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REVIEW PAPER

On the shoulders of giants: uncovering key themes of organizational unlearning research in mainstream management journals

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Abstract

Unlearning has evinced immense traction and opportunity in debates pertaining to organizational learning, innovation, management of change, knowledge management, and new product development, to name but a few. Provided the diversity and expansiveness of the phenomenon, past studies have undertaken both narrative and systematic reviews to synthesize the field of organizational unlearning (OU). Although highly commendable and enlightening, these scholarly efforts would be augmented by contemplating the share of leading management journals towards furthering the research on unlearning. Moreover, a systematic comprehension of the research themes of OU can be instrumental in representing the intellectual structure of the field. For this purpose, we undertake a combination of bibliometric and thematic analysis to identify critical trends that have helped shape unlearning research. The results discern the main scientific actors (articles, authors, journals, universities), research design, and dimensions of OU. In addition, eight clusters of unlearning along with underlying theoretical perspectives are analyzed, which may help scholars integrate the development of one domain to another, formulate pertinent research questions related to OU, and encourage interdisciplinary research.

Keywords Organizational unlearning · Organizational learning · Bibliometrics · Leading management journals · Co-occurrence analysis · Thematic analysis · VOSviewer

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1 Introduction

Not long ago, organizations were often attributed to conservatism, stability, and aversion to change (Drucker 1999). For this reason, although indispensable, learning in organizations was considered serendipitous, sporadic, and antithetical to the spirit of organizing. Learning, on the one hand, promotes experimentation, variety, and disorganization. On the other hand, organizing opposes variety and instability (Contu et al. 2003; Weick and Westley 1996). But this view about organizations quickly changed, given that organizations are operating in a volatile, uncertain, complex, and ambiguous environment. This means that organizations have to become destabilizers and continuously innovate and change (Drucker 1999; Starbuck 1983). Furthermore, organizations cannot circumvent learning; otherwise, that leads to the repetition of mistakes, insensitivity to the stakeholders' cues, and commitment of valuable resources to the areas of nonresults.

However, as organizations continue to learn new knowledge, behaviors, and practices, it may be that a portion of that knowledge becomes obsolete and ineffective due to continuous changes in the external environment (Hedberg 1981). In such a case, organizations must be capable of discarding established knowledge, practices, values, and/or behaviors that have become redundant and inhibit the acquisition of new knowledge and behaviors (Becker 2018; Nystrom and Starbuck 1984). This practice of discarding obsolete knowledge and/or behaviors is known as organizational unlearning (henceforth OU) and is crucial to maintaining organizational viability and competitiveness (Hedberg 1981; Tsang 2017). In this regard, it is essential to note that unlearning is a conscious and deliberate attempt to eliminate obsolete and misleading knowledge. Thus, OU is different from passive *forgetting*, defined as an inadvertent or accidental loss of knowledge due to its disuse, failure to capture new knowledge, memory decay, or personnel turnover (Argote 2013; Easterby-Smith and Lyles 2011; Martin de Holan et al. 2004).

Since the publication of the seminal book chapter of Hedberg (1981), *How Organizations Learn and Unlearn*, there has been a recent surge of interest in studying the phenomenon of OU among academicians, researchers, and practitioners from diverse theoretical and empirical backgrounds. Most of the earlier studies focused on unlearning in crisis management (Hedberg et al. 1976; Nystrom and Starbuck 1984; Sheaffer and Mano-Negrin 2003; Snihur 2018; Starbuck and Hedberg 1977). Some studies regard OU as a prerequisite to learning new knowledge and behaviors (Bettis and Prahalad 1995; Hamel 1991; Hedberg 1981; Starbuck 1996). While this debate on whether unlearning is a prerequisite for learning is still prevalent, several emerging aspects, including the mechanism of unlearning (Azmi 2008; Cegarra-Navarro and Wensley 2019; Zhao et al. 2013), differences between unlearning and accidental forgetting (Cegarra-Navarro et al. 2014a, b; Fernandez and Sune 2009; Martin de Holan and Phillips 2004a, b; Martin de Holan et al. 2004; Tsang and Zahra 2008), unlearning as a catalyst of change (Akgün et al. 2007a; Azmi 2008), innovation (Becker 2008,

2010; Mariano and Casey 2015; Rebernik and Širec 2007), and knowledge transfer in multinational enterprises (Tsang 2008, 2017; Wang et al. 2017; Yildiz and Fey 2010; Zahra et al. 2011), have begun to receive increased attention. A plethora of other studies have also explored the relationship of unlearning with topics like new product development (Akgün et al. 2006, 2007b; Lyu et al. 2020), environmental knowledge (Martelo-Landroguez et al. 2018), and quality of health care (Cegarra-Navarro et al. 2011; Cegarra-Navarro et al. 2014a, b; Rushmer and Davies 2004). Overall, these efforts endeavor to "loosening up unlearning and forgetting's enclosed system and connecting the field to other research streams such as change management, innovation, learning" (Klammer and Gueldenberg 2019: p. 874). Therefore, although the knowledge base of unlearning has proliferated by virtue of its linkage to other concepts, yet it has evolved in a fragmented manner, and it is difficult to capture the entire gamut of OU.

Provided the diversity and fragmentation of the phenomenon and in an attempt to synthesize the existing body of knowledge, scholars have undertaken traditional and systematic reviews of the unlearning literature. A systematic review is different from a traditional review in the sense that the former provides a systematic, transparent, and replicable means for gathering, synthesizing, and appraising the results of previous studies on a specific topic (Gomes et al. 2016; Tranfield et al. 2003). On the one hand, the review articles on unlearning by Azmi (2008), Becker (2005), and Tsang and Zahra (2008) fall into the traditional review category. On the other hand, Hislop et al. (2014), Howells and Scholderer (2016), and Klammer and Gueldenberg (2019) reviews on unlearning can be placed in the systematic review category.[1]

Although both the categories of review articles have provided an invaluable contribution to the existing state of knowledge and helped advance our understanding of unlearning research, several shortcomings are evident. First, none of the previous studies have systematically addressed the key themes or research clusters that have helped shape the unlearning research. Unlearning has been associated with multiple concepts like organizational learning (henceforth OL), innovation, and organizational transformation. Subsequently, these reviews have not facilitated the integration of unlearning with the aforementioned research domains and have also precluded researchers to 'leverage developments from one domain to another' domain (Raghuram et al. 2019: p. 309). Second, none of the studies have reported the contribution of leading management journals vis-à-vis unlearning, i.e., authors' characteristics, collaboration network amongst authors, methodological issues applied in unlearning research, dimensions of unlearning and analyzing the most influential articles, books, and book chapters of unlearning.

Given these conditions, this study aims to extend and complement the previous reviews while simultaneously providing a qualitative and quantitative view of leading trends of unlearning research. For this, we restrict our focus to the contribution of leading business and management journals publishing on unlearning over 43 years (1976–2019). This is in line with the justification of Locke and Golden-Biddle (1997), Sergeeva and Andreeva (2016), and Gomes et al. (2016) that

[1] A summary of these reviews on unlearning is presented in Appendix 1 (Table 18).

mainstream journals represent 'a proxy for academic scholarship' by constituting a rigorous review process, publishing only the highest quality manuscript, and providing an accurate view of the topic (Sergeeva and Andreeva 2016: p. 243). This study incorporates bibliometric procedures to analyze the leading trends and map the key research themes of unlearning in mainstream management journals. Bibliometric procedures yield both the quantitative description of leading trends (main authors, journals, documents, and institutions) as well as provide a meticulous view of the qualitative content (prominent themes of unlearning research) of a concept (Ferreira et al. 2014; Gaviria-Marin et al. 2019; Mas-Tur et al. 2020). This study explicitly incorporates bibliometric methods like citation analysis (Garfield 1972) to report the leading trends of unlearning research. A co-citation analysis (Small et al. 1973) is used to identify linkages among influential articles of OU, and co-occurrence of keyword analysis (Callon et al. 1991) is used to present the main research themes of OU. For this reason, bibliometric analysis is preferred over other classical tools of literature review (traditional reviews, scoping studies, systematic review, and integrative literature review) as far as this study is concerned.

This study contributes to the unlearning literature in several ways. First, it establishes the leading business and management journals' contribution as outlets for publishing research on unlearning. This will help the researchers to select the right journal and prepare their manuscripts per the targeted journal's scope. Second, it analyzes the characteristics of leading authors and institutions that publish research on unlearning. This may help the other researchers working in the field of unlearning to collaborate with these leading scholars. It also provides budding researchers to undertake their doctoral and post-doctoral research under the mentorship of these researchers. Third, this study analyzes the subject matter of the most influential studies on unlearning carried out during the last 43 years. This analysis will help establish the intellectual core of unlearning, whereby future works can extend or even improve the interpretation of previous studies. Fourth, this study proposes an integrative framework of unlearning based on prominent themes of OU, uncovers the primary theoretical lenses operative in each theme, and identifies theme-wise research gaps that can be used as a starting point for future research.

The rest of the article proceeds as follows. First, Sect. 2 explains the fundamentals of unlearning like origin, evolution, definition, and subject matter of OU. Then, Sect. 3 presents the methodology used in this study to systematically search unlearning articles, select leading management journals, and perform bibliometric analysis. Next, Sect. 4 shows the results of bibliometric analysis. Finally, Sect. 5 discusses the findings and their implications for future theoretical and empirical research of OU.

2 Foundations of organizational unlearning

2.1 Origin and development

Thorough knowledge of the origin, changes, and development of unlearning since its inception is necessary to gauge the future of research. One effective way to achieve this objective is to divide the progress of research into different periods as

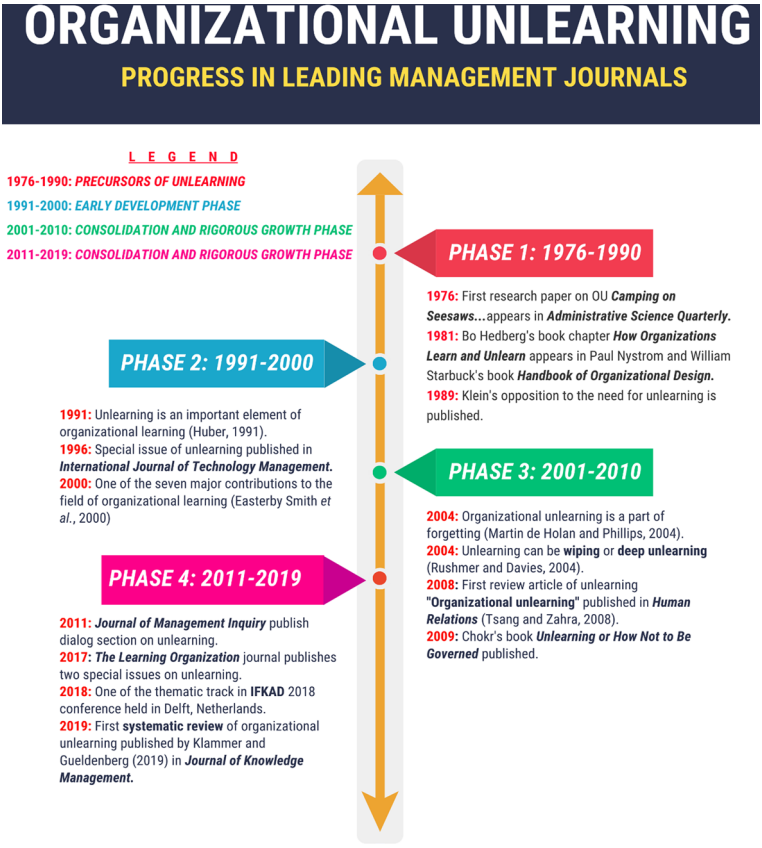

Fig. 1 Timeline infographic of organizational unlearning (1976–2019). There are three distinct phases in organizational unlearning research. The 1976–1990 time period can be labeled as *Precursors of Unlearning*, 1991–2000 is characterized by *Early Development*, and the year 2000 onwards has witnessed the *Consolidation and Rigorous phase* of unlearning research

(1) precursors or initiation of unlearning (1976–1990), (2) early development phase (1991–2000), and (3) consolidation and rigorous growth phase (2000 onwards). Similar phases have also been proposed by Furrer et al. (2008), Gaviria-Marin et al. (2019), and Serenko (2013). For instance, Gaviria-Marin et al. (2019) divided the development of knowledge management based on the first (the 1960s), second (1990s), third (2000s), and fourth-generation (2010 onwards). Figure 1 shows the timeline of OU covering each of the three phases.

Unlearning first appeared in the writings of educational reformists like Dewey (1938) and Toffler (1971). For instance, Toffler (1971) believed that due to the increased pace of mechanization and industrialization, the obsolescence rate of knowledge has also increased and that "today's 'fact' becomes tomorrow's 'misinformation'" (Toffler 1971: p. 414). Therefore, to improve learning efficiency, future schools must be cautious not to overload students with information but instigate a

tendency to understand the relevance of new ideas and revitalize them by discarding obsolete ones (Dewey 1938; Toffler 1971). This view of unlearning is regaining currency among the academic community lately with the writings of Antonacopoulou (2009), Chokr (2009), and Brook et al. (2016).

Unlearning in organizational studies started with the study of Hedberg and associates to study Swedish firms struggling to avoid bankruptcy due to changes in the external environment and failure to pay sufficient attention to the evolution of its environment (Hedberg et al. 1976; Nystrom and Starbuck 1984; Starbuck 2017; Starbuck and Hedberg 1977). In such a case, past learning compels organizations to reinforce the success formulas embedded as organizational routines (Fiol and Lyles 1985; Levitt and March 1988). This stage of overlooking the intensity of crisis is called *weathering the storm* and consumes a substantial portion of an organization's financial and non-financial resources (Hedberg et al. 1976). Finally, when managers realize that threats have become inexorable, they take desperate measures to challenge organizations' status quo. These measures constitute the second stage, popularly called *organizational unlearning*. However, unlearning involves an umpteen number of challenges and resistance from individuals because it signifies a profound departure from the status quo. Nevertheless, the efficiency of unlearning is a prerequisite for the third stage of *rediscovery and regeneration* (Hedberg et al. 1976).

2.2 Definitions and subject matter

Table 1 presents a chronological outline of various definitions of unlearning prevalent during four different phases—1976–1990, 1991–2000, 2001–2010, and 2011—present. Most definitions attribute a unified connotation to unlearning, i.e., it is *an intentional process*, *whereby organizations question*, *identify and discard obsolete knowledge* (Easterby-Smith and Lyles 2011; Hedberg 1981; Klein 1989; Martin de Holan et al. 2004; Zhao et al. 2013), *routines* (Akgün et al. 2006; Matsuo 2018; Tsang 2008; Tsang and Zahra 2008), *beliefs* (Baker and Sinkula 1999; Hislop et al. 2014), *or behaviors* (Hamel 1991; Becker 2010) *in order to acquire new knowledge and behaviors* (Becker 2010; Cegarra-Navarro et al. 2011). Moreover, unlearning definitions fall into either one of the two categories, namely, *process-oriented* and *outcome-oriented*. The *process-oriented* definition emphasizes how organizations discard their obsolete knowledge and behaviors (Baker and Sinkula 1999; Easterby-Smith and Lyles 2011; Matsuo 2018). The *outcome-oriented* definitions are more concerned about the consequences of unlearning. Such consequences include acquiring new knowledge and behaviors, relearning, and adaptation (Becker 2010; Hedberg 1981; Wang et al. 2019). Conclusively, the *outcome-oriented* definitions of unlearning are relatively broader in scope than the *process-oriented* definitions. However, *outcome-oriented* definitions are often criticized because of their inability to separate the process of learning/relearning from unlearning, a subject matter beyond the scope of the present study (see Sharma and Lenka 2019; Wang et al. 2019). This classification is in line with Wang et al. (2019), where they proposed two perspectives of unlearning: (i) elimination of outdated routines and (ii) learning/relearning. The first perspective emphasizes the process orientation, and the second

Table 1 Definitions of organizational unlearning in leading management journals

Author(s)	Definition	Aspects of unlearning		
		Impetus to unlearn	Replaced by new element?	Level of analysis
Definitions used between 1976–1990				
Hedberg et al. (1976)	'…effectiveness of existing activity programs and traditional strategies is disconfirmed, and the processes binding the organization to today's behavioral patterns are disengaged' (p. 51)	Manage crises and meet techno-social changes	Yes (behaviors)	Organization
Klein (1989)	'Unlearning…as 'a process through which one discards knowledge… [which] makes way for new responses and mental maps' (Hedberg, 1981): i.e., as the elimination of an old response by substituting a new one' (p. 291)	Planned organizational change	Yes (cognition)	Organization
Definitions used between 1991–2000				
Hamel (1991)	'The problem of unlearning is not only a cognitive problem—altering perceptual maps—but a problem of driving out old behavior with new behavior' (p. 97)	Unlearn to learn new skills	Yes (behaviors)	International strategic alliances
Huber (1991)	"unlearning" serves primarily to emphasize a decrease, or an increase in the range of potential behaviors' (p. 104)	Contributing OL process	Yes (behaviors)	Organization

Table 1 (continued)

Author(s)	Definition	Aspects of unlearning		
		Impetus to unlearn	Replaced by new element?	Level of analysis
Baker and Sinkula (1999)	'When organizations proactively question long-held routines, assumptions, and beliefs, they are engaging in the practice of unlearning' (p. 411)	Organization performance by learning	–	Organization
Definitions used between 2001–2010				
Martin de Holan et al. (2004)[¶]	'Unlearning involves…disorganizing knowledge by breaking routines, changing structures and managing cultures in ways that dismantle deeply embedded knowledge' (p. 49)	Increase organizational competitiveness	–	Organization
Akgün et al. (2006)	'unlearning—eliminating or changing how memory is manifested in organizations/teams—such as changing team beliefs, norms, and values' (p. 211)	Improving NPD team learning process	–	NPD Teams
Tsang (2008)	'organizational unlearning refers to the discarding of old routines to make way for new ones… intentional process…does not place a value judgement on the routines that are discarded' (p. 7)	Effective knowledge transfer	Yes (routines)	Sino-foreign Joint Ventures
Antonacopoulou (2009)[§]	'Unlearning as a mode of learning requires practising asking different questions by extending the outcomes sought' (p. 424)	Actionable knowledge	Yes (cognition)	–

