be obtained by any individual study (Campbell et al. 2003). This approach helps in identifying themes among different studies and assists in theory test and theory-building by exploring differences and similarities between studies (Petticrew and Roberts 2006). It challenges the reviewer to analyse studies in enough detail to preserve the individual integrity of each of them, without getting lost in details, producing usable synthesis (Sandelowski, Docherty, and Emden 1997). Meta-ethnography (Campbell et al., 2003) and realistic synthesis (Tranfield, Denyer, and Smart 2003) are examples of this approach. Although meta-synthesis is a qualitative SLR technique, it is often combined with quantitative methods, as in quantitative content analysis (Krippendorf 2004) and CNA (Colicchia and Strozzi 2012). Bibliometric quantifications and the study of the frequencies of co-citation and co-word networks are robust techniques to classify thematic areas, clusters-related research fields and researchers, and to identify and visualise contemporany and emerging themes (Zhao and Strotmann 2015; Fahimnia et al., 2015; Thomé et al., forthcoming).

In the remainder of this paper, the term meta-synthesis (Tranfield, Denyer, and Smart 2003) is adopted for qualitative SLR, reserving the term meta-analysis (Hunter and Schmidt 2015) to the secondary statistical analysis of statistical results from primary research. Method-specific guidelines go beyond the realm of this paper and can be consulted in Petticrew and Roberts (2006), Cobo et al. (2011), Hunther and Schmidt (2015) and Zhao and Strotmann (2015), among others.

3. A step-by-step approach

This step-by-step approach is a guideline. Some LR techniques embrace all steps while others will fit in some but not all steps. For instance, inter-coder reliability steps might be less critical in meta-analysis than it is in meta-synthesis. However,

the proposed approach herein should guide the main phases of LR. It embraces eight steps based on Cooper's (2010) seven-step approach for research synthesis, Higgins and Green (2008) guidelines for SLR updates and Zhao and Strotmann (2015) procedures for CNA. The eight steps are: (i) planning and formulating the problem; (ii) searching the literature; (iii) data gathering; (iv) quality evaluation; (v) data analysis and synthesis; (vi) intrepretation; (vii) presenting results; and (viii) updating the review. Each major step comprises specific substeps or tasks. Reliability checks among researchers are performed along the entire process, with emphasis in search reliability for study selection (Step 2) and consistency of category coding during data gathering (Step 3). Figure 1 despicts the main SLR steps.

3.1. Planning and formulating the problem

At the onset of the review, a team should be constituted and be involved in all the major steps of the process (Higgins and Green 2008; CRD 2009; Campbell Collaboration 2014). The use of multiple reviewers should ensure transparency, strength the search for inclusiveness and assist in synthesising and reporting results, satisfying the three Denyer and Tranfield's (2009) quality

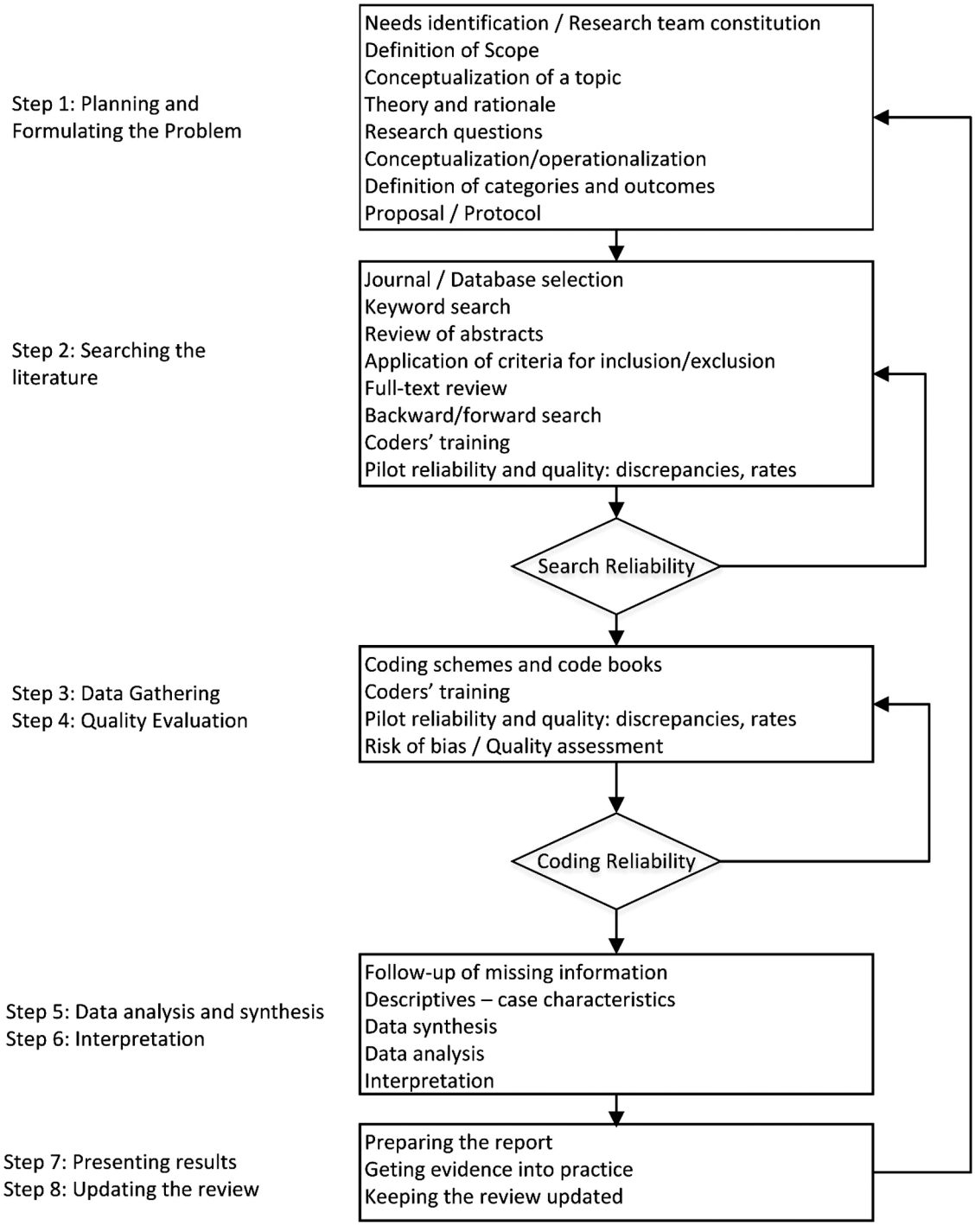


Figure 1. Eight steps to conduct a SLR in OM.

criteria for SLR in management: transparency, inclusiveness and explanatory power.