Table 1 (continued)

Author(s)	Definition	Aspects of unlearning		
		Impetus to unlearn	Replaced by new element?	Level of analysis
Becker (2010)	'the process by which individuals and organizations acknowledge and release prior learning (including assumptions and mental frameworks) in order to accommodate new information and behaviors' (p. 252)	Assistance to organizational change process	Yes (behaviors & cognition)	Organization
Definitions used between 2011–present				
Cegarra-Navarro et al. (2011)	'unlearning context provides an environment that supports the balance between exploration and exploitation when this proves necessary and it is through such a context that members of an organisation will identify outdated systems (e.g. procedures, structural and cultural artifacts) by introducing new approaches resulting in improved services' (p. 1102)	Balance the exploratory and exploitative knowledge process	Yes (artifacts of system)	Small and Medium Enterprises
Easterby-Smith and Lyles (2011)[¶]	'unlearning refers to deliberate attempts to dispose of unwanted knowledge' (p. 311)	Organizational competitiveness	–	Organization

Table 1 (continued)

Author(s)	Definition	Aspects of unlearning		
		Impetus to unlearn	Replaced by new element?	Level of analysis
Lee and Sukoco (2011)	'when current conditions reveal the collective memory is inadequate to respond to those demands. Unlearning involves actively reviewing and breaking down the organization's long-held routines, assumptions, and beliefs' (p. 410)	Success of NPD teams	Yes (cognition)	Team
Zhao et al. (2013)	'Organisational unlearning is the dynamic process in which an organisation identifies and gets rid of useless and obsolete knowledge and routines, which hinder the acquisition and creation of new knowledge' (p. 902)	Dynamic process of knowledge management	Yes (cognition)	Organization
Hislop et al. (2014)	'unlearning…does not involve the permanent loss of something but instead involves a person consciously discarding, abandoning, or giving up particular values, knowledge, or behaviour by consciously choosing not to continue using them' (p. 542)	–	–	Individual
Brook et al. (2016)[§]	'unlearning can also open up new possibilities for 'not knowing' and 'non-action' (p. 370, 375)	Address intractable and wicked problem	Yes (cognition)	Individual

Table 1 (continued)

Author(s)	Definition	Aspects of unlearning		
		Impetus to unlearn	Replaced by new element?	Level of analysis
Matsuo (2018)	'…unlearning refers to a process of clearing out old routines and beliefs that no longer meet current challenges…' (p. 50)	Relationship between individual and organizational unlearning	Yes (routines)	Individual

[¶]Martin de Holan et al. (2004) and Easterby-Smith and Lyles (2011) believes organizational unlearning to be a sub-set of broader framework of organizational forgetting

[§]Antonacopoulou (2009) and Brook et al. (2016) definition differs from majority of works discussed on organizational unlearning

perspective is more inclined towards the outcome of unlearning, i.e., acquisition of new learning/relearning. However, our approach is different from Wang et al. (2019) because the impetus to unlearn cannot be restricted to learning/relearning, nor is relearning the ultimate objective of unlearning (Sharma and Lenka 2019). Firms unlearn to manage a crisis (Sheaffer and Mano-Negrin 2003; Snihur 2018), change (Becker 2010) and increase organizational effectiveness (Easterby-Smith and Lyles 2011). The definitions enumerated in Table 1 provide a mixture of both perspectives, and it is impossible to chalk out a distinct phase, wherein we can state that a particular orientation was more dominant than the other orientation.

In addition, Table 1 also enlists the triggers of the unlearning process, level of analysis (individual, group, or organization), and element that replaces the discarded element (knowledge, routines, habits, mental models, or behaviors). This allows us to compare the conceptualization of unlearning in organizational studies according to various phases of evolution. Despite a certain degree of homogeneity in definitions, unlearning underwent certain changes during construct development.[2] Especially during the initial phase (1976–2000), unlearning was considered synonymous or even subsumable under other constructs. For instance, Huber (1991) considered unlearning conceptually subsumable under OL. Organizations unlearned existing knowledge to learn new knowledge, thereby creating a sequential cycle of learning-unlearning-relearning. It became a truism that "unlearning must precede the learning of new behaviors" (Hedberg 1981: p. 58), and "learning cannot occur until after there has been unlearning" (Starbuck 1996: p. 726). However, Tsang (2008) empirically refuted this argument by showing that "organizational learning and unlearning are distinct processes" that can happen at different times (p. 19). Organizations can unlearn knowledge without the subsequent acquisition of new knowledge.

Moreover, unlearning is a distinct type of organizational change process (Tsang 2008). But this created a hindrance in the development of OU because "questions that purport to address unlearning actually target aspects of general change conditions and processes instead of actual unlearning" (Cegarra-Navarro and Wensley 2019: p. 70). Therefore, an alternate approach to catalyze the unlearning process (awareness, relinquish, and relearning) is to develop an *unlearning context* (Cegarra-Navarro and Sánchez-Polo 2008). The *unlearning context* consists of examination of lens fitting, change in individual habits, and consolidation of emergent understandings. *Examination of lens fitting* refers to structures and processes that allow individuals to question the current habits and consider alternate information; *change in individual habits* allows groups to recognize the need for changing existing habits; *consolidation of emergent understandings* helps organizations to implement new knowledge and routines.

Finally, since OU was introduced by Hedberg (1981) in organizational studies after reviewing the psychological literature, certain psychological concepts appear to be synonymous with unlearning. For example, Klein (1989) argues that the

[2] We thank an anonymous reviewer for this insightful suggestion to examine other concepts that were used synonymously with unlearning.

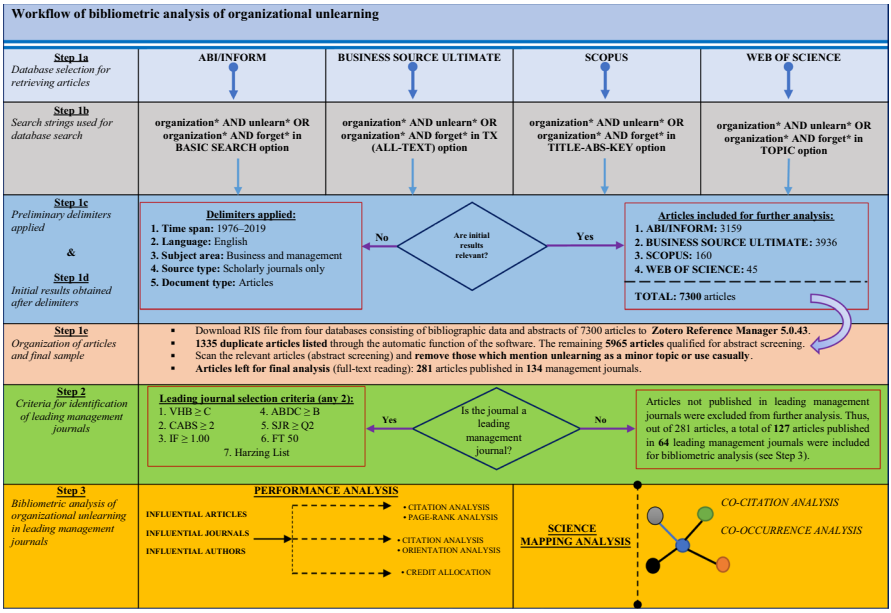

Fig. 2 Workflow of bibliometric analysis of organizational unlearning in leading management journals

unlearning model is a replica of *extinction* (removal of undesirable knowledge from individuals through dissuasion), *replacement* (dissemination of new knowledge as an alternative to existing knowledge), *exorcism* (purging individuals that are unable to change), and *salvation* (replacing current managers with external and visionary managers). Based on similar reasoning, Howells and Scholderer (2016) assert that unlearning is covered by other psychological concepts like *extinction*, *inhibition* (new learning hampers the recall of old learning and vice versa), and *suppression* (elimination of negative thoughts and emotions).

3 Methodology

This section describes a four-step methodology to review and assimilate the intellectual structure of OU. The first step involves the database search strategy to retrieve and organize articles of OU for further analysis. This is accomplished using a systematic literature review technique. The second step is used to ascertain the effectiveness of the database search strategy using sensitivity and precision tests. The third step includes the methodology for selecting leading management journals of OU. The final step involves utilizing various bibliometric techniques (citation analysis, co-citation analysis, and co-occurrence of keyword analysis) to present the leading trends of unlearning research and visualize the main themes of OU.

Figure 2 provides a schematic framework of the research design adopted for this study. This figure sequentially describes the database selection process, choice of search strings or keywords for database search, use of delimiters, and organization

of articles. It also deals with the selection of leading management journals and bibliometric analysis.

3.1 Database search strategy

First, a systematic methodology for conducting a literature survey was followed (Tranfield et al. 2003; Rhaiem and Amara 2019). For this purpose, four different databases, namely ABI/INFORM (EBSCOhost), Business Source Ultimate (ProQuest), Scopus (Elsevier), and Web of Science (Clarivate Analytics), were searched for relevant literature of OU. The selection of these databases was made because researchers working in the multidisciplinary fields—including management and organization studies—generally recommend searching several databases to locate research articles on a given area of inquiry (Hislop et al. 2014). In addition, searching more than one database preempts the possibility of missing out on unique articles relevant to a systematic review (Lawrence 2008). Hence, we used the following combination of keywords (organization* AND unlearn* OR organization* AND forget*) in the BASIC SEARCH option of ABI/INFORM Collection, ALL-TEXT (TX) tab of Business Source Ultimate, TOPIC tab of Web of Science, and TITLE-ABSTRACT-KEYWORD (TITLE-ABS-KEY) option of Scopus. "Organization*," "unlearn*," and "forget*" are wild-card search strategy terms, where a database recall (number of articles returned) includes all forms of semantics like organizational, organizations, unlearning, unlearnt, unlearns, forgets, forgetting, etc. (Klammer and Gueldenberg 2019; Rhaiem and Amara 2019). Furthermore, the time range for the literature search was set to 1976–2019 because the seminal article of OU (Hedberg et al. 1976) was published in *Administrative Science Quarterly* (*ASQ*).

The results of all four databases were processed with the following delimiters: (a) the corpus of source type was restricted to scholarly journals and hence, dissertations and theses, newspapers, magazines, trade journals, reports, and working papers were excluded; (b) document type was restricted to journal articles only, and we did not include conference papers, books, book chapters, editorials, letters, and short surveys; (c) subject area of articles was limited to 'business,' 'management,' and 'accounting' categories and we excluded articles published in 'engineering,' 'decision sciences,' 'computer science,' 'psychology,' and 'medicine'; (d) language of articles was restricted to 'English.' This process of database search with four delimiters resulted in 7300 articles (160 in Scopus, 3159 in ABI/INFORM, 3936 in Business Source Ultimate, and 45 in Web of Science). For the initial selection of articles based on abstract screening, the RIS (Research Information System) file consisting of bibliographic information and abstracts included in a particular database was downloaded from four databases, respectively. Next, the RIS files were imported to *Zotero Reference Manager 5.0.43*, a software package facilitating the organization of bibliographic material (title, year of publication, authors, journals, pagination details, references, and digital object identifier details). We referred to the database again for abstract screening for articles whose abstract was missing in the RIS file. The software listed 1335 duplicate articles. Subsequently, we read the abstracts of the remaining 5965 documents, and based on abstract screening, 281 articles were

selected for a full-text review. This filtering process led to a dataset of 281 articles published in 134 business and management journals. The dataset included only those articles that talked about unlearning as a central topic or a means to achieve any other process or objective. Finally, after the full-text read of 281 articles, 45 articles were not relevant to the current analysis because they were not related to unlearning/forgetting in organization studies.

To ascertain the effectiveness of the database search strategy, *sensitivity* and *precision* index of all four databases is reported in the following subsection.

3.2 Sensitivity and precision index of database search strategy

The next step pertains to the calculation of *precision* and *sensitivity* indices of the database search. Both are important indicators for measuring the performance of a bibliographic database search. The methodology for calculating *precision* and *sensitivity* is taken from systematic reviews conducted in the medical field (Watson and Richardson 1999; Wieland and Dickersin 2005). *Precision* means the ratio of true to false positives or the total number of relevant articles identified by the database divided by the total number of both relevant (true positives) and irrelevant (false positives) articles identified by a particular database search (Watson and Richardson 1999). *Sensitivity* refers to the ratio of the total number of relevant articles found in a specific database (say, ABI/INFORM) to the total number of relevant articles included in all databases.

The *sensitivity* and *precision* values for each database, i.e., ABI/INFORM, Scopus, Web of Science, and Business Source Ultimate was computed. Table 2 shows an inverse relationship between *sensitivity* and *precision* because if a database identifies many false positives, it lowers the precision index of that database (Watson and Richardson 1999). For example, the precision index of Business Source Ultimate database search is merely 3 percent due to many false-positive results, but its sensitivity index is around 45 percent due to a sufficient number of relevant results derived from the current search strategy. We also observe that the Scopus search provided a balanced value of *sensitivity* (30.63 percent) and *precision* (17.44 percent) index. This implies that the Scopus database search did not include many false-positive results of unlearning and forgetting, and its representation of true positive articles vis-à-vis other databases is also substantial.

3.3 Selection of leading management journals

Since this study is aimed to review the domain of OU in leading management journals only, a quality threshold index was applied to 134 journals. To ensure quality and maximum coverage of articles, we included journals that qualified at least **two** of the seven major journal ranking frameworks. The first three are derived from Bouncken et al. (2015). In addition, with the advent of new ranking frameworks, journals were subjected to an additional four criteria. These are listed below:

Table 2 Precision and sensitivity index of database search on organizational unlearning

	Database			
	ABI/INFORM	Scopus	Business source ultimate	Web of science
Relevant results (1976–2019)	71	49	129	32
Total results (after delimiters)	3159	160	3936	45
Precision[†] (percent)	2.25 (71/3159*100)	30.63 (49/160*100)	3.28 (129/3936*100)	71.11 (32/45*100)
Sensitivity[Ω] (percent)	25.27 (71/281*100)	17.44 (49/281*100)	45.91 (129/281*100)	11.38 (32/281*100)

[†]Since, ***precision*** is a local index of an individual database, it is calculated as a ratio of relevant results to total results retrieved from a particular database

[Ω]***Sensitivity*** is a global index of database search strategy. Hence, it is calculated as a ratio of relevant result of a particular database to the sum of results included in all databases. For example, the denominator value of ***sensitivity*** index is calculated as a sum of relevant results (281) included in ABI/INFORM (71), Scopus (49), Business Source Ultimate (129), and Web of Science (32)

1. The German Academic Association for Business Research (VHB) ‘‘Jourqual 3” with the cut-off of ≥ C [range A + , A, B, C, D].
2. The Chartered British Association of Business Schools (CABS) ‘‘Academic Journal Quality Guide 2018” with the cut-off of ≥ 2 [range 4*, 4, 3, 2, 1].
3. The Thomson Reuters ‘‘Journal Citation Reports (JCR) Impact Factors’’ with a cut-off of ≥ 1.000.
4. Australian Business Deans Council’s (ABDC) “ABDC Journal Quality List” (include A* to B journals) [range A*, A, B, C].
5. Financial Times top 50 journals.
6. Anne-Wil Harzing’s “Harzing Journal Quality List” (59th Edition).
7. SCImago Journal Ranking “SJR Score” for 2017 (include Q1 and Q2 journals).

The results are presented in Table 3, where the relevant score of seven criteria is coded and mentioned against respective journals. Out of 134 journals, only 64 journals qualified at least two criteria and were included for bibliometric analysis.

Following this, a final dataset of 127 articles[3] published in 64 leading management journals was selected. These articles were divided according to the timeline proposed in Fig. 1: 1976–1990 (6 articles), 1991–2000 (20 articles), 2001–2010 (36 articles), and 2011–2019 (65 articles). Subsequently, these 127 articles were subjected to bibliometric analysis.

3.4 Bibliometric methods

Bibliometrics refers to the application of various statistical and mathematical techniques to analyze and measure the qualitative and quantitative changes in an area of inquiry (Durieux and Gevenois 2010; Kraus et al. 2014). Such an analysis is helpful to explore, organize, and analyze a vast amount of data; allow integration of past, present, and future research; measure the impact and prestige of documents published in scientific journals; make decisions regarding appointment, promotions and funding of researcher or research group by the organization; determine geographic erosion or growth of research in a nation; and optimize research policy (Durieux and Gevenois 2010; Ferreira et al. 2019; Gaviria-Marín et al. 2019).

The science of bibliometrics is expressed through various bibliometric indicators and is defined as ‘measures referring to the scientific *impact* and/or *quantity of scientific publications*’ (Vinkler 1988: p. 241; Mas-Tur et al. 2020). Borgman and Furner (2002) propose two types of bibliometric indicators: *evaluative* and *relational* bibliometric indicators. *Evaluative bibliometrics* seeks to measure and compare publications’ impact using benchmark like citations received by a particular scientific actor. Contrarily, *relational bibliometrics* highlights the relationship between scientific actors in a discipline. Evaluative bibliometrics uses the same indicators as performance analysis or quality/quantity indicators. We employed the

[3] A list of 127 articles included for bibliometric analysis is available in Appendix 1 (Table 19)

Table 3 Methodology for selection of leading management journals for review

Journal	Criteria for Inclusion of Journal‡						
	VHBΩ	ABS§	JCR†	ABDC¶	FT 50	SJR^	Harzing List
Academy of Management Executive‡							
Academy of Management Journal	A+	4*	7.525	A*		Q1	
Academy of Management Learning and Education			3.274	A*		Q1	
Administrative Science Quarterly	A+	4*	8.024	A*		Q1	
Auditing	B	3	2.108	A*		Q1	
Baltic Journal of Management	C		1.469			Q2	
British Journal of Management	B	4	3.023	A		Q1	
Business Horizons	C	2	2.828			Q1	
California Management Review	B	3	3.909	A		Q1	
Creativity and Innovation Management	C	2	2.015			Q2	
European Business Review		2		B		Q1	
European Journal of Innovation Management	C		1.793			Q2	
European Management Journal	B	2	2.985	B		Q1	
European Management Review	B	3	1.600			Q2	
Harvard Business Review	C	3	5.691	A		Q2	
Human Relations	B	4	3.367	A*		Q1	
Human Resource Development Quarterly		2	3.000	B		Q1	
Human Resource Management	B	4	2.476	A*		Q1	
Human Resource Management Journal	B	4	3.816	A		Q1	
IEEE Transactions on Engineering Management	B	3	2.784	A		Q1	
Industrial and Corporate Change	B	3	1.981	A		Q1	
Industrial Marketing Management	B	3	4.779	A*		Q1	
International Journal of Human Resource Management	B	3	3.040	A		Q1	
International Journal of Information Management	C	2		A		Q1	
International Journal of Innovation Management	B	2		B		Q2	
International Journal of Production Economics	B	3	5.134	A		Q1	
International Journal of Production Research	B	3	4.577	A		Q1	
International Journal of Technology Management	C	2	1.348	B		Q2	
Journal of the Academy of Marketing Science	A	4*	9.360			Q1	
Journal of Business Research	B	3	4.028	A		Q1	
Journal of Contingencies and Crisis Management			1.977			Q2	
Journal of European Industrial Training‡							
Journal of Evolutionary Economics		2	1.433	A		Q1	
Journal of International Business Studies	A	4*	9.158	A*		Q1	
Journal of International Entrepreneurship	C					Q1	
Journal of Knowledge Management	C	2	4.604	A		Q1	
Journal of Management	A	4*	8.852	A*		Q1	
Journal of Management Inquiry	B	3	1.986	A		Q1	
Journal of Management Studies	A	4	5.839	A*		Q1	
Journal of the Operational Research Society	B	3	2.175			Q1	
Journal of Organizational Change Management		2	1.185	B		Q2	
Knowledge Management Research & Practice			1.485	A		Q2	
Knowledge and Process Management				B		Q2	
Kybernetes			1.754			Q2	
Long Range Planning	B	3	3.363	A		Q1	
Management Decision	C	2	1.963	B		Q1	
Management International Review	B	3	2.689	A		Q1	
Management Learning	B	3	1.935	A		Q2	
Management Science	A+	4*	4.219	A*		Q1	
Manufacturing & Service Operations Management	A	3	4.281	A*		Q1	
Marketing Science	A+	4*	3.019	A*		Q1	
MIT Sloan Management Review	C	3	2.196	A		Q1	
Organizational Dynamics	C	2	1.397	A		Q2	
Organization Science	A+	4*	3.257	A*		Q1	
R & D Management			2.908	A			
Scandinavian Journal of Management	B	2	1.415	B		Q2	
Strategic Management Journal	A	4*	5.572	A*		Q1	
Strategic Organization	B	4	3.109	A		Q1	
Sustainability	C		2.592			Q2	
Technological Forecasting and Social Change	B	3	3.815	A			
Technovation	C	3	5.729	A		Q1	
The Journal of Product Innovation Management	A	4	3.781	A*		Q1	
Thunderbird International Business Review	C	2		B		Q1	
The TQM Journal				B		Q1	

‡For inclusion in further review, a journal needs to satisfy at least ***two*** of the seven criteria. Although the *Journal of European Industrial Training* qualifies only one criterion, it is renamed as *European Journal of Training & Development* that satisfies more than two criteria. Similarly, *Academy of Management Executive* does not qualify any criterion, it is renamed to *Academy of Management Perspectives* that satisfies more than two criteria

ΩFor inclusion in the review, a cut off rating for a journal was set to at least C. *Source* VHB's JOUR-

Table 3 (continued)

QUAL 3

[§]For inclusion in the review, a journal needed to have at least a rating of 2. *Source* CABS' AJG 2018

[†]Indicates the Impact Factor (IF) of 2018. Only journals with IF ≥ 1.000 could qualify for review. *Source*: InCites Journal Citation Reports, Web of Science

[¶]For further review, a journal must have a rating of at least B. *Source:* ABDC's Journal Quality List, 2016

^For further review, a journal must be placed in at least Quartile 2. *Source* SCImago Journal Ranking, 2018

number of publications to assess the most productive scientific actors. Additionally, we use total citations to determine the most influential scientific actors of OU.

Moving to relational bibliometrics, this paper utilizes co-citation analysis (Small et al. 1973) to establish the structural relationship among the published works of OU. Co-citation occurs when another publication jointly cites two or more documents. By citing a common set of documents in a bibliography, a researcher attempts to "establish connections between two or more references that have been published in the past" (Raghuram et al. 2019: p. 310). Subsequently, as more and more articles cite these two references jointly, it not only signals a close relationship between these co-cited articles but also highlights their importance individually to the specific research field (Ferreira et al. 2019). Co-citation analysis is used to map the intellectual structure of literature, identify fundamental articles of a research field, examine the evolution of particular literature, and evoke transdisciplinary research by synthesizing knowledge across several academic disciplines (Raghuram et al. 2019).

This paper also visualizes the key research themes of unlearning by using the *co-occurrence of keyword analysis* (Callon et al. 1991). The co-occurrence of keyword analysis is based on the premises of co-occurrence or co-absence of keywords. Two keywords, *a* and *b*, co-occur if used together in the same article (Callon et al. 1991). It is based on the following assumptions (Liu et al. 2012):

- The authors of the scientific article select their keywords carefully and judiciously,
- The keywords provide an adequate and reliable description of the paper's content,
- The use of two keywords in a paper suggests that the author is proposing a relationship between the two or more concepts,
- If enough authors recognize the same relationship between keywords, it can be called a significant relationship.

The above-mentioned techniques of relational bibliometrics, i.e., co-citation analysis and co-occurrence of keyword analysis, are performed using a freely available computer program, *VOSviewer* (van Eck and Waltman 2010). VOSviewer uses bibliographical information to produce a network diagram to map the relationship between key ideas, concepts, and problems. In this paper,

the co-occurrence of keywords analysis identifies the most often used keywords and the key research themes in OU literature. Prior studies have used co-occurrence analysis to detect the evolution of a concept and how such development has led to new research topics by identifying the prominent research clusters (Liu et al. 2012; Ronda-Pupo and Guerras-Martin 2012).

4 Results

In the following subsections, we report the bibliometric results of 127 articles on OU published in leading management journals from 1976 to 2019. The results are divided into eleven sub-sections that broadly cover the performance analysis of documents, authors, and institutions/universities using citation analysis. In addition, with the help of co-citation analysis, we visualize the structural relationship among published works of unlearning and present an overview of the main themes of OU using the co-occurrence of keyword analysis.

4.1 Source and nature of articles

Table 4 shows that *Management Learning* (*ML*) is the main source of OU articles ($n = 12$ articles), followed by *Journal of Knowledge Management (JKM)* with six articles, *Human Resource Development Quarterly*, *Human Relations* (*HR*), *Journal of Management Inquiry* (*JMI*) with five articles each, *Journal of Business Research* (*JBR*), *Journal of Organizational Change Management* (*JOCM*), and *Organizational Dynamics* (*OD*) with four articles each. Out of 64 journals reviewed, a total of 37 journals (57.81 percent) contributed only one article on unlearning.

Around 45 percent of articles published in leading management journals were empirical, i.e., they adopted a qualitative or quantitative method of inquiry to validate theoretical propositions. Approximately 27.56 percent of articles critically examined the extant literature and theories to propose a conceptual framework of unlearning in organizations. The top three sources for empirical articles on unlearning were *JBR* (7.02 percent), *Management Decision* (5.26 percent), and *Management International Review* (5.26 percent). The top three sources for conceptual articles were *JMI* (13.79 percent), *HR* (10.34 percent), and *Journal of Management Studies* (10.34 percent).

4.2 Citation analysis

Citation analysis is based on the proposition that the impact of a scientific actor can be measured by the number of citations received by an author, a document, an

Table 4 Share of leading management journals in publication of organizational unlearning research

Title of journal	Total (n = 127)	Publication time period				Article classification			
		1976–1990 (n = 6)	1991–2000 (n = 20)	2001–2010 (n = 36)	2011–2019 (n = 65)	Conceptual (n = 29)	Empirical (n = 57)	Review (n = 6)	Other* (n = 35)
Academy of Management Executive (AME)	1	1	0	0	0	1	0	0	0
Academy of Management Journal (AMJ)	2	0	0	1	1	0	1	0	1
Academy of Management Learning and Education (AMLE)	2	0	0	2	0	0	0	0	2
Administrative Science Quarterly (ASQ)	1	1	0	0	0	1	0	0	0
Auditing	1	0	0	0	1	0	1	0	0
Baltic Journal of Management (BJM)	1	0	0	0	1	0	1	0	0
British Journal of Management (BrJM)	1	0	0	0	1	0	0	0	1
Business Horizons (BH)	1	0	0	0	1	0	0	0	1
California Management Review (CMR)	1	0	0	1	0	1	0	0	0
Creativity and Innovation Management (CIM)	2	0	1	1	0	0	0	0	2
European Business Review (EBR)	1	0	0	1	0	1	0	0	0
European Journal of Innovation Management (EJIM)	1	0	0	0	1	0	0	0	1
European Management Journal (EMJ)	1	0	0	0	1	0	1	0	0
European Management Review (EMR)	2	0	0	0	2	0	1	0	1
Harvard Business Review (HBR)	3	1	0	1	1	0	0	0	3
Human Relations (HR)	5	0	2	2	1	3	1	1	0
Human Resource Development Quarterly (HRDQ)	2	0	1	0	1	0	1	1	0
Human Resource Management (HRM)	1	0	0	0	1	0	1	0	0
Human Resource Management Journal (HRMJ)	1	0	0	0	1	0	0	0	1
IEEE Transactions on Engineering Management (IEEE)	1	0	0	0	1	0	1	0	0
Industrial and Corporate Change (ICC)	2	0	0	0	2	0	1	0	1
Industrial Marketing Management (IMM)	1	0	0	1	0	0	1	0	0
International Journal of Human Resource Management (IJHRM)	1	0	0	0	1	0	1	0	0

Table 4 (continued)

Title of journal	Total (n = 127)	Publication time period				Article classification			
		1976–1990 (n = 6)	1991–2000 (n = 20)	2001–2010 (n = 36)	2011–2019 (n = 65)	Conceptual (n = 29)	Empirical (n = 57)	Review (n = 6)	Other* (n = 35)
International Journal of Information Management (IJInfoM)	2	0	0	1	1	0	2	0	0
International Journal of Innovation Management (IJInnM)	1	0	0	0	1	0	1	0	0
International Journal of Production Economics (IJPE)	1	0	0	0	1	0	1	0	0
International Journal of Production Research (IJPR)	2	0	0	2	0	0	2	0	0
International Journal of Technology Management (IJTM)	4	0	2	1	1	2	1	0	1
Journal of the Academy of Marketing Science (JAMS)	1	0	1	0	0	0	1	0	0
Journal of Business Research (JBR)	4	0	0	0	4	0	4	0	0
Journal of Contingencies and Crisis Management (JCCM)	1	0	0	0	1	0	0	0	1
Journal of European Industrial Training (JEIT)	3	0	0	2	1	0	3	0	0
Journal of Evolutionary Economics (JEE)	1	0	0	0	1	0	1	0	0
Journal of International Business Studies (JIBS)	1	0	0	0	1	0	1	0	0
Journal of International Entrepreneurship (JIE)	1	0	0	0	1	0	1	0	0
Journal of Knowledge Management (JKM)	6	0	0	0	6	1	2	1	2
Journal of Management (JoM)	1	0	0	0	1	0	1	0	0
Journal of Management Inquiry (JMI)	5	0	0	0	5	4	0	0	1
Journal of Management Studies (JMS)	3	1	2	0	0	3	0	0	0
Journal of the Operational Research Society (JORS)	1	0	0	1	0	0	1	0	0
Journal of Organizational Change Management (JOCM)	4	0	0	3	1	2	1	0	1
Knowledge and Process Management (KPM)	1	0	0	1	0	0	1	0	0
Knowledge Management Research & Practice (KMRP)	1	0	0	0	1	0	0	1	0
Kybernetes (Kybernetes)	2	0	0	1	1	1	1	0	0
Long Range Planning (LRP)	1	0	0	0	1	0	0	0	1
Management Decision (MD)	2	0	0	0	2	0	2	0	0

Table 4 (continued)

Title of journal	Total (n = 127)	Publication time period				Article classification			
		1976–1990 (n = 6)	1991–2000 (n = 20)	2001–2010 (n = 36)	2011–2019 (n = 65)	Conceptual (n = 29)	Empirical (n = 57)	Review (n = 6)	Other* (n = 35)
Management International Review (MIR)	3	0	0	1	2	0	3	0	0
Management Learning (ML)	12	0	2	4	6	1	3	2	6
Management Science (MS)	3	0	0	3	0	0	2	0	1
Manufacturing & Service Operations Management (M&SOM)	1	0	0	0	1	0	1	0	0
Marketing Science (Mkt Sci)	1	0	0	0	1	0	1	0	0
MIT Sloan Management Review (MIT Sloan)	1	0	0	1	0	1	0	0	0
Organizational Dynamics (OD)	4	1	3	0	0	3	0	0	1
Organization Science (OS)	3	0	2	0	1	1	1	0	1
R & D Management (R &D)	1	0	0	0	1	0	1	0	0
Scandinavian Journal of Management (Scan JM)	4	1	1	2	0	2	0	0	2
Strategic Management Journal (SMJ)	2	0	2	0	0	1	1	0	0
Strategic Organization (SO)	2	0	0	1	1	0	1	0	1
Sustainability (Sustain.)	1	0	0	0	1	0	1	0	0
Technological Forecasting and Social Change (TFSC)	1	0	0	0	1	0	1	0	0
Technovation (Techno)	1	0	1	0	0	0	0	0	1
The Journal of Product Innovation Management (JPIM)	1	0	0	1	0	0	1	0	0
The TQM Journal (TQM)	1	0	0	0	1	0	1	0	0
Thunderbird International Business Review (TIBR)	1	0	0	1	0	0	0	0	1

Note: A series of 5 articles appeared in *Journal of Management Inquiry*, Volume 20 (3) in 2011, that dealt with organizational forgetting

*Includes case studies, interviews, commentaries, dialog, invited articles, and viewpoints

Table 5 Orientation-based classification of leading journals in organizational unlearning

Rank	Journal	Decade wise classification of articles				Citations of unlearning†			% Journal‡	% Articles‡	Category
		1976–90	1991–00	2001–10	2011–19	WoS	GS	Total			
1	*ML*	0	2	4	6	270	707	977	6.25	20.4	*Productivity orientation*
2	*HR*	0	2	2	1	421	2345	2766			
3	*JMI*	0	0	0	5	72	283	355			
4	*JBR*	0	0	0	4	40	42	82			
1	*HBR*	1	0	1	1	438	2993	3431	21.8	17.3	*Top 50 ranked journals based on WoS SSCI list 2018*
2	*JMS*	1	2	0	0	454	1675	2129			
3	*MS*	0	0	3	0	319	813	1132			
4	*SMJ*	0	2	0	0	2318	8298	10,616			
5	*AMJ*	0	0	1	1	349	896	1245			
6	*ASQ*	1	0	0	0	400	1245	1645			
7	*JPIM*	0	0	1	0	82	206	288			
8	*IMM*	0	0	1	0	67	213	280			
9	*Techno*	0	1	0	0	41	93	134			
10	*AME*	1	0	0	0	0	72	72			
11	*JoM*	0	0	0	1	19	50	69			
12	*M&SOM*	0	0	0	1	15	23	38			
13	*JIBS*	0	0	0	1	10	24	34			
14	*LRP*	0	0	0	1	7	9	16			

Table 5 (continued)

Rank	Journal	Decade wise classification of articles				Citations of unlearning†			% Journal‡	% Articles‡	Category
		1976–90	1991–00	2001–10	2011–19	WoS	GS	Total			
1	*JKM*	0	0	0	6	105	354	459	12.5	16.5	*Learning, knowledge and change orientation*
2	*JOCM*	0	0	3	1	175	463	638			
3	*JEIT*	0	0	2	1	4	226	230			
4	*ICC*	0	0	0	2	55	104	159			
5	*AMLE*	0	0	2	0	40	88	128			
6	*IJInfoM*	0	0	1	1	29	76	105			
7	*KPM*	0	0	1	0	0	91	91			
8	*KMRP*	0	0	0	1	7	20	27			
1	*IJTM*	0	2	1	1	182	479	661	10.9	9.45	*Technology, creativity and innovation orientation*
2	*Kybernetes*	0	0	1	1	47	126	173			
3	*CIM*	0	1	1	0	0	289	289			
4	*R & D*	0	0	0	1	19	36	55			
5	*TFSC*	0	0	0	1	10	33	43			
6	*EJIM*	0	0	0	1	3	3	6			
7	*IJInnM*	0	0	0	1	0	3	3			

Table 5 (continued)

Rank	Journal	Decade wise classification of articles				Citations of unlearning†			% Journal‡	% Articles‡	Category
		1976–90	1991–00	2001–10	2011–19	WoS	GS	Total			
1	*OS*	0	2	0	1	3085	11,002	14,087	14.0	8.67	*Inter-disciplinary*
2	*JAMS*	0	1	0	0	694	2485	3179			
3	*CMR*	0	0	1	0	54	191	245			
4	*TIBR*	0	0	1	0	0	71	71			
5	*BrJM*	0	0	0	1	9	21	30			
5	*JCC*	0	0	0	1	8	22	30			
6	*TQM*	0	0	0	1	0	12	12			
7	*Sustain*	0	0	0	1	4	7	11			
8	*JIE*	0	0	0	1	0	5	5			

Table 5 (continued)

Rank	Journal	Decade wise classification of articles				Citations of unlearning†			% Journal‡	% Articles‡	Category
		1976–90	1991–00	2001–10	2011–19	WoS	GS	Total			
1	*Scan JM*	1	1	2	0	12	78	90	26.5	20.4	*Other business journals*
2	*MIR*	0	0	1	2	5	151	156			
3	*MD*	0	0	0	2	57	108	165			
4	*SO*	0	0	1	1	2	77	79			
5	*IJPR*	0	0	2	0	23	54	77			
6	*EMR*	0	0	0	2	17	27	44			
7	*MIT Sloan*	0	0	1	0	57	263	320			
8	*Mkt Sci*	0	0	0	1	28	85	113			
9	*JORS*	0	0	1	0	18	41	59			
10	*EBR*	0	0	1	0	0	52	52			
11	*IEEE*	0	0	0	1	8	34	42			
12	*EMJ*	0	0	0	1	16	20	36			
13	*Auditing*	0	0	0	1	6	21	27			
14	*IJPE*	0	0	0	1	7	12	19			
15	*BJM*	0	0	0	1	5	13	18			
16	*BH*	0	0	0	1	4	8	12			
17	*JEE*	0	0	0	1	2	6	8			

Table 5 (continued)

Rank	Journal	Decade wise classification of articles				Citations of unlearning†			% Journal‡	% Articles‡	Category
		1976–90	1991–00	2001–10	2011–19	WoS	GS	Total			
1	*OD*	1	3	0	0	645	2476	3121	7.81	7.09	*HR and OB orientation*
2	*HRDQ*	0	1	0	1	0	154	154			
3	*HRMJ*	0	0	0	1	48	155	203			
4	*HRM*	0	0	0	1	29	94	123			
5	*IJHRM*	0	0	0	1	0	0	0			
Total	64	6	20	36	65	10,8	40,1	50,9	100.00	100.00	7

Source Google Scholar and Web of Science

Note: The abbreviation of journals is the same as in Table 4. WoS and GS are Web of Science and Google Scholar citations respectively. Ranking is based on the number of articles contributed to organizational unlearning. In case of a tie, total number of citations is used

†Citations of unlearning mean the total number of citations (both Web of Science and Google Scholar) received by publications in a respective journal

‡% journal and % articles denote the percentage of coverage of journals and articles in the respective category

institution, or a journal (Garfield 1972). The following sub-sections report the citation analysis of journals, articles, books, and book chapters.