Ascertaining the need for a SLR is also an initial requirement (Tranfield, Denyer, and Smart 2003; Higgins and Green 2008; CRD 2009; Campbell Collaboration 2014). One should check the existence of a LR in a given topic scrutinising major Journals, vendor and citation databases. SLR can be conducted for both new and well-established research areas. For the later, a tertiary research under the form of a meta-analysis or of a review of reviews (overviews) often applies (Higgins and Green 2008; Campbell Collaboration 2014).

Once decided to conduct a SLR, it is advisable to define clearly the scope (Cooper 1988; vom Brocke et al. 2009). Cooper's (1988) suggested taxonomy of SLR scope comprises research focus, goal, perspective, coverage, organisation and audience. Focus refers to the central issue of interest (research outcomes and methods, theories and applications). Goals of LR can be integrative synthesis, critical review and identification of central issues in a field. Perspective describes the point of view of the reviewer and can be neutral or passionate defence or espousal of a position. Coverage is classified in exhaustive or comprehensive presentation of works, exhaustive with selective citation based on a survey of selected papers, representative of a research field, and central or pivotal presentation of works or topics in a given field. The second type of exhaustive coverage is usually called a 'survey of the literature'. It is important to notice that both types of exhaustive coverage claim to cover the whole field but only the first reveals the information base and selection criteria that allow the reader to evaluate exhaustiveness and representativeness of the cited literature (Cooper 1988). LR can be organised among three axis: historical, methodological or conceptual. Finally, the audience of a LR can be specialised scholars, general scholars, practitioners or policy-makers, and the general public. The definition of LR's scope is important for three reasons: (i) to situate the reader from the outset about LR aims and reach; (ii) to assist in directing the research; and (iii) to structure the reporting of results.

The next phase is the identification of the research topic (Cronin, Ryan, and Coughlan 2008; vom Brocke et al. 2009), which Torraco (2005, 359) defines as 'a broad conception of what is known about the topic and potential areas where knowledge may be needed'. The theories and rationale for the SLR are clearly stated at this point: 'What will be analysed and why?' and 'Which theories apply?' (Neuendorf 2002). What are the RQs? Specific guidelines to formulate RQ differ in medicine (e.g. CRD 2009), social sciences (e.g. Petticrew and Roberts 2006) and management. For the latter, the acronym CIMO describes the required constituent parts of the RQ: context, intervention, mechanisms and outcomes (Denyer and Tranfield 2009). The conceptualisation and operationalisation stage follows the RQ. It consists of defining the variables included in the SLR and specifying with which categories to measure them. For both quantitative and qualitative reviews, the categories of variables should be exhaustive and mutually exclusive. While predefined categories are paramount in meta-analysis (Lipsey and Wilson 2001), qualitative content analysts often resort to a combination of categories deducted during the analysis with categories predefined at the onset (Neuendorf 2002).

The stage of problem formulation should be reflected in the SLR proposal (Tranfield, Denyer, and Smart 2003) or protocol (Higgins and Green 2008; CRD 2009; Campbell Collaboration 2014). Protocols are frameworks, used in the SLR process, which are developed before the start of the literature search. They describe specific steps, including at least the research topic and questions, the search strategy with criteria to include/exclude studies, methods used to retrieve studies, criteria for the determination of findings, details about coding, statistical procedures and treatment of qualitative research (White 2009; Moher et al. 2015).

3.2. Searching the literature

A seven-step approach is recommended to search and select studies, based on vom Brocke et al. (2009), Thomé et al. (2012), and Thomé, Hollmann, and Scavarda (2014). The steps are: (i) bibliographic database or journals selection, (ii) keywords search, (iii) review of selected abstracts, (iv) application of criteria for inclusion/exclusion of studies, (v) full-text review of selected papers, (vi) backward search and (vii) forward search in retrieved papers. A pilot reliability and quality check should be conducted in this step to resolve inter-coders discrepancies, as well as coder's training to validate and improve conceptual alignment among coders. The selection of studies (Steps iv, vi and vii) can be automated with the application of search and data reduction algorithms (e.g. Persson 1994; Cobo et al. 2011).

The literature search starts with the database selection in accordance with the research protocol. Examples of databases are citation databases (e.g. Reuter's ISI of Web™, Scopus from Elsevier), aggregate collections, vendors databases as academic publishers and journal titles. At least two but preferably more than two databases or journals should be searched (Levy and Ellis 2006; vom Brocke et al. 2009; Thomé et al. 2012; Thomé, Hollmann, and Scavarda 2014). Citation databases ensure a broader diversification of studies, as it indexes several Journals and vendors databases in a single location. Peer-reviewed Journals can serve as a gauge of primary research quality, but the search should not be restricted to indexed Journals. It carries the risk of incurring in publication bias, due to the time required to publish, which precludes recent research to appear in the reviews. There is equally the tendency of researchers to publish only studies showing positive results (Rothstein and Hopewell 2009). Reputed conferences in the area, publications from trade and industry magazines, thesis and dissertations might also be included in the search.

Keywords should be sufficiently broad to not artificially restrict the number of studies but specific enough to bring only the studies related to the topic (Cooper 2010). The researcher should balance precision (the proportion of relevant studies retrieved among all possible relevant studies) and specificity (the proportion of relevant studies retrieved among all retrieved studies) (Petticrew and Roberts 2006). If this balance is not adequate, keywords should be redefined.

Abstracts are reviewed to confirm the inclusion of studies meeting the search criteria. The process of excluding articles selected from the keyword search can seriously threat the validity of the synthesis. It is recommended that at least two reviewers should select papers for exclusion (Neuendorf 2002; Levy and Ellis 2006; vom Brocke et al. 2009; Campbell Collaboration 2014).

Greenhalgh and Peacock (2005) alert to the importance of extending the search beyond the keywords for inclusiveness, asking expert opinions and doing 'snowball' backward and forward

searches. The process of backward search refers to reviewing the literature cited in the articles yielded from the keyword search (Webster and Watson 2002). Forward search means reviewing additional sources that have cited the retrieved articles (e.g. by querying citation databases). An important issue in any literature search is to decide when to stop. Petticrew and Roberts (2006) suggest a short answer: fund, time and logic. A good logical decision is to stop when each additional search return fewer studies than previous rounds, or return the same type of studies or when new studies add little to existing findings (Levy and Ellis 2006).

3.3. Data gathering and quality evaluation

Coding and data gathering in meta-analysis are some variation of Lipsey and Wilson's (2001) coding scheme. It includes study id, a description of the sampling and of the nature of interventions at the study level, and effect size descriptors, such as dependent or outcome construct and measure, effect size data. In meta-synthesis, data gathering is often organised with the use of study and concept matrix (Webster and Watson 2002; Levy and Ellis 2006; vom Brocke et al. 2009), which lists the unit of analysis in lines (e.g. articles) and categories in columns. In both quantitative and qualitative synthesis, the development of codes and a codebook is paramount (Neuendorf 2002; Higgins and Green 2008; Campbell Collaboration 2014). Extensive coders' training is required prior to data gathering (Neuendorf 2002).

Study quality is the fit between the study's goal and its design and implementation (Valentine 2009). There is an important distinction between the methodological quality of the study and the quality of reporting results. Poor reporting might affect the evaluation of methodological quality. However, quality appraisals here refer to the later. There are three major categories of risks of bias that should be included in quality assessments: (i) publication bias leading to the selective exclusion of relevant studies (Cooper, Hedges, and Valentine 2009); (ii) inappropriate research methodology or incorrect methodological applications (e.g. randomised vs non-randomised trials); and (iii) bias during selective reporting of primary studies (Higgins and Green 2008; Campbell Collaboration 2014). The most common forms of the latter are omission of outcomes, selective choice of data, double reporting, reporting of subsets and under-reporting (Higgins and Green 2008). Four quality criteria relate to the study's validity are: internal, external, construct and statistical (Cooper 2010). Internal validity is 'the ability of the basic design to yield an unbiased estimate of the effects on the target outcomes relative to a defined counterfactual condition' (Campbell Collaboration 2014, 9). External validity is the generalisability of the results of the research to other settings. Construct validity refers to the adequacy of the operational characteristics and outcome measures to the abstract categories they represent (Valentine 2009). Finally, statistical validity is the adequacy and absence of errors in statistical inference and measures of variables and relationships in the study.

3.4. Search and coding reliability checks

Inter-coders reliability checks should be conducted in every major decision to include or to exclude studies, as much as during data entry and analysis. Reliability refers to the replicability of the process and measures how well coders are in agreement about the concepts to select studies and to classify descriptors and outcomes. For the Campbell Collaboration 'multiple review team members are needed to provide essential reliability checks on important judgments that must be made during the review process such as identification of studies meeting the inclusion criteria, extraction of data from those studies, and data entry' (Campbell Collaboration 2014, 12). Decisions to include or to exclude studies should be documented, and disagreements should be debated until resolved. Neuendorf (2002) suggests that a formative reliability check should be performed during the coding of the first 10–50% of studies, with statistical reliability rates reported and that a summative check of inter-coders agreement should be conducted and reported at the end of coding. There are several techniques to calculate agreement among judges (e.g. see Neuendorf 2002; Krippendorf 2004), which goes beyond the scope of this paper. Coders' training is paramount to increase overall study reliability.

3.5. Data analysis, synthesis and interpretation

The path leading from a collection of primary research to a research synthesis evolves from analysis to synthesis, to comprehension and finally to knowledge (Hart 1998). There is no universal recipe for the analysis stage. Contextual data on the unit of analysis such as publication years, journals, authors and study characteristics relevant to the synthesis comprise the study and case descriptors. They are a common element in both qualitative and quantitative SLR. Torraco (2005) distinguishes four types of analysis in meta-synthesis: research agenda, taxonomies, frameworks and meta-theory. The research agenda should flow logically from the critical review of the literature and should pose propositions for new research. Taxonomy or other forms of classification of previous literature should lay the ground for synthesis and new theorising. Conceptual frameworks or alternative conceptual models are based on the critical assessment and synthesis. The integration and synthesis of previous theories and frameworks constitute the basis for new theories or meta-theories (Torraco 2005).

Analytical methods for quantitative data in meta-analysis are the focus of several textbooks and software manuals (e.g. Cooper, Hedges, and Valentine 2009; Hunter and Schmidt 2015). Several methods apply to meta-synthesis as well, among which content analysis and CNA are worth mentioning. Content analysis is a method of measurement applied to text (and other symbols) that combine qualitative approaches with quantitative analysis (Neuendorf 2002; Seuring and Gold 2012). It combines study descriptors with analytical categories in search of explanation and knowledge. In CNA, an article, an author, a journal or a word are nodes and citations or references to others represent the arcs. By an analysis of the network one can map research fields, track knowledge flows, identify most influential papers and authors, measure relatedness among nodes, describe research fields or domains' 'backbones' and describe the research front of most active authors and topics (Zhao and Strotmann 2015). In applying CNA in OM-SLR, Colicchia and Strozzi (2012) suggested the acronym of Systematic Literature Network Analysis, which combines qualitative meta-synthesis with the mathematical rigor of graph theory. Cobo et al. (2011, 2012) apply longitudinal co-word

analysis to retrace the evolution of thematic areas in four steps: (i) detecting research themes, (ii) building strategic diagrams or interconnected network of themes (iii) detecting thematic areas or themes that are common to different periods and (iv) carrying out impact assessment or performance analysis of themes. Thematic areas are measured based on density and centrality of clusters of subthemes. Centrality measures the degree of interaction among clusters of themes and indicates the importance of a theme for the development of a research field. It is calculated as $c = 10\sum e_{kh}$, where k is a keyword belonging to the theme and h *is* a keyword belonging to other themes. Density measures the internal strength of the network, and indicates the development of a theme. It is calculated as $d = 100\left(\sum e_{ij}/w\right)$, where i and j are keywords belonging to the theme and w is the total number of keywords in the theme. The index e_{ij} is the similarity index, calculated as $e_{ij} = c_{ij_2}/c_i c_j$, with c_{ij} being the number of documents in which two keywords i and j co-occur, c_i and c_j being the number of documents in which each one occurs. An application is provided in Subsection 4.5.2 and is illustrated with visualisation maps built with Pajek software (De Nooy, Mrvar, and Batagelj 2005). Before the analysis and synthesis stages, it is important to ascertain if there are missing information and how to treat them. The Cochrane collaboration recommends to draw a matrix of missing effect sizes and to search for information from protocols, other published reports or contacting directly the authors. Adjustments for missing cases are not recommended, but a sensitivity analysis is recommended instead, 'showing how conclusions might be affected if studies at high risk of bias were included in the analyses' (Higgins and Green 2008, 209).