4.2.1 Of journals

Table 5 reports the evolution of 64 journals based on productivity (total number of articles) and influence (total number of citations). Since the nature, aims, and scope of these journals are quite diverging, consistent with Gaviria-Marín et al. (2019), we have attempted to classify them into specific categories. This allows a common ground to compare journals that share a similar orientation.

The first category is based on *productivity*. It includes four journals (*ML*, *HR*, *JMI*, and *JBR*) and published 20.47 percent of unlearning articles. The second category includes articles published in the *top-50* journals of the Web of Science Social Science Citation Index (SSCI) list of 2018. These journals have published 17.32 percent of all OU articles. The third category includes journals covering *learning, knowledge, and change* management. Surprisingly, these have only published 16.53 percent of all OU articles, even though unlearning is closely associated with this orientation. The fourth group includes journals with a focus on *technology, creativity, and innovation* orientation. This category has published 9.45 percent of all OU articles and represents 10.94 percent of all leading journals. Finally, another group of journals covers *human resources and organizational behavior* (HR/OB) orientation. It includes journals like *OD*, *International Journal of Human Resource Management* (*IJHRM*), and *Human Resource Development Quarterly* (*HRDQ*) and published 7.09 percent of all articles on OU. In this way, we divided leading journals into seven categories according to different orientations.

From a micro-perspective, in the group of most productive journals, i.e., journals publishing the highest number of articles on unlearning, *ML*, *HR*, and *JMI* stands out as being exclusively dedicated to the field. *HR* appears as the most influential journal with 2766 citations, according to the Scopus and Web of Science database. Among the top-50 ranked journals in SSCI, *Strategic Management Journal* is the most influential journal with 10,616 citations. It is also the second most influential journal across all categories. *JKM* has published the highest number of unlearning articles (6 articles) with 459 citations among learning, knowledge, and change-oriented journals. All six articles of the journal appeared during the 2011–19 period. Finally, among HR/OB-oriented journals, only *OD* has received more than 1000 citations (3121 cites) from other studies. This is because the articles in *IJHRM* and *HRDQ* were published in 2018, and it takes time to receive citations from other studies (Wang 2013).

4.2.2 Of influential articles

Table 6 divides the most-cited articles on unlearning published in the leading management journals into two broad categories: (a) titles having 'unlearning' related keywords and (b) titles not having 'unlearning' related keywords, but elucidate upon unlearning substantially. This is because the second category of articles deal with multi-dimensional topics and has a higher probability of getting cited. However, the

Table 6 Analysis of the most influential articles on organizational unlearning

Title of article	Journal[¶]	Vol	Issue	Year	Pages	Cites	Age*	C/Y[‡]
Titles with keyword 'unlearning'								
To avoid organizational crises, unlearn	*OD*	12	4	1984	53–65	411	35	11.74
Remembrance of things past: Dynamics of organizational forgetting	*MS*	50	11	2004	1603–13	231	15	15.40
Designing organizations for competitive advantage: The power of unlearning and learning	*OD*	27	3	1999	24–38	161	20	8.05
Unlearning the organization	*OD*	22	2	1993	67–79	146	26	5.62
Organizational unlearning	*HR*	61	10	2008	1435–62	166	11	15.09
Organizational unlearning as changes in beliefs and routines in organizations	*JOCM*	20	6	2007	794–812	138	12	11.50
Antecedents and consequences of unlearning in new product development teams	*JoPIM*	23	1	2006	73–88	105	13	8.08
Unlearning ineffective or obsolete technologies	*IJoTM*	11	7/8	1996	725–37	93	23	4.04
On stopping doing those things that are not getting us to where we want to be: Unlearning, wicked problems and critical action learning	*HR*	69	2	2016	369–89	27	3	9.00
Forget unlearning? How an empirically unwarranted concept from psychology was imported to flourish in management and organisation studies	*ML*	47	4	2016	443–63	25	3	8.33
Titles not having keyword 'unlearning' but elucidate upon unlearning								
Organizational learning: The contributing processes and the literatures	*OS*	2	1	1991	88–115	3438	28	122.79
Competition for competence and inter-partner learning within international strategic alliances	*SMJ*	12	S1	1991	83–103	2047	28	73.11
The synergistic effect of market orientation and learning orientation on organizational performance	*JoAMS*	27	4	1999	411–27	857	20	42.85
The dominant logic: Retrospective and extension	*SMJ*	16	1	1995	5–14	530	24	22.08
The new new product development game	*HBR*	64	1	1986	137–46	473	33	14.33
Camping on seesaws: Prescriptions for a self-designing organization	*ASQ*	21	1	1976	41–65	416	43	9.67
Organizational learning: Debates past, present and future	*JMS*	37	6	2000	783–96	338	19	17.79
Organizational learning and the learning organization: A dichotomy between descriptive and prescriptive research	*HR*	50	1	1997	73–89	253	22	11.50

Source Web of Science

[¶]Abbreviations of journals are available in Table 4

*Age of an article = {(Year of analysis: 2019) − Year of publication}

[‡]Cites per year is calculated as the ratio of number of total citations to number of years elapsed since the article was first published

first category of articles will only attract citations from scholars interested in studying the nuances of unlearning. The three most cited and influential articles in the first category include Nystrom and Starbuck (1984), Martin de Holan and Phillips (2004a), and Lei et al. (1999). The most recent articles included in the first category are Howells and Scholderer (2016) and Brook et al. (2016).

As far as the second group is concerned, Huber (1991) is the most influential article with 122.79 citations per year. The seminal paper on unlearning by Hedberg et al. (1976) has received 416 Web of Science citations as of September 2020. Note that this list only includes articles published in academic journals and excludes one of the highly cited book chapters of Hedberg (1981), titled *How Organizations Learn and Unlearn*.

4.2.3 Of nature of references in influential studies

Table 7 presents a breakdown of the bibliographical sources used by the most influential articles on OU. As expected, scholarly journals constitute the most significant portion of references. This is followed by books and book chapters. However, this table does not describe which books and book chapters are most often cited by these influential studies. The following sub-section deals with this analysis.

4.2.4 Of influential books and book chapters

Tables 8 and 9 presents the most influential books and book chapters on OU, respectively. This analysis is essential because: first, readers of unlearning must be aware of these knowledge sources, and second, unlearning itself began with a book chapter by Hedberg (1981). Subsequently, this chapter is far more cited by scholars than the journal article of Hedberg et al. (1976) in *ASQ*. Unlearning is prominently discussed in books like *Experience and Education* by Dewey (1938), *Strategy + Structure = Performance…*, edited by Thorelli (1977), *Handbook of Organizational Design*, edited by Nystrom and Starbuck (1981), *Competing for the Future* by Hamel and Prahalad (1994), and *Unlearning or how not to be 'Governed'* by Chokr (2009), among several others. The most influential book chapter is Hedberg (1981) with 4310 citations, followed by Imai et al.'s (1985) book chapter on how Japanese companies manage new product development using learning and unlearning.

4.3 PageRank analysis

In addition to citation analysis, Ding et al. (2009) emphasized that the 'prestige' of an article is also an important indicator of influence. Prestige is defined as the extent to which an article has been cited by other highly cited papers. It is based on the proposition that "not all citations are created equal." A highly cited paper may not necessarily be a prestigious paper (Mishra et al. 2016). PageRank is an alternative method to account for both the popularity and prestige of an article (Brin and Page 1998). It is calculated as follows:

Table 7 Bibliographic analysis of influential papers in terms of nature of references

Title of Paper	Source of references					
	Scholarly Journals	Conf. Papers	Books	Book Chapters	Thesis	Others
To avoid organizational crises, unlearn (1984)	5	–	1	5	–	–
Remembrance of things past: Dynamics of organizational forgetting (2004)	46	–	12	5	–	1
Designing organizations for competitive advantage: The power of unlearning and learning (1999)	11	–	8	–	–	1
Unlearning the organization (1993)	6	–	6	1	–	3
Organizational unlearning (2008)	79	1	7	15	–	–
Organizational unlearning as changes in beliefs and routines in organizations (2007)	50	–	23	12	–	–
Antecedents and consequences of unlearning in new product development teams (2006)	62	–	14	3	–	1
Unlearning ineffective or obsolete technologies (1996)	9	–	8	6	–	–
Forget unlearning? How an empirically unwarranted concept from psychology was imported to flourish in management and organisation studies (2016)	62	–	6	1	–	1
On stopping doing those things that are not getting us to where we want to be: Unlearning, wicked problems and critical action learning (2016)	42	1	20	11	–	–
Organizational learning: The contributing processes and the literatures (1991)	119	2	44	27	–	1
Competition for competence and inter-partner learning within international strategic alliances (1991)	30	1	22	10	2	5
The synergistic effect of market orientation and learning orientation on organizational performance (1999)	44	–	13	3	–	2
The dominant logic: Retrospective and extension (1995)	14	1	16	2	1	–
The new new product development game (1986)	1	–	2	1	–	–
Camping on seesaws: Prescriptions for a self-designing organization (1976)	40	2	28	7	1	7
Organizational learning: Debates past, present and future (2000)	26	10	16	1	1	–
Organizational learning and the learning organization: A dichotomy between descriptive and prescriptive research (1997)	50	–	13	5	10	1

Table 8 Influential books list

Title	Year	Author(s)	Publisher	Description about OU
Experience and Education	1938	John Dewey	MacMillan	Criticizes the traditional and modern school education, as either of them fail to promote philosophy of experience. The need for unlearning is felt to promote culture of lifelong learning
A Behavioral Theory of the Firm	1963	Richard M. Cyert and James G. March	Wiley-Blackwell	It is considered to be a seminal book on organizational learning. Since, unlearning is very intimately tied with learning, the reference of this book is inevitable in the writings of scholars on unlearning. However, directly it bears no relation with organizational unlearning
Future Shock	1971	Alvin Toffler	Bantam Books	Toffler believed that by teaching students how to learn, unlearn, and relearn, a new dimension can be added to education. This dimension will help taught to evaluate the accuracy, importance, viability, and look at the problems from a different angle
Strategy + Structure = Performance: The Strategic Planning Imperative	1977	Hans B. Thorelli (Ed.)	Indiana University Press	The essay of Starbuck and Hedberg (1977) is included in the fourth section of the book. The subject matter of unlearning is how the highly successful organizations combat the problem of stagnating or declining environment. For this, they studied the Swedish company, Facit AB, a manufacturer and seller of business machines, calculators, and office furnishings

Table 8 (continued)

Title	Year	Author(s)	Publisher	Description about OU
Handbook of Organizational Design: Adapting Organizations to their Environments	1981	Paul C. Nystrom and William H. Starbuck (Eds.)	Oxford University Press	The seminal chapter of Hedberg (1981) "How organizations learn and unlearn" appeared in this book. Overall, the book discusses about the effects of environments on organizations. Unlearning is a problem triggered approach and is necessarily required to overcome the changes in environmental conditions
Competing for the Future	1994	Gary Hamel and C.K. Prahalad	Harvard Business School Press	Managerial frame is a set of assumptions, beliefs, and biases about competition, customers, and strategic outlook. As it strengthens, it permeates the organizational settings. And companies are unable to jettison these images due to economic and emotional investment in the past. But, as competition grows, these dominant frames must be abandoned by 'unlearning' the dominant frames of reference. Selective unlearning of past 'installed base of thinking' is required
Organizational Learning: II Theory, Method and Practice	1996	Chris Argyris and Donald A. Schön	Addison-Wesley	Argyris and Schön (1978) classic *Organizational Learning: A Theory of Action Perspective* just got extended and the authors define organizational unlearning as: "acquiring information that leads to subtracting something (an obsolete strategy, for example) from an organization's existing stock of knowledge" (p. 3–4)

Table 8 (continued)

Title	Year	Author(s)	Publisher	Description about OU
Handbook of Organizational Learning and Knowledge	2003	M. Dierkes, A. B. Antal, J. Child, and I. Nonaka (Eds.)	Oxford University Press	Part III: *Factors and conditions shaping organizational learning* consists of a chapter by Starbuck and Hedberg (2003) 'how organizations learn from success and failure'. Long period of success often results in structural and strategic inertia, inattention, and process consistency. Unlearning can help organizations to challenge the past success formulas and continuously adapt
Rethinking Knowledge Management	2007	Claire R. McInerney and Ronald E. Day (Eds.)	Springer-Verlag	It consists of a chapter by Turc and Baumard (2007). By introducing the processes of knowledge inactivation and rivaling enforced enactment, the authors critically question the need of unlearning and posits that old and new knowledge can co-exist in organizational memory
Unlearning or How Not to be Governed?	2009	Nader N. Chokr	Societas	Unlearning is crucial for societal and emancipatory educational reforms as it helps citizens to think critically, self-reflect, and question the predominant social paradigms that needs an overhaul. Unlearning presupposes learning and knowledge dispensation is followed by imparting of KSA's

Table 8 (continued)

Title	Year	Author(s)	Publisher	Description about OU
Handbook of Organizational Learning and Knowledge Management	2011	Mark Easterby-Smith and Marjorie A. Lyles (Eds.)	John Wiley & Sons	A chapter by Martin de Holan and Phillips (2011) on 'organizational forgetting' appears in Part III. Unlearning is positive and deliberate discard of knowledge which helps organizations to acquire new knowledge
Handbook of Research on the Learning Organizations	2013	Anders Örtenblad (Ed.)	Edward-Elgar	In part III of the book dealing with reflections on learning organizations, Hsu (2013) chapter 'Alternative Learning Organization' discuss the skeptical view of the learning organization and suggest unlearning as the alternate to learning organization model
Organizational Learning: Creating, Retaining and Transferring Knowledge	2013	Linda Argote	Springer-Verlag	In chapter 3 'organizational forgetting', Argote (2013) depicts the process of knowledge depreciation with the case study of Lockheed production of L-1011 Tristar. The rates of knowledge depreciation in various industries (automotive, fast food franchise, and shipping industry) compared and the causes of forgetting are studied
Unlearn: Let Go of Past Success to Achieve Extraordinary Results	2018	Barry O'Reilly	McGraw-Hill Education	The central tenet of this book revolves around the 'unlearning cycle' that consists of three elements: unlearn, relearn, and breakthrough. This cycle actually captures the entire process of unlearning and is vital to achieve success amidst unfavorable circumstances

Table 9 Influential book chapters list

Chapter	Year	Author(s)	Source	Editors	Cites	Pages	Description about chapter
Saving an organization from a stagnating environment	1977	William H. Starbuck and Bo Hedberg	*Strategy + Structure = Performance*	Hans B. Thorelli	292	249–59	An organization that moves from benevolent to stagnating environment must practice unlearning in order to generate new, appropriate behaviors. This can be done by replacing members of top management team
How organizations learn and unlearn	1981	Bo Hedberg	*Handbook of Organizational Design: Adapting Organizations to their Environments*	Paul C. Nystrom and William H. Starbuck	4310	3–27	Considered as a seminal chapter on organizational unlearning. Unlearning is how actors discard knowledge through complete unlearning cycle. However, at times this cycle remains incomplete due to past success, myths, and leadership. Unlearning is often problem-triggered and makes way for relearning

Table 9 (continued)

Chapter	Year	Author(s)	Source	Editors	Cites	Pages	Description about chapter
Managing the new product development process: How Japanese companies learn and unlearn	1985	Ken-ichi Imai, Ikujiro Nonaka and Hirotaka Takeuchi	*The Uneasy Alliance: Managing the Productivity-Technology Dilemma*	R. Hayes, K. Clark, and C. Lorenz	996	337–375	Based on executives' interview of six organizations, the chapter discuss the six intra-firm factors that help in speedy and flexible development process of a new product. One such factor *is transfer of learning* to divisions and projects. Plus, Japanese companies *unlearnt* the lessons from past and this ensured operational flexibility. Unlearning is seen as a result of new crisis (Hedberg, 1981)
Organizations in the fog: An investigation into the dynamics of knowledge	1996	Philippe Baumard	*Organizational Learning and Competitive Advantage*	Bertrand Moingeon and Amy Edmondson	78	74–91	Organizations entrenched in ambiguity needs to restore clarity. This happens by generation of new or transforming existing knowledge. 'To live with complexity', an organization needs to learn and unlearn