Comprehension comes with the interpretation of the synthesis, with arguments that describe, discuss and explain the whole object of research. Knowledge is finally generated by the perception of principles, methods and events, learning from 'experimentation on the meaning of concepts and their application' (Hart 1998, 111).

3.6. Presenting results and updating the review

Publication guidelines and reporting standards for SLR abound in the areas of psychology, economics, epidemiology and medicine (e.g. Equator Network 2015). The presentation guidelines summarised here are adapted from the PRISMA Group framework because it is widely accepted as a gold standard for both meta-synthesis and meta-analysis, not bounded by specific research designs (Moher et al. 2009). PRISMA stands for preferred reporting items for systematic reviews and meta-analysis (http://www.prisma-statement.org).

The reports should contain at least an abstract with structured summary, introduction specifying the rationale and RQs/objectives, and sections on methods, results, discussion and conclusion. The methods section informs about SLR protocol and registration, eligibility criteria, information sources, search strategy, study selection, data collection process, data items, risk of bias in individual studies and across studies, and summary measures. Results regroup information on study selection, characteristics, risk of bias within and across studies, results of individual studies, synthesis of results and additional analysis. The discussion section summarises the evidence and lists the limitations of the SLR. Conclusions should close the reporting. Results updates are regularly included as mandatory in the protocols for both Cochrane and Campbell collaborations (Higgins and Green 2008; CRD 2009; Campbell Collaboration 2014). Hunter and Schmidt (2015) emphasise the need to update meta-analysis results regularly, as the effect size and relationships of interest may change as new evidence is aggregated with the addition of new studies.

4. The diffusion of SLR in OM

The step-by-step approach is applied in this section to address the use of LR in OM, as a practical example of the method. Both an analytical content analysis of LR types and themes and a bibliometric analysis of the thematic co-occurrence of keywords in OM are offered.

4.1. Planning and formulating the problem

The research team comprises OM scholars experienced in SLR. Sections 1 and 2 ascertain the need to understand the evolution of the use of SLR in OM due to its frequent application in different sciences for many decades and the paucity of rigor in its use in management (Tranfield, Denyer, and Smart 2003; Rousseau, Manning, and Denyer 2008; Denyer and Tranfield 2009), making it a subject of considerable relevance for OM scholars. Therefore, the following RQ-2 was put forward: 'Has SLR been used as a research method in OM and how?' In addressing RQ-2, both LR types (narrative, meta synthesis and meta analysis) and pivotal themes central to OM are investigated.

Pursuant to Cooper's (1988) taxonomy of SLR, the focus of this research is on SLR methods and central themes. Its goal is to emphasise central issues of SLR procedures, organised by methods and themes, with a neutral presentation of steps for a specialised audience of OM scholars. The research presents a comprehensive, purposely representative sample of methods and techniques used to conduct SLR in OM; and offers the prevalent themes in the field.

The definitions of LR types were included in the research protocol and used as the basis for the study selection and keywords. The keywords were: 'research synthesis' OR 'systematic review' OR 'evidence synthesis' OR 'research review' OR 'literature review' OR 'meta-analysis' OR 'meta-synthesis' OR 'mixed-method synthesis' OR 'narrative reviews' OR 'realist synthesis' OR 'meta-ethnography' OR 'state-of-the-art' OR 'rapid review' OR 'critical review' OR 'expert review' OR 'conceptual review'.

A two prone exclusion criteria were applied to the selection of LR. For the analysis of LR types and prevalent themes, referred herein as LR descriptors, only a fully fledged, single-purpose LR in OM themes was included. LR focused on introducing modelling, simulation, experiments and empirical research were excluded. This is consistent with Cooper's (1988, 7) observation that 'a literature review uses as its database reports of primary or original scholarship, and do not report new primary scholarship itself'. For the analysis of the frequency of co-occurrence of keywords forming the thematic clusters, referred herein as OM thematic areas, only thematic clusters with at least three and at most five co-occurrences were included. The protocol stated the statistical procedures for calculation and the acceptable levels for reliability checks, the coding schemes, training procedures and quality assessment.

Table 1. Selected database in OM extracted from the Academic Journal Quality Guide.

Journal titles	Databases	Papers retrieved
International Journal of Production Economics	Science Direct	35
International Journal of Operations and Production Management	Emerald	32
Production and Operations Management	Wiley	29
Supply Chain Management: An International Journal	Emerald	29
International Journal of Production Research	Taylor & Francis	29
Production Planning and Control	Taylor & Francis	14
Journal of Operations Management	Science Direct	13
IEEE Transactions on Engineering Management	IEEE	5
Journal of Scheduling	Springer	4
Manufacturing and Service Operations Management	Informs	2
Reliability Engineering and System Safety	Science Direct	1

4.2. Searching the literature

The search and selection of studies followed the approach described in Subsection 3.2. The Combined Journal Guide of the British Association of Business Schools (ABS) was used for the literature search (Petersen, Aase, and Heiser 2011). All journals ranked with grades four and three in the area of operations, technology and management in the 2014 ABS guide formed the information base of this SLR. The search was conducted with the same search keywords outlined in Subsection 4.1, in two different types of bibliographic databases, respectively, for LR descriptors and for the thematic co-word analysis. For the LR descriptors, individual vendors' databases were scrutinised to form a complete and exhaustive information base from which the sample of LR was drawn as depicted in Table 1. For the co-occurrence of words in OM thematic areas, the citation database of the Web of Science was searched for keywords' retrieval.

Keywords were adapted to the search engines of each database and applied to titles, abstracts and keywords of articles, with no limitation on publication dates. The search on vendors' databases returned 409 papers. After abstract review by three authors, 193 LRs were selected for full-text review and classification. The review process was interactive and resulted in high level of agreement. The discrepancies were debated. Subsection 4.4 reports the statistical analysis of the search reliability. The search on ISI of Web citation database returned 1784 keywords after cleaning for duplicates.

Backward and forward searches were performed, in an attempt to locate LR articles published in the selected Journals that could have elicited the original keyword search. Backward search was automated by applying the keywords to the articles' references. Forward search consisted in applying the keywords to the cited references of selected articles in the ISI of Web. No additional studies were located, attesting the robustness of the original search.

Table 1 presents the selected journals by vendor database and papers retrieved by journal. Seven databases are included in the search for relevant studies. Five journals cover together around 80% of the total of LR in OM. The complete list of papers retrieved is available upon request.