Table 9 (continued)

Chapter	Year	Author(s)	Source	Editors	Cites	Pages	Description about chapter
How organizations learn from success and failure	2003	William H. Starbuck and Paul C. Nystrom	*Handbook of Organizational Learning and Knowledge*	M. Dierkes, A. B. Antal, J. Child, and I. Nonaka	161	327–350	In studying behavioral and cognitive aspects of organizational learning, it is proved that chronic success weakens organizations ability to unlearn radically and often tends to reinforce the success stories of heroes. Due to this, environmental scanning stops and inertial structures develop. In this sense, past success becomes a liability
Organizational learning and organizational forgetting	2004	Frank Blackler, N. Crump and S. McDonald	*Organizational Learning and Learning Organization*	Mark Easterby-Smith, John Burgoyne and Luis Araujo	47	194–217	Based upon activity theory (Engeström 1991), authors coin 'organizational dementia', meaning the loss of memory of key events which went undocumented due to 'clear desk policy' of project team. Organizational forgetting occurs when community's collective infrastructure for learning disintegrates or is unused, called as forgetting by silence or solitude (p. 208)

Table 9 (continued)

Chapter	Year	Author(s)	Source	Editors	Cites	Pages	Description about chapter
Can organizations really unlearn?	2007	Emil Turc and Philippe Baumard	*Rethinking Knowledge Management*	Claire R. McInerney and Ronald E. Day	18	125–146	Unlearning, together with knowledge inactivation and rivaling enforced enactment (called knowledge neutralization) helps in eliminating undesired behaviors and increase firms' operational capacity
Organizational forgetting	2011	Pablo Martin de Holan and Nelson Phillips	*Handbook of Organizational Learning and Knowledge Management*	Mark Easterby-Smith and Marjorie A. Lyles	57	433–451	Unlearning is a form of forgetting, that is purposeful, positive, and allows the acquisition of new knowledge to take place. In the 2*2 matrix of forgetting typology, unlearning is placed as quadrant of purposeful discard of existing knowledge

Suppose an article X is cited by papers P1, P2, …, Pn. Next, we define a damping factor d, representing the fraction of random walks that continue to propagate along with the citations. Usually, the value of d is fixed at 0.85; however, it can be set between 0 and 1. Now, C(Pi) is the number of times paper Pi has cited other papers. The PageRank of article X, denoted by PR(X) in a network of N papers, is as follows:

$$PR(X) = \frac{(1-d)}{N} + d\left(\frac{PR(P1)}{C(P1)} + \frac{PR(P2)}{C(P2)} + \cdots + \frac{PR(Pn)}{C(Pn)}\right)$$

$$given, 0\langle d\rangle 1$$

Table 10 presents the top ten papers using the PageRank algorithm. Comparing Tables 6 and 10, we see that Tsang and Zahra's (2008) review paper on unlearning is in the first position. This list is different from Table 6, and hence, it proves that there is no significant correlation between highly cited articles and prestigious articles. The reasons for the difference between the results of Tables 6 and 10 can be explained as follows. PageRank analysis measures the impact of an article by counting the citations received and the influence of the citing article. In contrast, citation analysis only requires knowing the number of citations received, and it is immaterial to evaluate the influence of an article that cites the other document. Hence, citation analysis determines an article's popularity, whereas PageRank analysis deals with both the popularity and prestige of an article.

4.4 Authorship pattern and collaboration indices

Single-authored articles represent 29.27 percent, while multi-authored articles accumulate to 70.73 percent. The recent phase (2011–2019) has witnessed a sharp increase in articles by three or more authors (36.58 percent). This can be explained by the increased opportunities for collaboration and networking between researchers and practitioners. The number of papers written by authors belonging to one country overwhelms those written by authors belonging to two or more than two countries (65.85 percent vs. 34.15 percent). Moreover, multi-authored papers prefer to network with researchers of the same country of origin. Hence, during 2011–2019, although the number of multi-authored papers saw an increasing pattern, the single country representation was highest during this phase (60 percent). More than 63 percent of articles were written by authors from two or more institutions. Around one-third (36.59 percent) of articles were produced by authors representing the same institution. Therefore, even though cross-country participation is less preferred, authors collaborate with people from different institutions. The faculty participation rate has outnumbered research scholars and practitioners (96.34 percent vs. 14.63 percent). Moreover, authors publishing in the field of unlearning tend to be in the same discipline (67.07 percent). This trend has remained constant throughout the period of review (Table 11).

Table 10 PageRank analysis

Rank	Author	Year	Title of the study	PageRank†
1	Tsang and Zahra	2008	*Organizational unlearning*	0.016385
2	Zahra et al	2011	*Emerging multinationals venturing into developed economies: Implications for learning, unlearning, and entrepreneurial capability*	0.015987
3	Leal-Rodríguez et al	2015	*Organizational unlearning, innovation outcomes, and performance: The moderating effect of firm size*	0.011394
4	Zhao et al	2013	*Organizational unlearning and organizational relearning: A dynamic process of knowledge management*	0.011354
5	Cegarra-Navarro et al	2016	*Linking unlearning with work–life balance: An initial empirical investigation into SMEs*	0.011141
6	Cepeda-Carrión et al	2015	*Linking unlearning with service quality through learning processes in the Spanish banking industry*	0.010553
7	Brook et al	2016	*On stopping doing those things that are not getting us to where we want to be: Unlearning, wicked problems and critical action learning*	0.009231
8	Cegarra-Navarro et al	2007	*Linking unlearning and relational capital through organisational relearning*	0.008860
9	Akgün et al	2007	*Organizational unlearning as changes in beliefs and routines in organizations*	0.008500
10	Starbuck	2017	*Organizational learning and unlearning*	0.007433

†PageRank values are generated from Gephi software, an open-source visualization software

Table 11 Author characteristics and collaboration statistics

Author description	Total (n = 127)	Time period			
		1976–1990 (n = 6)	1991–2000 (n = 20)	2001–2010 (n = 36)	2011–2019 (n = 65)
Number of authors involved in article[¶]					
One	25.20	16.67	45.00	33.33	15.38
Two	38.58	66.66	40.00	41.67	33.85
Three and above	36.22	16.67	15.00	25.00	50.77
Collaboration Indices					
(i) Degree of Collaboration (DC)	–	0.833	0.550	0.667	0.846
(ii) Collaborative Index (CI)	–	2.400	1.700	1.667	2.508
(iii) Collaborative Coefficient (CC)	–	0.445	0.300	0.378	0.525
Number of countries represented by authors[‡]					
One	66.93	50.00	90.00	69.44	60.00
Two	29.92	50.00	10.00	27.78	35.38
Three and above	3.15	0	0	2.78	4.62
Number of institutions/ universities collaborating[§]					
One	33.08	33.33	45.00	44.44	23.08
Two	42.51	66.67	45.00	27.78	47.69
Three and above	24.41	0	10.00	27.78	29.23
Designation of authors[Ω]					
Faculty	97.63	100.00	95.00	97.22	98.46
Research Scholar and others	12.60	16.67	5.00	8.33	16.92
Number of disciplines represented by contributing authors					
One	71.65	33.33	80.00	72.22	72.30
Two	22.83	50.00	20.00	27.78	18.46
Three and above	5.52	16.67	0	0	9.24

Note: All figures are in percentage

[¶]In case article is an interview, only interviewer is counted

[‡]Based on location of institution served at the time of publication of paper

[§]This, apart from authors' affiliation, represents institutes who have funded the project

[Ω]This represents figure greater than number of articles because in articles: i. "Emerging Multinationals Venturing into Developed Economies Implication for Learning, Unlearning, and Entrepreneurial Capability"; ii. "How unlearning affects radical innovation: The dynamics of social capital and slack resources"; iii. "Linking organizational learning with technical innovation and organizational culture"; iv. "Organizational unlearning and organizational relearning: a dynamic process of knowledge management", both Ph.D. candidate and faculty have contributed. In "On stopping doing those things that are not getting us to where we want to be: Unlearning, wicked problems and critical action learning", a consultant and faculties have contributed

Table 12 Organizational unlearning authors' total and adjusted appearances

Author	University	Region	Time Period											
			1976–1990			1991–2000			2001–2010			2011–2019		
			DC	APS	ECS	DC	APS	ECS	DC	APS	ECS	DC	APS	ECS
BLT Hedberg	Gothenburg U	Sweden	2	1.17	0.83	–	–	–	–	–	–	–	–	–
WH Starbuck	U. Wisconsin-Milwaukee	USA	2	0.50	0.83	1	1.00	1.00	1	1.00	1.00	–	–	–
PC Nystrom	U. Wisconsin-Milwaukee	USA	2	1.00	0.83	–	–	–	–	–	–	–	–	–
EWK Tsang	U. of Texas	USA	–	–	–	1	1.00	1.00	3	2.67	2.50	2	1.17	1.33
SA Zahra	U. of Minnesota	USA	–	–	–	–	–	–	1	0.33	0.50	1	0.50	0.33
Easterby-Smith	Lancaster U	UK	–	–	–	1	0.50	0.33	–	–	–	1	0.67	0.50
D Nicolini	Tavistock Institute	UK	–	–	–	2	0.84	0.83	–	–	–	–	–	–
JW Slocum, Jr	Southern Methodist U	USA	–	–	–	2	0.66	0.83	–	–	–	–	–	–
AE Akgün	Gebze Institute of Tech	Turkey	–	–	–	–	–	–	4	1.90	1.24	–	–	–
GS Lynn	Stevens Institute of Tech	USA	–	–	–	–	–	–	4	1.20	1.24	–	–	–
JC Byrne	Pace University	USA	–	–	–	–	–	–	3	0.64	0.91	–	–	–
JGC Navarro	U. Polytech of Cartagena	Spain	–	–	–	–	–	–	1	0.67	0.50	6	2.80	2.24
K Becker	Queensland U. of Tech	Australia	–	–	–	–	–	–	3	2.50	2.33	–	–	–
PM de Holan	IE Business School	Spain	–	–	–	–	–	–	3	1.84	1.33	3	2.33	2.33
N Phillips	U. of Cambridge	UK	–	–	–	–	–	–	3	1.00	1.33	–	–	–
S Eldrige	Lancaster U	UK	–	–	–	–	–	–	–	–	–	3	0.77	0.86
Y Zhao	Jilin U	China	–	–	–	–	–	–	–	–	–	4	0.96	1.11
Y Lu	Jilin U	China	–	–	–	–	–	–	–	–	–	2	0.60	0.53
X Wang	Jilin U	China	–	–	–	–	–	–	–	–	–	4	1.40	1.11
Leal-Rodriguez	U. Loyola Andalucía	Spain	–	–	–	–	–	–	–	–	–	4	0.73	0.95
Cepeda-Carrión	U. of Seville	Spain	–	–	–	–	–	–	–	–	–	3	0.93	0.83
J Ortega-Gutierrez	U. of Seville	Spain	–	–	–	–	–	–	–	–	–	3	0.67	0.70
AKP Wensley	U. of Toronto	Canada	–	–	–	–	–	–	–	–	–	3	1.17	1.13
A Klammer	U. of Liechtenstein	Liechtenstein	–	–	–	–	–	–	–	–	–	3	1.84	1.33

Table 12 (continued)

Author	University	Region	Time Period											
			1976–1990			1991–2000			2001–2010			2011–2019		
			DC	APS	ECS	DC	APS	ECS	DC	APS	ECS	DC	APS	ECS
S Gueldenberg	U. of Liechtenstein	Liechtenstein	–	–	–	–	–	–	–	–	–	3	0.83	1.33
M. Matsuo	Hokkaido U	Japan	–	–	–	–	–	–	–	–	–	4	4.00	4.00

Note: To qualify in this list, an author needed to have at least 2 publications in leading management journals on organizational unlearning between the period 1976–2018. There were 112 author appearances, of which 24 have qualified; Adjusted appearance score or APS is based on formula of weight assignment given by Senanayake, Piraveenan and Zomaya (2015). Since, the contribution of each author is unique, score to a particular author is calculated using formula: $W_d^s = \frac{N_a - R_s + 1}{0.5N_a(N_a+1)}$, where W_d^s = weight proportion assigned to authors based on contribution to an article; N_a = number of authors in a document; R_s = position of author in list of contributing authors

Earlier, we have seen that authors of unlearning are engaged in increasing collaborative links. Wu et al. (2019) attribute the reasons for rising collaboration as improvements in communication technology, the complexity of problems that require interdisciplinary solutions, and professional and career benefits. Quantitative assessment of research collaboration is made through (a.) degree of collaboration, DC; (b.) collaborative index, CI; and (c.) collaborative coefficient, CC (Subramanyam 1983; Andrés 2009). For understanding the mathematical calculations of these coefficients, refer to Appendix 2.

Table 11 shows that all three coefficients of collaboration (DC, CI, and CC) were highest during 2011–2019. Therefore, authors have exhibited a rising tendency to form large teams and work collaboratively to optimize knowledge discovery and dissemination (Wu et al. 2019).

4.5 Author's productivity

Table 12 presents the productivity score of leading authors publishing in high-impact journals on unlearning, using the three prominent credit allocation techniques: (a) normalized page size or NPS, (b) author position score or APS, (c) direct count or DC, and (d) equal credit score or ECS (Serenko et al. 2010). NPS is a ratio of the number of pages to the number of authors. NPS determines the relative contribution of each author. However, it is not considered a robust method as merely counting the page of an article cannot determine quality. Moreover, a majority of journals have restrictions regarding word count and pages of an article. This method is avoided in calculating the author's productivity.

Table 12 shows the temporal evolution of the most productive authors on OU. A few authors dominate each time period. However, Tsang and Starbuck are the authors who have consistently published on unlearning in leading management journals. The reported three coefficients are DC, APS, and ECS. DC is like an unadjusted appearance score and assigns a value of 1.00 for each author, regardless of the number and position of authors in a paper. Cegarra-Navarro is the most productive author according to this method, as he has published six articles during 2011–2019 in leading management journals.

APS considers the position of an author in a publication. It is akin to adjusted appearance and is calculated based on the recommendation of Senanayake et al. (2015). Since Tsang has published most of the articles alone, he has the highest APS during 2001–10.

ECS accords equal credit to all the authors irrespective of their position in a publication. It is calculated as 1/N, where N is the number of authors in a paper. For example, if there are three authors, each author receives a 0.33 (1/3) credit. Tsang has the highest ECS of 2.50 in 2001–10. Matsuo (4.00) is followed by Martin de Holan (2.33) in terms of the highest ECS in 2011–19.

Table 13 Institute/University Statistics

University/Institution	Key author	Region	Productivity Indices			Influence Indices		
			DC‡	ECS¶	UPS*	ARWU	QS	THE
Gothenburg U	B. L. T. Hedberg	Sweden	3.00	1.33	1.50	101–150	269	201–250
U of Wisconsin-Milwaukee	W.H. Starbuck P.C. Nystrom	USA	4.00	1.66	1.50	401–500	53	401–500
Hitotsubashi U	–	Japan	2.00	1.00	1.00	–	456	–
Nanyang Technological U	E. W. K. Tsang	Singapore	3.00	2.33	2.47	96	12	51
Lancaster U	Easterby-Smith S. Eldridge	UK	9.00	2.89	1.87	301–400	131	146
Bodø Graduate School	–	Norway	2.00	1.00	1.00	–	–	–
U. of Texas	E. W. K. Tsang	USA	6.00	4.33	4.44	40	63	39
Southern Methodist U	J. W. Slocum, Jr	USA	4.00	1.66	1.83	–	651–700	351–400
University of Vermont	–	USA	2.00	1.00	1.00	301–400	531–540	351–400
Gebze Technical U	A. E. Akgün	Turkey	5.00	1.49	1.50	–	–	801–1000
Stevens Institute of Tech	A. E. Akgün	USA	3.00	0.91	1.19	–	651–700	501–600
Pace U	J. C. Byrne	USA	2.00	0.58	0.47	–	–	–
U. Polytechnic of Cartagena	J. G. C. Navarro	Spain	6.00	2.41	3.73	–	–	–
Central Queensland U	K. Becker	Australia	3.00	1.00	1.00	–	601–650	501–600
Queensland U. of Tech	K. Becker	Australia	2.00	2.00	2.00	201–300	244	201–250
U. of Maribor	–	Slovenia	2.00	1.00	1.00	–	801–1000	801–1000
U. of Seville	J. O. Gutiérrez	Spain	7.00	2.36	3.66	–	601–650	601–800
EOI Business School	–	Spain	2.00	0.66	0.17	–	–	–
U. of Cambridge	N. Phillips	UK	4.00	1.66	1.26	3	6	2
Polytechnic U. of Catalonia	–	Spain	2.00	1.00	1.00	–	–	501–600
U. of Minnesota	S. A. Zahra	USA	2.00	0.83	0.83	37	156	71
IE Business School	P. M. de Holan	Spain	7.00	3.66	4.58	–	–	–
INCAE Business School	P. M. de Holan	Costa Rica	3.00	2.00	1.77	–	–	–

Table 13 (continued)

University/Institution	Key author	Region	Productivity Indices			Influence Indices		
			DC‡	ECS¶	UPS*	ARWU	QS	THE
U. of Murcia	–	Spain	4.00	1.25	1.07	–	801–1000	801–1000
U. of Canberra	–	Australia	3.00	1.00	1.00	–	601–650	251–300
U. of Toronto	A. K. P. Wensley	Canada	3.00	1.13	1.24	23	28	21
Aarhus U	–	Denmark	2.00	1.00	1.00	65	141	123
Hokkaido U	M. Matsuo	Japan	4.00	4.00	4.00	151–200	128	401–500
National Dong Hwa U	–	Taiwan	3.00	1.00	1.00	–	–	–
U. Loyola Andalucía	A. L. Leal- Rodríguez	Spain	3.00	0.95	0.53	–	–	–
Friedrich-Alexander-U	–	Germany	3.00	0.60	1.00	–	299	–
Jilin U	Y. Zhao, Y. Lu, and X. Wang	China	13.00	3.41	3.67	201–300	475	801–1000
U. of Liechtenstein	Klammer and Gueldenberg	Liechtenstein	7.00	3.00	3.00	–	–	–
Tongji U	–	China	2.00	0.50	0.70	301–400	291	401–500
Loughborough U	–	UK	4.00	1.00	1.00	–	218	401–500

Note: A total of 79 institutions/universities appeared in this list. Of them, 35 with unadjusted appearance of ≥ 2 made the list and presented in the table above

‡DC = direct count. Each university represented by a contributing author gets a score of 1

¶ECS = equal credit scoring. Score of university is calculated as ratio of 1/number of contributing universities in a paper. For example, if there are 2 universities in a paper, then ECS is 0.50 (1/2) for each university/institute

*UPS = university position score. This depends on the position held by institute (represented by author) in a paper

§Although established in 1973 as Instituto de Empresa, since 2009, this institute is a part of IE Business School, Spain. The stand-alone score of Instituto de Empresa is 1.33 with total 3 appearances. This is a consolidated score of IE Business School

4.6 Universities/institutions productivity

Table 13 reports the productivity (direct count score, equal credit score, and university position score) and influence (Academic World University Rankings or ARWU, Quacquarelli-Symonds Rankings or QS, and Times Higher Education Ranking or THE) indices of universities/institutions that have published in leading management journals on unlearning (Serenko 2013). A majority of institutes from the US (7), Spain (7), and Australia (3) are included in Table 13. The DC score is equivalent to the unadjusted appearance score of universities. Here, irrespective of the institution's position in a publication, a score of 1.00 is awarded to all contributing universities. The top three institutions based on the DC technique include Jilin University (13.00), Lancaster University (9.00), and the University of Liechtenstein (7.00). ECS is equivalent to an adjusted appearance score. It is calculated as 1/number of contributing universities in a paper. Like the DC technique, the EC score does not depend on the university's position in a publication. The top institutions based on ECS are the University of Texas (4.33) in the US, Hokkaido University (4.00) in Japan, IE Business School (3.66) in Spain, Jilin University (3.41) in China, and the University of Liechtenstein (3.00) in Liechtenstein. On the other hand, the university position score recognizes the contribution of the university in a publication. It depends on the position held by the representative author of a university in a paper. The university position score is calculated by using the formula proposed by Howard and Day (1995):

$$\left(1.5^{n-i}\right) \Big/ \sum_{i=1}^{n} 1.5^{i-1}$$

where n represents the total number of universities and i represents the ordinal position of a university in a publication.

For example, a paper with four universities generates a score of 0.415, 0.277, 0.185, and 0.123, respectively, depending on their position in the paper. The top three institutions, according to this credit allocation method, are the IE Business School (4.58), University of Texas (4.44), and the Hokkaido University (4.00),

The influence indices of universities are based on the ARWU, QS, and THE rankings. According to all the three ranking frameworks, the University of Cambridge is the most influential university publishing on OU. The University of Toronto is the second most influential university included in this review. The University of Texas is the third most influential university with a ranking of 40, 63, and 39, according to ARWU, QS, and THE ranking, respectively. In this list, 21 universities did not have an ARWU rank, and 13 universities did not have either a QS or a THE rank.

4.7 Research design in leading management journals

The articles on OU in the first phase (1976–1990) did not involve empirical studies. This is because the concept was in its nascent stage. Empirical studies on unlearning were published after the 1990s. The preferred sample size was between 0 and 100. Later on, the use of large samples increased during 2011–2019, and 12 studies reported

Table 14 Research design of organizational unlearning in top management journals

Elements of research design	Total	Time period			
		1976–1990	1991–2000	2001–2010	2011–2019
Target Sample Size[†]					
0–100	17	–	3	7	10
101–250	13	–	–	2	11
251–400	5	–	–	2	3
401–600	9	–	–	1	8
601 and above	13	–	1	2	10
Not reported	3	–	–	1	2
Response Rate Achieved					
0–10%	–	–	–	–	–
10–30%	10	–	1	1	8
30–50%	4	–	–	–	4
50% and above	11	–	–	4	7
Not reported/not applicable	38	–	3	10	25
Data Collection Method					
Structured, semi-structured and unstructured interviews	8	–	–	5	3
In-depth interviews	10	1	3	1	5
Mail questionnaires	29	–	1	6	22
Secondary sources	13	2	2	4	5
Observations	9	–	1	2	6
Others	5	–	–	–	5
Respondent Profile					
C-level officers (CEO's, CFO's etc.)	10	1	2	–	7
Managers/Directors	23	1	2	8	12
Employees	14	1	1	3	9
Others/not reported	23	–	2	4	17
Data Analysis Technique					
Qualitative (case study, thematic)	19	2	3	6	8
Quantitative	48	–	1	9	38
Others	–	–	–	–	–
Statistical Technique Employed					
Descriptive Statistics	6	–	–	1	5
Correlation Analysis	–	–	–	–	6
Regression Analysis	5	–	–	1	4
Exploratory Factor Analysis	4	–	–	2	2
Confirmatory Factor Analysis	7	–	1	3	3
Structural Equation Modelling	8	–	–	1	7
Others	16	–	–	3	13
Reliability and Validity					
Reliability calculated	20	–	1	5	14
Validity calculated	20	–	1	5	14

Table 14 (continued)

Elements of research design	Total	Time period			
		1976–1990	1991–2000	2001–2010	2011–2019
Not reported	4	–	–	–	4
Unit of research analysis					
Individual	7	–	–	1	6
Teams and Firm/Business unit	6	–	–	2	4
Organization	38	2	3	11	22
Multinational Ventures	10	–	1	2	7

Note: Only empirical articles were considered for analysis in this table

¶The total number of studies can exceed the qualified empirical studies (as mentioned in Appendix 1 Table 19) because an article may have used multiple methodology for collection of data and/or analysis of results. For example, data about a case organization can be accumulated using secondary sources (annual reports, magazines, website) as well as interviews and/or observation by the researcher

†This can denote the figure of respondents who initially agreed to provide data to researcher or initial target sample size, depending on the information available

a sample size above 400 (Table 14). The table also presents the response rate of studies on OU. Most of the studies (19) did not report the response rate. However, the response rate disclosure increased during 2011–2019 because journals have become stricter in adhering to transparency and disclosure guidelines of material facts. On average, the majority of studies (12) achieved a response rate between 10 and 49 percent.

Mail surveys have been considered the most convenient data collection method, followed by structured, semi-structured, and unstructured interviews. The respondent profile mainly included managers and employees. This is because employees are the primary actors during learning, unlearning, and relearning (Zhao et al. 2013). Most of the studies have used quantitative data analysis techniques. Use of case study, inductive and deductive logical reasoning, grounded theory, or thematic analysis are elusive. Moreover, statistical techniques like confirmatory factor analysis (CFA) and structural equation modeling (SEM) are the most prominently used techniques in quantitative data analysis methods. Prior to SEM's application, unlearning research was dominated by case-based analysis due to its highly abstract character. However, as the need to operationalize unlearning was felt, researchers applied CFA and SEM to develop novel measurement scales of OU. This application is quite appropriate because SEM is beneficial "when researchers deal with data obtained through questioning respondents via primary data collection such as surveys and experiments" (Davvetas et al. 2020: p. 253). Researchers operationalize unlearning as a reflective construct consisting of either two (Akgün et al. 2006; Matsuo 2018) or three dimensions (Cegarra-Navarro and Sánchez-Polo 2008; Martelo-Landroguez et al. 2018). Moreover, SEM is used to establish the relationship of unlearning with other variables. For instance, Leal-Rodríguez et al. (2015) used SEM to test the relationship of unlearning with organizational performance in the Spanish automotive components manufacturing sector. SEM is also helpful to study the influence of mediating and moderating variables that affect the relationship of unlearning with other variables. For example, Lyu et al. (2020) used firm size as a moderating variable to

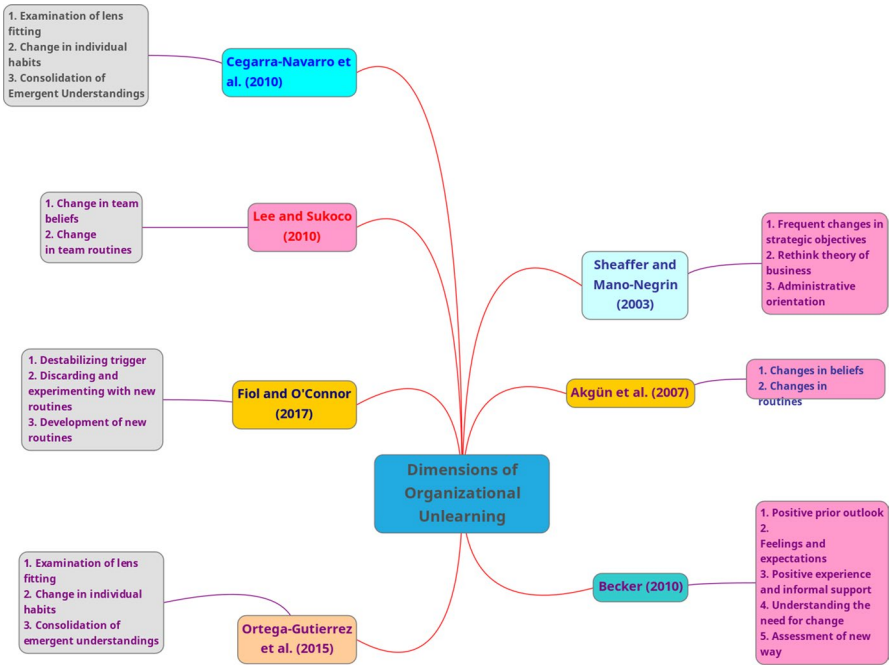

Fig. 3 Dimensions of organizational unlearning. Various authors have proposed different dimensions of organizational unlearning. The essence, however, remains the same. Unlearning usually begins with a destabilizing trigger (e. g. crisis, problems), followed by identifying and discarding obsolete knowledge, behavior, and routines. It ends with relearning or experimenting with new knowledge or behavior

investigate the linkage of unlearning with environmental turbulence and entrepreneurial orientation in Chinese manufacturing firms undergoing radical innovation. Lastly, CFA and SEM are applied to assess the psychometric properties (reliability and validity) of the measurement scales intended to measure OU. The techniques categorized as 'others' in Table 14 include agent-based modeling (Miller and Martignoni 2016) and hierarchical linear modeling (Matsuo 2018). Reliability and validity constitute the two important pillars that support the verifiability and generalizability of the research. Most of the studies (44) calculated these indices and reported them vividly. As expected, the unit of analysis of unlearning studies mainly pertains to the organizational level. However, research has proved that the other levels (individual, group, or team) of unlearning are equally important (Hislop et al. 2014; Zhao et al. 2013). The unlearning studies in multinational ventures relate to transferring routines and knowledge in overseas joint ventures (Tsang 2008). In addition, Tsang's (2008, 2017) case studies on Sino-foreign joint ventures are also included under this heading.

4.8 Dimensions of organizational unlearning

Since the publication of Hedberg's (1981) seminal chapter, researchers have measured the unlearning construct in numerous ways. For instance, Hedberg (1981)

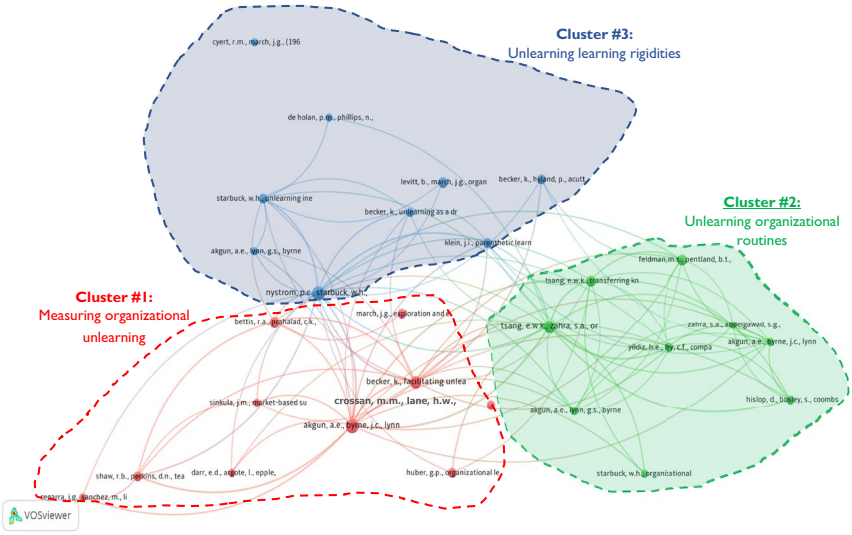

Fig. 4 Co-citation analysis of organizational unlearning references (1976–2019). This figure must be read vis-à-vis Table 15. The minimum occurrence of cited references was > 5. 28 references out of 7227 qualified for further analysis. As a result, three clusters are formed. The labels beside the cluster are only indicative and not software-generated

proposed three dimensions of unlearning: disconfirming mechanisms to identify and select stimuli, disconfirming the relationship between stimuli and response, and disconfirming connection between responses. Since Hedberg's (1981) work reviews psychology literature and incorporates interference theory, these dimensions naturally address the stimuli-response uncoupling mechanism. Figure 3 provides a summary of studies that have proposed various dimensions of unlearning. Of these, the dimensions developed by Akgün et al. (2007a) and Cegarra-Navarro and Sánchez-Polo (2008) are the most popular in the current scholarship. Akgün et al. (2007a) conceptualized unlearning as *changes in beliefs* and *routines* to become receptive to new markets and technologies. Cegarra-Navarro and Sánchez-Polo (2008) operationalized unlearning as a second-order construct with three dimensions: *examining lens-fitting, changing individual habits, and consolidating emergent understandings*. Several empirical studies have adapted these two classification schemes to measure unlearning in organizations (Cegarra-Navarro et al. 2011; Lee and Sukoco 2011; Martelo-Landroguez et al. 2018; Yang et al. 2014).

4.9 Co-citation analysis of organizational unlearning

Co-citation analysis[4] is defined as the frequency with which two articles are cited together by another article (Small et al. 1973; Raghuram et al. 2019). It establishes

[4] We thank an anonymous reviewer for this insightful suggestion to conduct co-citation analysis of unlearning.

Table 15 Co-citation analysis of organizational unlearning references

Total cites	Cluster 1 (red) Measuring organizational unlearning$^{\Omega}$	Total cites	Cluster 2 (green) Unlearning organizational routines$^{\Omega}$	Total cites	Cluster 3 (blue) Unlearning learning rigidities$^{\Omega}$
22	Akgün et al. (2007a)	20	Tsang and Zahra (2008)	23	Nystrom and Starbuck (1984)
15	Becker (2010)	11	Tsang (2008)	11	Levitt and March (1988)
10	Bettis and Prahalad (1995)	10	Feldman and Pentland (2003)	9	Klein (1989)
9	Huber (1991)	8	Yildiz and Fey (2010)	9	Starbuck (1996)
9	March (1991)	7	Akgün et al. (2007b)	9	Becker et al. (2006)
9	Shaw and Perkins (1991)	7	Hislop et al. (2014)	7	Becker (2008)
7	Crossan et al. (1999)	6	Starbuck (2017)	6	Akgün et al. (2003)
6	Cegarra-Navarro and Sánchez-Polo (2008)	6	Akgün et al. (2006)	6	Cyert and March (1963)
6	Darr et al. (1995)	6	Zahra et al. (2011)	6	Martin de Holan and Phillips (2004a)
6	Sinkula (2002)				

Source Author's own elaboration based on VOSviewer data

$^{\Omega}$Indicates the name of each cluster

Note: The references included in each cluster are rank ordered on the basis of total cites received; Refer Fig. 4 for network visualization of co-citation analysis

a relationship between two or more publications that have been previously published. Figure 4 presents a co-citation network of references appearing in unlearning articles. Each node (circle) is an article, and an edge (curved lines) connects these articles. To ensure that only influential articles were included in the analysis, we selected a threshold level so that each reference was cited at least five times in unlearning publications. This resulted in 28 references divided into three distinct clusters: Cluster 1 (red) *measuring organizational unlearning* (10 items), Cluster 2 (green) *unlearning organizational routines* (9 items), and Cluster 3 (blue) *unlearning learning rigidities* (9 items). Table 15 enlists the references included in each cluster and the number of times another publication cites them.

4.9.1 Measuring organizational unlearning

Cluster 1 is labeled as measuring organizational unlearning because most references in this group deal with operationalizing unlearning construct. Akgün et al. (2007a) is the most-cited paper in this cluster. It is a conceptual paper in which authors attempt to conceptualize and operationalize unlearning. Based on two dimensions—changes in beliefs and changes in routines—a typology of unlearning consisting of formative, operative, reinventive, and adjustive unlearning is developed. Other papers in this cluster manifest a balance of conceptual (Bettis and Prahalad 1995; Huber 1991; Sinkula 2002) and empirical (Becker 2010; Cegarra-Navarro and Sánchez-Polo 2008) articles. The analysis of cluster 1 is quite similar to the previous section, where we studied different dimensions of unlearning and synthesized the prior attempts of researchers to quantify the unlearning process (see Fig. 3). In this regard, Huber (1991) argues that unlearning directly affects information interpretation, i.e., attributing commonly understood interpretation to information, which, in turn, leads to OL. Later on, Bettis and Prahalad (1995) proposed an unlearning curve and devised a mathematical function which states that learning in a particular period (Lt) depends on the amount of unlearning in the past (Ft − 1), or, Lt = f[F(t − 1)]. Sinkula (2002) presented an *unlearning ecology* that draws heavily from Hedberg's (1981) stimuli-response uncoupling framework. Similarly, Becker (2010) identified seven factors (positive prior outlook, feelings and expectations, positive experiences and informal support, understanding the need for change, assessment of new way, history of organizational change, and organizational support and training) influencing unlearning during the implementation of enterprise information system in the Australian energy industry. However, Crossan et al. (1999), March (1991), and Shaw and Perkins (1991) do not deal with unlearning directly. But their arguments are quite relevant to the unlearning debate. For example, Shaw and Perkins (1991) advanced reflective and experimental organizations as two themes of learning-efficient organizations. These two themes are similar to unlearning, whereby organizations reflect their existing knowledge and routines to experiment with future actions (Cegarra-Navarro et al. 2012; Sinkula 2002).