4.3. Data gathering and quality evaluation

For the content analysis of LR types and themes, a data gathering template was created to ease coding, based on coding schemes debated during initial training. The populated contents of the template were exported regularly to a flat file in matrix format for reliability check. The statistical analysis of reliability reported in Subsection 4.4 was performed during data gathering and coding discrepancies were debated regarding the research methods use in OM-LRs, the corresponding themes and time periods of publications. For the quality of retrieved papers, as all LRs were from top peer-reviewed OM journals, one may consider that this selection minimises the chances of including poor-quality and unreliable reviews in the analysis. However, the possibility of incurring in publication bias due to the non-inclusion of grey literature is a consequence of this selection strategy and is considered a search limitation. The rationale for the non-inclusion of grey literature despite the risk of publication bias it incurs is based on the trade-off between selecting high-quality LR only and the risk of broadening the information basis with studies of doubtful reliability.

4.4. Search and coding reliability checks

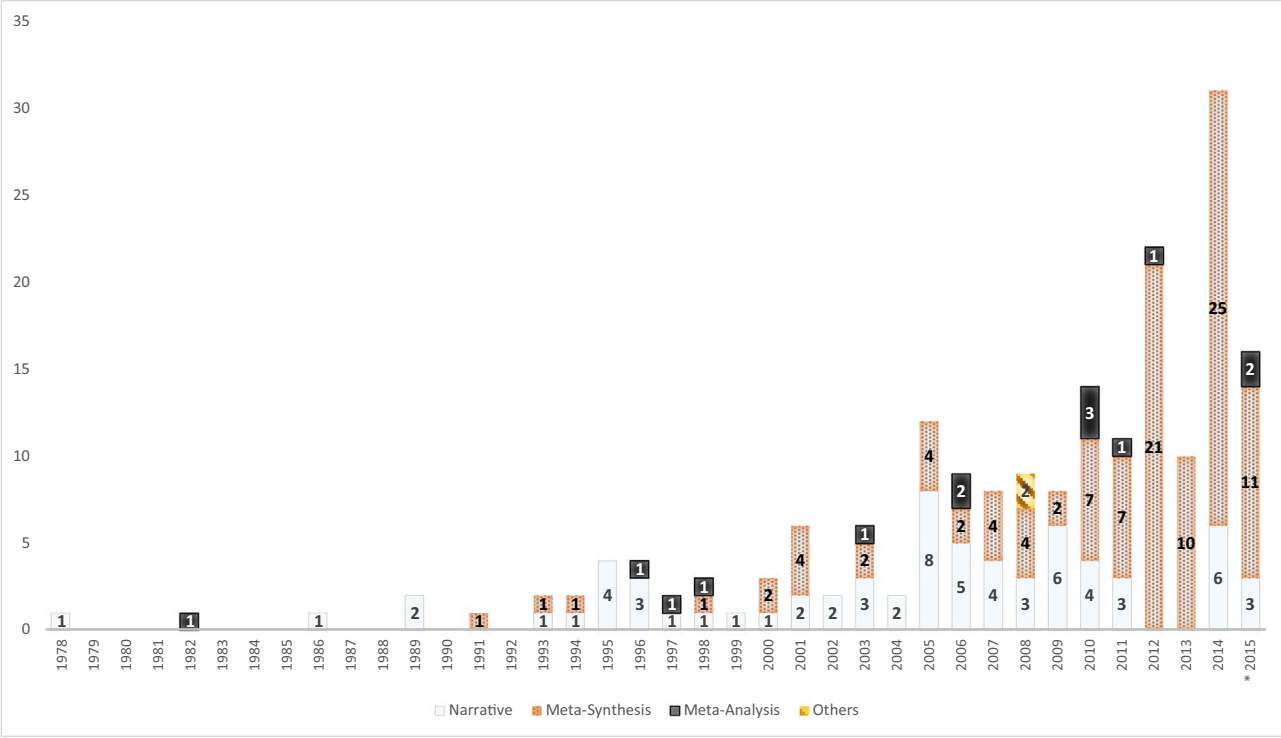
Coders' training was organised into two rounds, combined with reliability checks for 'literature search' (Step 2), 'data gathering' (Step 3) and 'quality evaluation' (Step 4). During 'Planning and formulating the problem' (Step 1), the criteria to select studies and the analytical categories for coding were debated, as part of the first round of training. A codebook was drafted, studies were selected and an initial coding of 15% of selected studies took place. Study selection met with a high Krippendorff's alpha for three reviewers of 0.978, indicating a very high-search reliability. During the second round of training, category coding of the initial 15% of studies was debated. The code book was reviewed and amended. Reliability checks were also performed during data analysis. Themes formed by the frequency of co-occurrence of keywords and its interpretation were debated between the authors until disagreements were resolved.

4.5. Data analysis, synthesis and interpretation

This subsection is subdivided in two analytical parts. First it presents LR publications by year and type, steps in OM-LR and a taxonomy of OM themes. Next it offers the evolution of motor OM themes, and a synthesis of the relationship among clusters of OM subthemes abstracted from the frequencies of co-occurrence of keywords.

4.5.1. LR descriptors

Figure 2 provides the evolution of LR studies in OM, highlighting the types often found in the literature by year of publication.



* January to May

Figure 2. LRs in OM by type and year.

Table 2. Percentages of steps performed in OM-LR by type of LR.

Steps	Description	Type of literature review			Total (%)
		Narrative (%)	Meta-synthesis (%)	Meta-analysis (%)	
1	Research question/hypothesis described	63	75	100	73
1	Analytical categories defined	84	96	92	91
1	Period covered by LR reported	17	83	75	58
2	Criteria for study's selection	40	90	92	71
2	Use of more than one database or journal	81	96	92	90
2	Description of search keywords	6	75	50	48
2	Backward or forward search reported	3	28	17	18
3	Use of more than one reviewer/coder	10	55	50	38
Coding reliability	Inter-coders reliability described (e.g. training, consensus)	2	32	17	20
Coding reliability	Inter-coders agreement rates reported	0	5	17	4
3	Statement about literature type included (e.g. peer reviewed, grey)	27	85	92	64
4	Quality appraisal of primary research	17	41	83	35
7	Likelihood of publication bias reported	0	18	42	13

Note: Percentages are column percentages calculated on the total number of LR by type.

The number of LR has increased significantly in the beginning of this century, with an accentuated growth after 2010. The traditional narrative reviews present a slow, but persistent growth. The growth of SLR is significant and sustained. While the number of meta-analysis remains relatively constant, there is a notable growth of meta-synthesis, reaching a peak of 25 studies in 2014. The relative stability in the number of meta-analysis might be partly attributable to the difficulty in analysing heterogeneous constructs and study methodologies in management research (Tranfield, Denyer, and Smart 2003; Tranfield, Denyer, and Burr 2004). However, the non-inclusion of thesis and dissertations in the example SLR might likewise distort downward the trend in meta-analysis use. It is expected that the increase in the number of meta-analysis and meta-synthesis will provide more transparent and reproducible LR. This prompts the following propositions.

P1: Meta-analysis and meta-synthesis conducted in OM closely follow the step-by-step guideline herein proposed for SLR.

P2: Meta-analysis fits closely the SLR guideline than meta-synthesis.

To address these propositions, Table 2 depicts the percentages of LR that performed one of the main steps of the SLR guideline described in Section 3, organised by the main type of LR identified in this review (i.e. narrative, meta-synthesis, and meta-analysis). The table does not intend to be exhaustive, covering all the mentioned tasks of each step of the guideline, but it aims to provide a general overview of the use of formal steps in the reviews.

Regarding Step 1, 'Planning and Formulating the Problem', just 63% of narrative reviews clearly stated the RQs and/or hypothesis against 75% of meta-syntheses. All meta-analyses (100%) had clearly stated hypotheses. Analytical categories and periods covered by the reviews are more often reported in SLRs than in

narrative reviews. Differences are even more striking in some tasks regarding the searching and data gathering stages (Steps 2 and 3): criteria to select studies, search keyword description, backward or forward searches, use of more than one reviewer, and statement about the type of literature included (e.g. peer-reviewed or grey) is virtually absent in narrative reviews. This makes the reproducibility of study findings in traditional narrative reviews at least difficult. Inter-coders reliability, a key aspect of content analysis (Seuring and Gold 2012) was reported in very few SLRs and the reporting of reliability rates was absent from all narrative reviews and almost all SLRs, meta-syntheses and meta-analyses alike. Quality appraisals (Step 4) were more often present in meta-analysis (83%) than in meta-synthesis (41%) and narrative review (17%). Publication bias were not assessed in narrative reviews, and met with low percentages in both meta-syntheses (18%) and meta-analyses (42%). Steps 5 (data analysis and synthesis) and 6 (interpretation) were covered in all studies regardless of LR type and, consequently, are not reported separately in Table 3. No review was a formal update of previous LR (Step 8).

In an attempt to deepen the understanding of OM-LR, the main themes of the OM field are depicted by type of LR in Table 3 The taxonomy of OM themes is a summary from the classification list of OM themes from the Production and Operations Management Society (POMS) (http://www.poms.org/journal/departments/) and the European Operations Management Association (EurOMA) (http://www.euroma2015.org/themes.html). One should mention that studies can fit in more than one OM theme. For example, several papers bridge SCM with other themes such as inventory management (e.g. Marquès et al. 2010), information systems and technology in operations (e.g. Wang, Heng, and Ho 2005), sustainability in operations (e.g. Despeisse et al. 2012) and research methods in OM (e.g. Seuring and Gold 2012). Some papers cover more than two themes, as Taylor and Taylor (2014) with PPM, sustainability in operations and service operations. This is why themes were tabulated by total number of answers in Table 3. Due to the necessarily subjective nature of these multiple categories, the classification was made by at least two authors and coding discrepancies were debated until they were agreed-upon.

Table 3 presents in its last column the total number of responses covered by each of the OM theme displayed in its first column, resulting in a total of 336 responses. As one paper can cover more than one theme, this total number of responses is higher than the 193 LRs retrieved. These responses are also classified according to the types of LR (narrative, meta-synthesis, and meta-analysis).

Different OM themes have been contemplated in LRs, with more emphasis in themes regarding SCM, intra-firm operations and operations strategy. SLRs (meta-synthesis and meta-analysis combined) outnumber traditional narrative reviews in most of the topics. However, narrative reviews are concentrated in the more traditional areas of intra-firm OM, as opposed to the more recent themes of SCM. In particular, there is a larger concentration of traditional narrative review in operations planning, scheduling and control, and inventory management, prompting the following proposition.

> P3: New motor themes of OM-LR tend to be associated with systematic reviews, while narrative reviews prevail in well-established and more traditional themes.

4.5.2. OM thematic areas

The evolution of motor themes and its relationships with clusters of sub-themes are described herein. Figure 3 presents the percentage of LRs by OM themes, comparing the periods of 1978–2009 (first 31 years) with 2010–2014 (last 5 years). This last period is representative of the state of the art as it includes LR regrouping emergent and recent primary research in OM as well as more mature research work from previous periods. Only complete years were included. The number of responses (*n*) covered by the OM themes during the two periods was, respectively, 152 and 184, totalling the 336, as already reported in Table 3. The bars in Figure 3 are the proportions of LR of a given theme in the period over the total number of LR themes in that period.

Table 3. OM topics by type of LR.

	Type of literature review			
Operations management topics	Narrative	Meta-synthesis	Meta-analysis	Total
Supply Chain Management	27	56	4	87
Supply chain design, management, negotiations	21	44	3	68
Supply chain, other	6	12	1	19
Inter firm operations	46	34	2	82
Operations planning, scheduling, and control	20	6	1	27
Inventory management	7	2	1	10
Information systems and technology in operations	6	7	0	13
Inter firm operations, other	13	19	0	32
Operations strategy	25	42	8	75
Operations strategy	8	6	2	16
Lean and agile operations	3	12	2	17
Innovation, product, and service development	4	7	2	13
Total quality management, kaizen, and six sigma	3	4	2	9
Mass customisation and servitisation	4	4	0	8
Other	3	9	0	12
Performance measurement and management (PPM)	7	10	5	22
Research methods in operations management	11	10	2	23
Sustainability in operations (incl. social responsibility)	10	12	0	22
Service operations	8	2	0	10
Others	3	9	3	15
Total	137	175	24	336

Notes: Numbers are total of responses. One LR can be classified in more than one OM topic.