4.9.2 Unlearning organizational routines

Cluster 2 consists of articles that deal with unlearning organizational routines. The papers included in this cluster examine unlearning of routines at the individual level (Hislop et al. 2014), team level (Akgün et al. 2006, 2007b), and organizational level (Tsang and Zahra 2008), including multinational enterprises (Zahra et al. 2011), international joint ventures (Tsang 2008) and mergers and acquisitions (Yildiz and Fey 2010). Tsang and Zahra (2008) is the most cited paper in this cluster. They define OU as "discarding of old routines to make way for new ones, if any" (p. 1437). Prima facie, a routine is perceived as a source of inertia, inflexibility, and impossible to discard from organizational memory. However, Feldman and Pentland (2003) proposed two aspects of organizational routines—ostensive (an abstract idea of a routine) and performative (actual performance of a routine), which opens up the avenue for unlearning routines. Since the performative aspect involves a human element, therefore, "participants engage in reflective self-monitoring in order to see what they are doing" (Feldman and Pentland 2003: p. 102). Conclusively, routines can be improvised, and it is quite possible to unlearn and relearn organizational routines via self-reflective learning by organizational members.

The behavioral dimension of unlearning deals explicitly with setting aside old routines, beliefs, standard operating procedures, and daily practices (Yildiz and Fey 2010). Baker and Sinkula (1999) assert that "when organizations proactively question long-held routines, assumptions, and beliefs, they are engaging in the practice of unlearning" (p. 413). Behavioral unlearning helps in the institutionalization of newly acquired knowledge. Empirical evidence suggests that organizational members resist implementing new routines due to not-invented-here syndrome, status quo bias (Kim and Kankanhalli 2009), and incompatibility of new routines with the existing organizational values and beliefs (Tsang 2008; Wang et al. 2017; Yildiz and Fey 2010). Therefore, unlearning this legacy of the past may help organizations acquire, implement, and institutionalize new routines effectively.

In addition to facilitating knowledge institutionalization, behavioral unlearning is also instrumental in efficient knowledge transfer by international joint ventures (Tsang 2008) and mergers and acquisitions (Wang et al. 2017; Yildiz and Fey 2010). Research has shown that acquired mergers and acquisitions and joint ventures usually operate with their own set of routines and values. These routines and values create a stumbling block in the path of acquiring new routines. Unlike greenfield ventures, acquisition ventures are not 'clean slates,' and before transferring new routines to local enterprises, a foreign partner needs to ensure that local employees are willing and able to unlearn the prior routines. For this to happen, educate local employees about the necessity and benefits of setting aside old ways and experiment with new routines, foster a culture of unlearning, and augment the compatibility of new routines with existing routines (Tsang 2008; Yildiz and Fey 2010).

4.9.3 Unlearning learning rigidities

Cluster 3 mainly deals with unlearning learning rigidities. The articles in this cluster include Nystrom and Starbuck (1984), Levitt and March (1988), Klein (1989),

Starbuck (1996), Akgün et al. (2003), Becker et al. (2006), and Becker (2008). Undoubtedly, OL is critical to sustaining competitive advantage (Argyris and Schön 1996). However, management scholars express their concerns when OL becomes a source of rigidity rather than flexibility (Contu et al. 2003; Starbuck 2017). When organizations learn, they encode incoming knowledge into programs, routines, and standard operating procedures that guide future behavior (Levitt and March 1988). This conviction of organizational efficiency augments during a stable environment and continued success, resulting in reinforcement of past routines without questioning their usefulness. However, organizations fail to recognize that "knowledge grows, and simultaneously it becomes obsolete as reality changes" (Hedberg 1981: p. 3). As a result, the same learning that produced intended outcomes in the past becomes a source of inertia and manifests in an internal crisis. The culmination of learning rigidity is when top managers fail to sense alternative opportunities. This is because their dominant logics and cognitive structures were never really challenged in a stable environment (Bettis and Prahalad 1995). Therefore, the central theme of this cluster is that in order to break the shackles of past learning that causes inertia, organizations also need to create a culture of unlearning by promoting experimentation, awareness, tolerance for failure (Klammer et al. 2019), coaching and performance feedback (Becker et al. 2006), and critical reflexive thinking (Matsuo 2018).

4.10 Thematic areas of organizational unlearning

The co-occurrence of keywords (Callon et al. 1991) examines the inter-relationship between the concepts represented by carefully chosen keywords. Unlearning literature was categorized into four major headings related to (a) learning, (b) unlearning, (c) knowledge management, and (d) organizational strategy (Table 16). Surprisingly, not even a single paper published in leading management journals from 1976 to 2000 used 'unlearning' related keywords. This can be attributed to the fact that unlearning was considered subsumable under organizational learning and other psychological concepts like extinction and inhibition. Apart from this, Table 16 shows that five papers (83.33 percent) during 1976–1990 and 12 papers (60.00 percent) during 1991–2000 did not report any keyword. Another interesting analysis is that during 2001–2010, the highest number of papers (n = 13, 36.11 percent) used 'unlearning' in the title but did not include 'unlearn*' as a keyword. With the growing recognition of the need for unlearning, this figure has come down to 13.85 percent during 2011–2019.

However, Table 16 is not enough to study the inter-relationship between four broad categories of keywords and unlearning in organizations. To bridge this gap, Fig. 5 depicts the network visualization of the most prominent keywords used in OU articles from 1976 to 2019 using VOSviewer. Figure 5 complements the results of Table 16.

Figure 5 shows eight research clusters similar to the broad categorization of thematic areas of OU in Table 16. Cluster 1, the largest cluster in terms of keywords, expands upon the relationship between unlearning and organizational change. The articles included in this cluster were published mostly after the year 2000. Cluster 2

Table 16 Thematic areas of organizational unlearning based on occurrence of keywords

Keywords used in articles	Total (n = 127)	Time period			
		1976–1990 (n = 6)	1991–2000 (n = 20)	2001–2010 (n = 36)	2011–2019 (n = 65)
Keywords related to learning in organizations					
Learning, learning cycles, learning process, learning orientation	8.66	0	10.00	30.56	20.00
Team learning, strategic learning, organizational learning	23.62	16.67	25.00	19.44	26.15
Learning organizations, knowledge organizations	3.94	0	5.00	11.11	0
Keywords related to unlearning in organizations					
Unlearning, unlearning context, knowledge discard	20.47	0	0	11.11	33.85
Organizational unlearning	14.96	0	0	8.33	24.62
Forgetting	7.87	0	0	11.11	9.23
Organizational forgetting	14.17	0	5.00	5.56	23.08
Keywords related to knowledge management					
Cognition and cognitive structures	5.51	0	12.00	5.56	3.08
Information and information processing	2.36	0	10.00	2.78	0
Knowledge, knowledge compatibility	6.30	0	5.00	2.78	9.23
Knowledge transfer	7.09	0	5.00	8.33	7.69
Knowledge management	9.45	0	0	13.89	10.77
Organizational memory	8.66	0	0	8.33	12.31
Exploration and exploitation of knowledge	6.30	0	0	0	12.31
Absorptive capacity	3.15	0	0	0	6.15
Keywords related to other strategic aspects					
Strategy and strategic management	12.60	16.67	5.00	5.56	18.46
Organizational change and change management	7.09	16.67	10.00	11.11	3.08
Innovation (technical, incremental, radical innovation)	14.96	0	0	11.11	23.08
Organizational routines	3.15	0	0	2.78	4.62
Organizational culture	3.93	0	0	5.56	4.62

Table 16 (continued)

Keywords used in articles	Total (n = 127)	Time period			
		1976–1990 (n = 6)	1991–2000 (n = 20)	2001–2010 (n = 36)	2011–2019 (n = 65)
Organizational/business performance	5.51	0	0	2.78	9.23
Papers with no keywords [Ω]	19.69	83.33	60.00	36.11	20.00
Papers using 'unlearn' as title but not included as keyword* [‡]	22.83	33.33	25.00	36.11	13.85

Note: All figures are in percentage; The number of papers will not equal decade-wise use of keywords and sum of the percentages will not equal to 100, because the papers could contain more than one keywords of different domains

[Ω]Of these 25 papers having no keyword, 6 were conceptual, 6 were empirical, and 13 consisted of either a dialog, editorial essay, commentary, viewpoint, interview or case study of organization(s)

[‡]A total of 120 unique keywords were located from 70 papers, albeit not all are included here. 'Unlearning' or 'organizational unlearning' did not appear as keyword until the year 2000, even though the articles were using this semantic in title or text

[*]The word 'unlearn' in this instance implies broad meaning. All related syntax (like unlearning, unlearning context, unlearnt, organizational unlearning) along with forgetting, organizational forgetting is included here

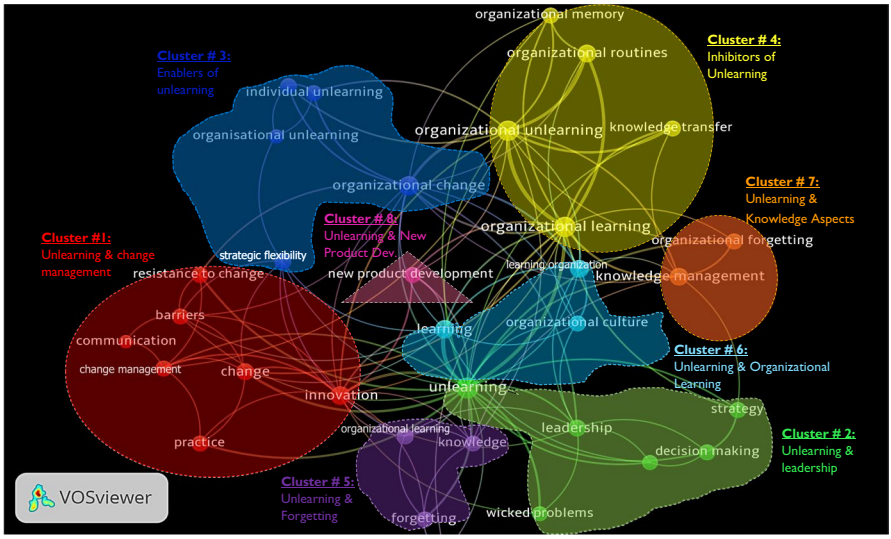

Fig. 5 Co-occurrence of keyword analysis of organizational unlearning (1976–2019). This figure must be read vis-à-vis Tables 16 and 17. The minimum occurrence of keywords was > 5. 36 keywords out of 427 qualified for further analysis. As a result, eight clusters are formed. The labels beside the cluster are only indicative and not software-generated

includes papers relating to the role of leadership in fostering a culture of unlearning in organizations. The debate about the importance of the leadership team in unlearning is recognized since the seminal article of Hedberg et al. (1976). Cluster 3 and cluster 4 form the gamut of unlearning and include papers explaining the enablers and inhibitors of unlearning. However, the understanding of factors that enable and inhibit the unlearning process still lacks in literature. Nevertheless, these two clusters give an overview of factors that affect unlearning at the workplace. Cluster 5 draws the attention towards clarifying the difference between two commonly used terms, yet erroneously used interchangeably in literature—unlearning and forgetting. Cluster 6, like cluster 2, includes papers published during the initial phase of unlearning (1976–1990). This cluster is represented by the linkage of OL and unlearning. Cluster 7 is primarily based on studies that highlight the role of unlearning in the knowledge management process. The early definitions have conceptualized unlearning as discarding obsolete knowledge (Hedberg 1981; Newstrom 1983). Subsequently, this cluster represents papers that have carried this relationship further, owing to the dawn of knowledge-based organizations (Drucker 1999). Lastly, cluster 8 deals with the role of unlearning during radical innovation, including technological innovation and new product development. A detailed analysis of each cluster is presented further.

4.10.1 Cluster # 1 (Red) "Unlearning and Aspects of Change Management"

This cluster consists of seven keywords that broadly discuss the role of OU during organizational change. The cluster consists of ten articles. Most of these articles deal

with unlearning at the organizational level. However, some studies analyze unlearning at the individual level because individual unlearning enables OU (Becker 2008, 2010; Scheiner et al. 2016). Individual unlearning is defined as a process by which individuals deliberately discard knowledge, values, and behaviors to acquire new ones (Matsuo 2018). Indeed, Zhao et al. (2013) affirm that "the process of organisational unlearning is the continuous evolution of individual unlearning-group unlearning-organisational unlearning" (p. 905). Mainly, the studies in this cluster have employed an exploratory research design by using qualitative methods like case studies (Becker 2008; Pratt and Barnett 1997) and semi-structured interviews (Conway and Monks 2011; Scheiner et al. 2016), and quantitative techniques like exploratory factor analysis (Becker 2010).

Unlearning is a vital constituent for changing organizations (Conway and Monks 2011; Pratt and Barnett 1997). Change is usually accompanied by individual resistance due to implicit norms or conventions held by organizational members, emotional attachment in the past, and the fear of moving to an unknown territory (Griffiths et al. 2005; Inkpen 2008; Wilkins and Bristow 1987). Status quo bias theory is often used to explain people's preference to maintain their current status or position (Kim and Kankanhalli 2009). According to status quo bias theory, people resist change if costs of change are higher than benefits (rational decision making), to avoid losses (cognitive misperception), and to retain control of their situation (psychological commitment). Unlearning can facilitate change by stimulating disconfirmation and dissonance with current practices, routines, and policies (Hedberg, 1981). This initial disconfirmation (awareness or questioning) sets a cycle of unlearning in motion followed by relinquishing the current way of doing things and relearning new practices (Becker 2005; Cegarra-Navarro and Wensley 2019). This entire process is captured using Lewin's change model (1951). It describes change using three stages: (a) unfreezing or disconfirming the status quo, (b) transition or developing new mental structure, and (c) refreezing or reinforcing the new equilibrium. Pratt and Barnett (1997) believe that unlearning is similar to the unfreezing stage, and Akgün et al. (2007a) consider unlearning to indicate the transition stage of the change model. However, we argue that unlearning captures all the three steps of Lewin's change model because it ensures that organizational members do not regress to old practices after transitioning to new practices (Tsang 2008). The outcome-oriented definitions (as discussed in Sect. 2) of OU substantiate this proposition. According to these definitions, unlearning processes do not terminate only after discarding obsolete practices but continue until organizations have relearned new ones.

Particularly, literature has associated unlearning and change management with the implementation of new technology. For instance, Becker (2010) identified several individual factors (understanding need for change, assessment of new way, positive experience, and informal support) and a couple of organizational factors (history of organizational change and organizational support and training) that propels the unlearning process during implementation of enterprise information system in public sector corporations operating in the Australian energy industry. Thus, unlearning acts as a catalyst to the change process (Akgün et al. 2007a).

4.10.2 Cluster # 2 (Light Green) "Unlearning and Leadership Aspects"

This cluster consists of six keywords mainly related to the role of leadership during the unlearning process. The contributors to this cluster include Hedberg et al. (1976), Nystrom and Starbuck (1984), Bettis and Prahalad (1995), Tripsas and Gavetti (2000), Hamori and Koyuncu (2015), and Matsuo (2019). The papers included in this cluster narrate incidents when organizations transition from a stable to a dynamic business environment. Most of the articles have used a case-based approach to show that the cognitive inertia of top managers or founders' biases is one of the barriers to unlearning obsolete practices. For instance, Nystrom and Starbuck (1984) have narrated the case of Facit AB, a Swedish manufacturer of mechanical calculators, whose leaders failed to sense the advent of the electronic revolution and continued investment in mechanical calculators. Similarly, Tripsas and Gavetti (2000) narrate the example of Polaroid Corporation, an American consumer electronics company that declined to accept the shift from analog to digital photography. This proposition can be explained using the threat-rigidity effects theory (Staw et al. 1981) and imprinting theory (Marquis and Tilcsik 2013). According to the threat-rigidity thesis, organizations respond to environmental change by restricting information processing and constriction in control. By restricting information inflow from limited sources, organizations rely heavily on past knowledge that does not challenge the status quo or solicit advice that confirms their preferences and decisions. Similarly, by centralizing authority and increasing formalization (constriction of control), decision-makers are reluctant to drift from the organization's core values and reinforce the proven formulas, irrespective of its relevance in changed circumstances (Staw et al. 1981). Imprinting theory suggests that organizations inherit the characteristics of a founder's personality, and their future decision-making is guided by these impressions (Marquis and Tilcsik 2013). A diverse body of evidence suggests that the founders' initial dominant strategy has a persistent effect on the subsequent leadership team (Dimov et al. 2012; Sinha et al. 2020). Moreover, past experience in a leadership position can adversely affect individual performance in a new setting because prior knowledge and skills must be unlearned before learning can happen in the changed context (Hamori and Koyuncu 2015). Therefore, in the above-mentioned studies, the imprinting lens highlights that leaders' failure to sense alternative opportunities can arise due to leaders' prior experience and founders' imprints.

Consequently, Nystrom and Starbuck (1984) proposed replacing the top management team, appointing new leaders, and hiring outside consultants to accelerate unlearning and adaptation. In addition, the top management team must listen to dissenters, seek new learning opportunities, experiment, and create an error-forgiving culture to create an environment for unlearning (Klammer et al. 2019). Nooyi and Govindarajan (2020) provide an overview of how PepsiCo unlearned the decade-long dominant logic (in production and marketing of soft drinks) by introducing *Performance with Purpose* program under the leadership of its former Chief Executive Officer, Indra Nooyi. The theoretical underpinning behind the linkage between unlearning and top management is explained using the upper echelons' perspective. It states that top managers' cognitive values and experience influence organizations'

capability to withstand future opportunities and threats (Hambrick and Mason 1984; Matsuo 2019).