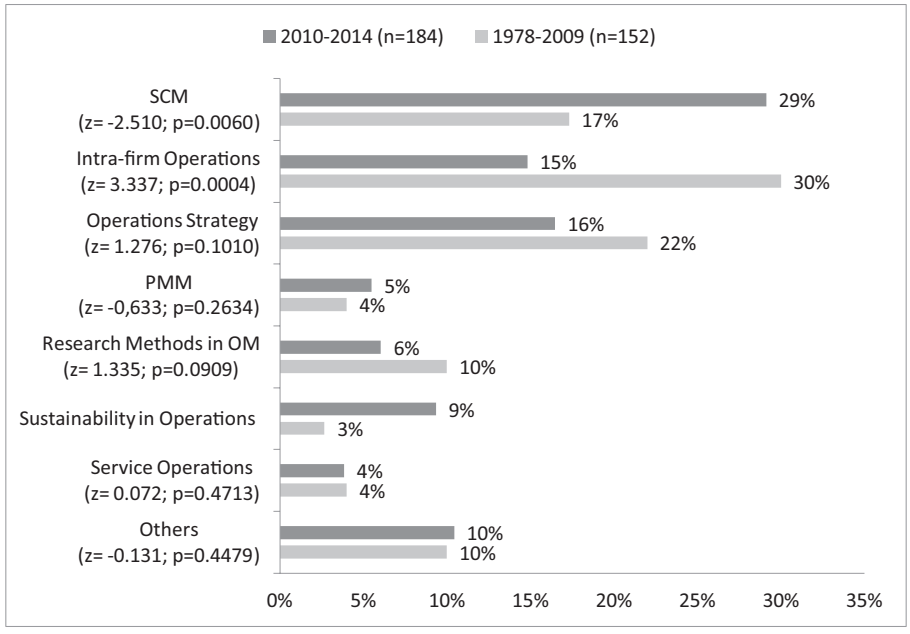


Figure 3. Percentage of LRs by themes and periods.

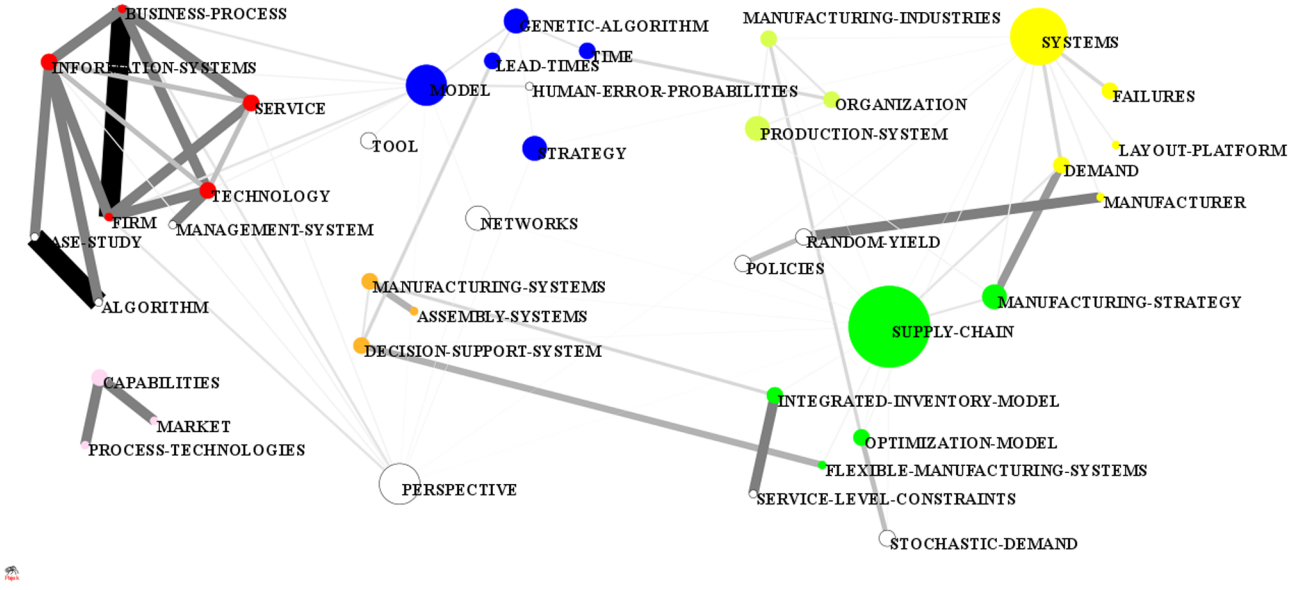


Figure 4. Networks of clusters of keywords: 2010–2014.

Z-scores and *p*-values for the difference between two proportions for a given theme in two successive periods are provided between parentheses below the name of the themes.

The proportion of LRs in SCM shows a steady increase in the last 5 years, in sharp contrast with LRs in intra-firm operations, which decreases during the same period. All the other themes appear as stable themes, with no clear tendency overall. This prompts to the following proposition:

> P4: OM scholars main focus shifted from a predominantly intra-firm prism to a network and SCM view.

The analysis of the OM-LR contemporary and emerging themes is complemented by a bibliometric analysis and study of co-citation networks of keywords (Cobo et al. 2011; Fahimnia et al., 2015). The analysis provided until now focuses on main thematic areas, consistent with the taxonomy of OM themes from POM and EurOMA. The analysis now turns to the understanding of the network of subjacent clusters of subthemes and the relationships among them. This is important because subthemes are common to different thematic areas and their relationships reveal some important continuities in OM research not evident at a first glance. For example, inventory models will be common to both intra-firm and SCM thematic areas, as it started in intra-firm sets but evolved to SCM inventory management. Figure 4 depicts the networks of clusters of keywords for the last five-year period (2010–2014).

The size of the circles represents the density of the occurrence of keywords and the thickness of the lines the intensity of the

relationships among themes. Business process forms a cluster with strong ties with the subthemes of information systems, service, technology, firm, management systems, case study and algorithm. The number of lines linking this cluster to both SCM- and intra-firm-related clusters of manufacturing systems and manufacturing industries places business processes at the interface of the major OM thematic areas, as a pivotal cluster. Supply chain forms a cluster in itself, but it regroups important subthemes of manufacturing strategy, integrated inventory model, optimisation model, flexible manufacturing systems, service level constraints and stochastic demand, once treated from an intra-firm prism. Conversely, integrated inventory model and flexible manufacturing systems from the SCM cluster also appear with strong association with the manufacturing system's cluster (assembly systems and decision support systems). Systems and genetic algorithms tie equally with supply chain, business processes and manufacturing industries, appearing as transversal themes. This is not surprising as these clusters regroup methods and systems that are instrumental to applications in other OM areas. Capabilities appear as an isolated cluster.

The clusters of subthemes were also analysed with the measures of centrality and density described in Subsection 3.5. The six clusters of keywords depicted in Figure 4 illustrate the centrality of subthemes, indicated in a scale from 0 to 1 in parenthesis next. They are: business process (1), genetic algorithm (0.86), supply chain (0.71), systems (0.57), manufacturing systems (0.43), manufacturing industries (0.29) and capabilities (0.14). The density of the themes also in a scale from 0 to 1 is in descending order: business process (1), capabilities (0.86), manufacturing systems (0.71), systems (0.57), manufacturing industries (0.43), genetic algorithm (0.29) and supply chain (0.14). The well-consolidated motor themes are those of high density and high centrality: business process and systems. Genetic algorithm and supply chain are motor themes at a lower level of development, as they present high centrality associated with low density. Capabilities and manufacturing systems have a high centrality associated with low density, usually denoting well-established transversal themes. Manufacturing industries have low density and low centrality, which is usually associated with new or declining themes.

The relationships among subthemes and the analysis of the density and centrality of co-occurrences prompt the following proposition:

> P5: OM themes and techniques are consolidating over time with extensions of well-established intra-firm themes to SCM and with the use of a common set of research methods and systems.

4.6. Presenting results and updating the review

Together with this paper's abstract and conclusion, this subsection exemplifies the main components of a SLR presentation. . The structure of LR reports is described in PRISMA guidelines for both qualitative and quantitative SLR. The PRISMA recommended contents for SLR reports are: summary, introduction, RQs and objectives, methods, results, discussions and conclusions, as exemplified in the paper. This subsection focuses on the main insights gained from the application of LR to OM, in an attempt to address the RQ-2 and propositions put forward throughout the paper.

The step-by-step guidelines to SLR described in Section 3 address RQ1 in a normative way, describing how SLRs can be conducted in OM. The application of the method to LR descriptors is an attempt to answer RQ2 on how OM-LR is been used, regarding LR types and themes. There is an increased use of LR in OM, with an apparent shift from narrative reviews to SLR, and an accelerated pace of growth after 2010. From the analysis of LR descriptors, it is readily apparent, although not surprisingly, that the growing numbers of OM-LR is not accompanied by the expected methodological rigour. Therefore, proposition P1 is answered negatively: SLRs in OM do not follow strictly the recommended steps. The steps of the guidelines described in this paper are better represented in systematic reviews. There are a low percentage of quality appraisals of primary data in meta-synthesis and an almost total absence of coding reliability and references to publication bias in all LR types. This leaves significant room for improvement in the use of LR techniques in OM. Yet, meta-analysis conforms closely to the guidelines than meta-synthesis, which partially substantiates P2.

The main OM-LR themes are SCM, intra-firm operations (planning, scheduling and control, inventory management, information systems and technology, among others), operations strategy, PMM, research methods and service operations. Narrative reviews prevail in intra-firm research, which might partly reflect that it is a solid and long-established research theme in OM. As such, it is likely to have started earlier than more contemporary research theme in LR. Conversely, this consubstantiate P3 supposition that SLR is more likely to occur for emergent OM themes. When comparing the prevalent OM themes in the first 31 years reviewed here with the evolution of actual research, there is a striking evidence of growing proportions of LR in SCM and a shrinking proportion of LR in intra-firm subthemes. This would be consistent with P4 assertion of a shift of focus from intra-firm research to networks in SCM. But it can also reflect the level of maturity of OM research areas, which could be evolving to become a consolidated research field. This point is further evidenced by the analysis and mapping of co-occurrence of keywords describing the main thematic areas. This analysis complement the previous description of OM themes as it shows the clusters of keywords or subthemes in OM research and its relationships. There are several interconnections among the areas. In particular, traditional research themes of intra-firm research, such as inventory management and manufacturing flexible systems, appear as high-density subthemes in supply chain. Furthermore, the subthemes of systems and research methods have high centrality and are linked to the other subthemes, which is suggestive of more mature research fields. There is cross fertilization among subthemes of the two most central thematic areas of SCM and intra-firm research and a consolidation of methods and techniques in the OM field, which makes proposition P5 likely to be confirmed.

5. Conclusion

This paper outlines a LR strategy for OM scholars contributing to a better understanding of the advantages of SLR and of some pitfalls of narrative reviews. It puts in evidence that SLR

in OM should follow a clear guideline to ensure more transparency, reliability and reproducibility of findings. The paper brings contributions for both academics and practitioners. The proposed approach provides academics a guideline with a broad coverage of the topic, without losing specificity. This addresses RQ1 providing a detailed presentation of step-by-step procedures intended to ease the correct application of the method.

The guideline is applied to analyse the use of LRs as a research method in OM and to show how OM themes evolved, addressing RQ2. It shows a prevailing trend of increased use of meta-syntheses in OM, followed by a slower increase in narrative reviews and by a much lower but stable and constant use of meta-analyses. It also indicates the growing numbers of OM-LR is not accompanied by the expected methodological rigour, leaving room for improvement in SLR processes and reporting, particularly regarding quality appraisals of primary research, coding reliability, and scrutiny of publication bias. As the increase in SLR over narrative reviews suggests, LR in OM will tend to be more transparent and reproducible, with a larger number of well-documented steps.

Practitioners can also get benefits with this research as it generates a consistent knowledge base by accumulating knowledge from a range of primary studies in OM conducted in the industry. The progression of themes pointed to a shift from an intra-firm prism (planning, scheduling and control, inventory management, information systems and technology, among others) to a network and SCM view. Well-established topics such as production planning and control are expanding from intra-firm settings into contemporary inter-firm networks in the supply chain.

Finally, this study would benefit from extensions in important directions leading to a research agenda. First, the relationships among OM subthemes should be further explored, highlighting emerging and declining themes in this research field. Second, a co-CNA for the major OM themes would contribute to a better understanding of the OM research front and could lead to the identification of areas for cross-fertilization of research among subthemes in OM. Third, the prevailing OM themes and topics covered by narrative reviews and SLRs are suitable candidates for meta-analysis. Fourth, as the growing number of LRs attest, the field is ripe for tertiary research under the form of overviews (or reviews of reviews) in several OM methods and themes. Fifth, the association of tertiary research to identify prevailing concepts, methods and themes with the quantification tools of bibliometric analysis is a promising new methodological tool, deserving further development and applications. This research agenda should open new avenues to further advance knowledge in OM.

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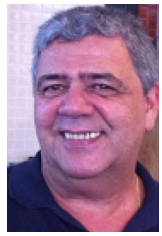

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