4.10.3 Cluster # 3 (Dark Blue) "Enablers of Organizational Unlearning" & Cluster # 4 (Yellow) "Inhibitors of Organizational Unlearning"

Cluster three "*Enablers of Organizational Unlearning*" and cluster four "*Inhibitors of Organizational Unlearning*" consist of five keywords each and forms the third-largest network structure of OU. These two clusters include 35 papers, and the main contributors include Becker (2005), Brook et al. (2016), Cegarra-Navarro and Wensley (2019), Hislop et al. (2014), Howells and Scholderer (2016), Klammer et al. (2019), Nystrom and Starbuck (1984), Tripsas and Gavetti (2000), and Tsang and Zahra (2008). Most of the studies have reported the enablers and barriers of unlearning at the organizational level. In this cluster, 15 studies are empirical (e.g., Matsuo 2019), six studies are conceptual (e.g., Cegarra-Navarro and Wensley 2019), ten studies are classified into the 'others' category (e.g., Klammer et al. 2019), and four review articles (e.g., Hislop et al. 2014).

Research on unlearning is more inclined towards the 'what' aspect, thereby ignoring the understanding of 'how.' This realization of how to instigate and sustain unlearning, i.e., what are the various factors that either positively or negatively affect OU, forms the subject matter of clusters three and four. It is essential because unlearning is not easy and involves substantial resistance from members during execution (Hedberg et al. 1976; Rushmer and Davies 2004). During initial phases of unlearning research, purging top leadership (as discussed in cluster two), organizational crisis, listening to dissents (like complaints, warnings, and disagreements), inputs from stakeholders, exploiting learning opportunities, and experimentation were considered to enable OU (Nystrom and Starbuck 1984; Starbuck 1996). However, context-specific enablers and barriers were required to understand OU's process during innovation, transformation, and technology implementation. In this line, Becker (2010) proposed some individual and organizational factors like positive prior outlook, positive experience, informal support, history of organizational change, and organizational support to catalyze the unlearning process during a technological change in the Australian energy sector. During the new product development process, Akgün et al. (2006) suggested certain factors like creating a sense of urgency, team crisis, team anxiety, and avoiding groupthink to enhance OU. The enablers of unlearning during radical innovation include environmental turbulence, entrepreneurial orientation (Lyu et al. 2020), creating awareness, temporal and spatial freedom, and error-forgiving culture (Klammer et al. 2019), and team reflexivity and team stress (Lee and Sukoco 2011).

4.10.4 Cluster # 5 (Purple) "Organizational Unlearning and Organizational Forgetting"

This cluster consists of four keywords (forgetting, knowledge, organizational learning, and management development). It includes contributions like Martin de Holan and Phillips (2004a, 2004b), Martin de Holan et al. (2004), Fernandez and Sune

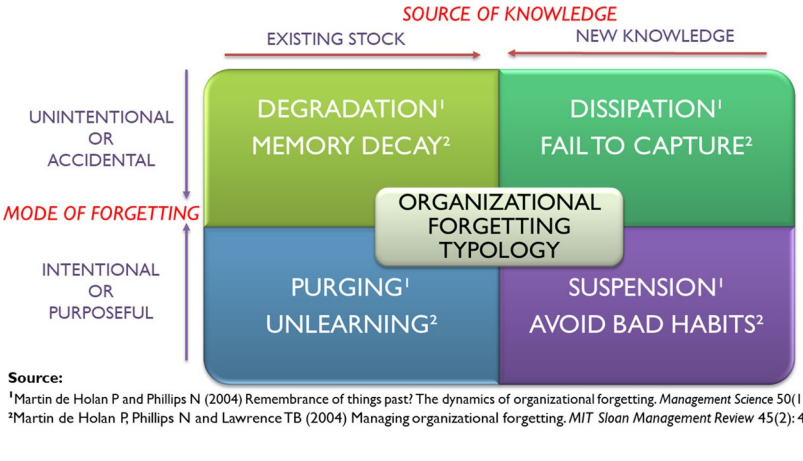

Fig. 6 Typology of organizational forgetting. This typology was developed by Martin de Holan and Phillips (2004a) and Martin de Holan et al. (2004) based on their research on Cuban hotels. The four quadrants are based on two dimensions: **mode of forgetting** (intentional or unintentional) and **source of knowledge** (existing knowledge or new knowledge that has not yet been codified). When an organization accidentally loses the existing stock of knowledge, it is called *forgetting*, *degradation,* or *memory decay* (upper left quadrant). The deliberate loss of existing knowledge is called *unlearning* or *purging* (lower left quadrant). When the new knowledge is accidentally lost, it is termed as *dissipation* or *fail to capture* (upper right quadrant). The deliberate loss of new knowledge is termed as *suspension* or *avoid bad habits* (lower right quadrant)

(2009), Martin de Holan (2011), Easterby-Smith and Lyles (2011), Miller and Martignoni (2016), and Cegarra-Navarro and Wensley (2019). There are 22 papers in this cluster. Three papers are conceptual (e.g., Martin de Holan et al. 2004), 11 are empirical (e.g., Miller and Martignoni 2016), and eight papers are classified into 'others' category because they analyze organizational forgetting using case-based analysis (e.g., Martin de Holan and Phillips 2004a).

The classic learning curve model asserts that knowledge accumulated from prior learning does not depreciate. Lately, researchers have empirically examined the element of organizational forgetting (OF) in the learning process, thereby developing a new approach incorporating both aspects, i.e., learning and forgetting (Agrawal and Muthulingam 2015; Argote 2013; Carmona and Grönlund 1998; Causholli 2016; Kim and Seo 2009; Thompson 2007). Forgetting is defined as an inadvertent loss of knowledge, routines, or practices from organizational memory due to personnel turnover, disuse of knowledge, and failure to capture/codify new knowledge (Agrawal and Muthulingam 2015; Argote 2013; Easterby-Smith and Lyles 2011; Fernandez and Sune 2009; López and Sune 2013; Martin de Holan and Phillips 2004a; Meschi and Métais 2013). Easterby-Smith and Lyles (2011) analyze OF from *cognitive*, *behavioral*, and *social* perspectives. The cognitive view of forgetting is the decay of records as a function of time, turnover of people, and failure to codify tacit knowledge into explicit knowledge (Argote 2013). The behavioral perspective is a loss of rationale to establish routines and habits. It can also be due to the turnover of key personnel who championed

these routines and practices. Lastly, the social perspective is the loss of social networks in organizations due to retirement, turnover, and breakdown in shared perspectives (Martin de Holan et al. 2004). The theories used to describe forgetting includes disuse theory and interference (or inhibition) theory. Both theories are adapted from the psychology discipline. The disuse theory states that as the connection between a stimulus and a response becomes suspended for a considerable length of time, the strength of the relationship between stimuli and response attenuates and is ultimately forgotten. Inhibition or interference theory states that the existence of past knowledge inhibits the acquisition of new knowledge (proactive interference) or vice versa (retroactive interference), thereby leading to forgetting of knowledge that cannot be recalled (Hedberg 1981).

Regardless of conceptualization, forgetting is often confused with unlearning. Several authors undermine the need to distinguish these two concepts by using them interchangeably (Huang et al. 2018; Meschi and Métais 2013; Zeng et al. 2019). Furthermore, the use of terms like intentional forgetting (Cegarra-Navarro and Wensley 2019) and routine unlearning (Rushmer and Davies 2004) hinders the attempt to distinguish between the two terms. As a result, several typologies were developed by Martin de Holan and associates (2004a, b), Azmi (2008), and Fernandez and Sune (2009) to differentiate these two terms. Figure 6 presents one such typology that distinguishes OF and OU. The 2 * 2 matrix employs two dimensions: intentionality and stock of knowledge. Forgetting/degradation/memory decay is an intersection of accidental loss of existing stock of knowledge. Unlearning/purging is a deliberate discard of existing knowledge (Martin de Holan and Phillips 2004a; Martin de Holan et al. 2004). Moreover, OF takes place at an individual level because organizations are incapable of forgetting themselves. On the other hand, OU is an organizational-level phenomenon where an old knowledge structure is replaced by a new knowledge structure (Cegarra-Navarro et al. 2014a, b). Another important line of distinction between unlearning and forgetting in terms of outcomes associated with these two processes is proposed by Carmona and Grönlund (1998). They state that unlearning is deliberately pursued by organizations to reach higher levels of learning. In contrast, forgetting does not involve replacing existing practices with better ones since it is accidental in nature. Consequently, unlearning is a functional process leading to higher learning levels, whereas forgetting is a dysfunctional process leading to an adverse impact on organizational performance (Agrawal and Muthulingam 2015; Azmi 2008; Causholli 2016; López and Sune 2013; Meschi and Métais 2013).

4.10.5 Cluster # 6 (Sky Blue) "Organizational Unlearning and Organizational Learning"[5]

This cluster consists of three keywords. There are 31 papers in this cluster, and the contributors include Klein (1989), Huber (1991), Bettis and Prahalad (1995), Baker

[5] We thank an anonymous reviewer for this insightful suggestion to rename cluster 6 in its present form.

and Sinkula (1999), Tsang (2001), Tsang (2001, 2008), Tsang and Zahra (2008), Antonacopoulou (2009), Zahra et al. (2011), and Matsuo (2018, 2019). The papers in this cluster mostly deal with the organizational level of analysis (n = 21), and most of them are conceptual (n = 12).

Any debate on OU is incomplete without deliberating on its relationship to OL. Numerous reviews (Easterby-Smith et al. 2000) and conceptual frameworks (Huber 1991; Baker and Sinkula 1999) of OL have realized the importance of unlearning at the workplace. For instance, Easterby-Smith et al. (2000) posited the notion of unlearning as one of the seven significant contributions that have been influential since *Organizational Learning: A Theory of Action Perspective*.[6] OL is a process of encoding past success stories, routines, and behaviors into organizational memory (Levitt and March 1988). Through invigorating case-based analysis of crisis-stricken companies, the proponents of unlearning identified that past learning created a roadblock for organizational adaptation and change (Hedberg et al. 1976; Nystrom and Starbuck 1984). The inertia engendered by prior learning hampered organizations' ability to introspect current strategies, let alone formulate new strategies (Starbuck 2017). Thus, OU emerged as a solution to dismantle such rigidities by intentionally discarding the existing routines, knowledge, and behaviors that lost their sheen and no longer contributed to organizational effectiveness. Gradually, unlearning assumed a pivotal position in academic debates about OL, albeit misconstrued as being subsumed in the latter (Huber 1991). This (mis)apprehension continued to dominate the early part of the 2000s and consequently precluded the opportunity for unlearning to thrive as a separate phenomenon independent of OL. Subsequently, Tsang's (2008) case study of Sino-foreign joint ventures (both greenfield and acquisition) established unlearning and learning as two mutually exclusive and distinct processes. Moreover, every instance of new learning may not necessarily require prior unlearning (Bettis and Prahalad 1995; Newstrom 1983; Sharma and Lenka 2019; Tsang and Zahra 2008), which forms the central premise of parenthetic learning theory (Klein 1989).

4.10.6 Cluster # 7 (Orange) "Unlearning and Aspects of Knowledge Management"

Cluster 7 consists of two keywords—knowledge management and organizational forgetting. This cluster manifests a certain degree of overlap with cluster 5 (unlearning and forgetting) due to the presence of somewhat identical keywords.[7] However, the subject matter of these two clusters is entirely different. In cluster 7, 'knowledge management' appears as a keyword along with 'organizational forgetting.' As we have already dealt with forgetting and its relationship with OU in cluster 5, this cluster will provide an overview of the linkages between unlearning and knowledge management.

[6] Although Argyris and Schön (1978) did not use the concept of unlearning in this book. It was only in *Organizational Learning II: Theory, Methods, and Practices* that unlearning appeared in writing of Argyris and Schön (1996).

[7] We thank an anonymous reviewer for this insightful suggestion to clarify the overlap between cluster #5 and #7.

There are 15 articles in this cluster, and the main contributors include Tsang (2008, 2016), Yildiz and Fey (2010), Cegarra-Navarro et al. (2011), Zhao et al. (2013), Cegarra-Navarro et al. (2014a, b), Wang et al. (2017), and Delshab and Boroujerdi (2018). These articles mainly investigate the impact of unlearning dimensions on knowledge management at the organizational level (n = 11) using quantitative data analysis techniques (n = 10). Studies in the context of international mergers and acquisitions and joint ventures have articulated the difficulty faced by foreign partners in transferring knowledge and routines to local enterprises (Inkpen 2008; Tsang 2008, 2016; Wang et al. 2017; Yildiz and Fey 2010). Two theoretical perspectives explicate this finding. First, internal stickiness theory states that the transfer of knowledge, routines, and best practices—either within an organization or beyond organizational boundaries—is replete with several barriers that have been categorized into four major headings (Szulanski 1996). These barriers emanate from knowledge transfer characteristics, knowledge source characteristics, knowledge recipient characteristics, and context characteristics (Inkpen 2008; Zeng et al. 2019). Second, congruence theory states that the degree to which the knowledge structures, attitudes, and routines of the sender and recipient unit are similar (or compatible), higher will be the knowledge absorption, and lower will be the probability of transfer stickiness (Wang et al. 2017; Zeng et al. 2019). Subsequently, unlearning is suggested as an alternative to correct knowledge transfer problems by discarding existing routines in such enterprises.

Knowledge has remained a vital element in unlearning definitions (Becker 2018; Hedberg 1981; Huber 1991). The relevance of OU in knowledge management (particularly during the creation and acquisition of new knowledge) has been especially emphasized (Becker 2018; Zhao et al. 2013). Indeed, successful unlearning creates a fertile ground for acquiring new knowledge (Inkpen 2008; Starbuck 1996; Wang et al. 2019; Yildiz and Fey 2010). Researchers substantiate this claim by adopting a knowledge-based view of the firm, which states that knowledge is an intangible and valuable resource that helps an organization sustain competitive advantage (Conner and Prahalad 1996). However, organizations must also discount the rate of knowledge obsolescence. The obsolete knowledge has to be unlearned and renewed with new knowledge appropriate for the ever-changing business environment. How unlearning creates a way to acquire new knowledge can be justified by three reasons: (a) the volume and velocity of technological advancement and radical innovation make the existing knowledge old and invalid for today's realities. Therefore, unlearning can help organizations discard obsolete knowledge and adapt to new knowledge; (b) if the new knowledge is perceived as inconsistent with the existing values and past experiences of the organization, then the old knowledge often impedes the acquisition of new knowledge. For this, unlearning those pieces of knowledge that are incompatible with the new knowledge can facilitate the institutionalization of the new knowledge (Mariano and Casey 2015; Wang et al. 2017; Yildiz and Fey 2010); and (c) the transition to modern knowledge sharing tools, popularly known as "Knowledge Management 2.0" or "Conversational Knowledge Management," can lead to the creation of counter-knowledge (Cegarra-Navarro et al. 2014a, b). Counter-knowledge is defined as "flaws in individuals' mental models which arise from rumors, inappropriate knowledge structures, and outdated routines or procedures"

and leads to degradation of existing knowledge and hinders the learning capability of organizations (Cegarra-Navarro et al. 2014a, b: p. 165). Therefore, unlearning corrects this problem by replacing counter-knowledge with new knowledge structures.

4.10.7 Cluster # 8 (Pink) "Organizational Unlearning and New Product Development"

This cluster consists of 10 articles and talks about the role of unlearning during innovation, particularly in terms of new product development (NPD) and radical innovation. The main contributors to this cluster are Takeuchi and Nonaka (1986), Akgün et al. (2006), Akgün et al. (2007b), Lee and Sukoco (2011), Wang et al. (2013), Yang et al. (2014), and Lyu et al. (2020). Perhaps, this is the only cluster that analyzes team-level unlearning. Most articles ($n=7$) study unlearning at the organizational level, and empirical articles ($n=7$) are primarily published in this cluster.

The traditional linear model of NPD is now moving towards a more flexible, open, and improvised NPD process (Takeuchi and Nonaka 1986). This is due to changing customer preferences, increased competition, and the limited shelf life of products. It is imprudent to institutionalize the past success of product innovation into standard practices (García-Muiña et al. 2009). Institutionalization creates rigidity in employees' mindsets, and they cannot meet the changing demands of the market and technology. This theme leverages two theoretical perspectives: *path-dependence theory* (Sydow et al. 2009) and *imprinting theory* (Marquis and Tilcsik 2013). *Path dependence theory* states that the unintended consequences of past decisions and positive feedback processes develop into a rigid and potentially inefficient action pattern, thereby organizations losing the capability to adapt to changing environments and explore better alternatives (Sydow et al. 2009). *Imprinting theory* is similar to path dependence theory because organizations cannot relinquish the cognitive schemes and competencies (imprints) developed during founding or other sensitive periods of organizational life cycle, thereby leading to a replicated decision-making pattern (Marquis and Tilcsik 2013; Sinha et al. 2020). However, it is different from path dependence because "the replicated pattern in the imprinting approach is ready-made at the beginning… and continues to influence future processes" (Sydow et al. 2009: p. 696).

Given these repercussions, Akgün et al. (2006) highlight the need for unlearning (change in beliefs and routines) in NPD teams. Unlearning helps NPD teams to operate in a state of "zero-information"—a condition where prior information does not matter (Takeuchi and Nonaka 1986). They must be prepared to incorporate stakeholders' cues into organizational offerings, which often challenges the established product development procedures and organizational beliefs. In this regard, Hamel and Zanini (2018) exemplify the case of Haier, a Chinese consumer electronics company, inviting responses from potential users about their needs and preferences for a new home air-conditioner. This allowed Haier to unlearn the past knowledge of product development procedures and address the problem of minimizing risk by radically rethinking the design of the air-conditioner.

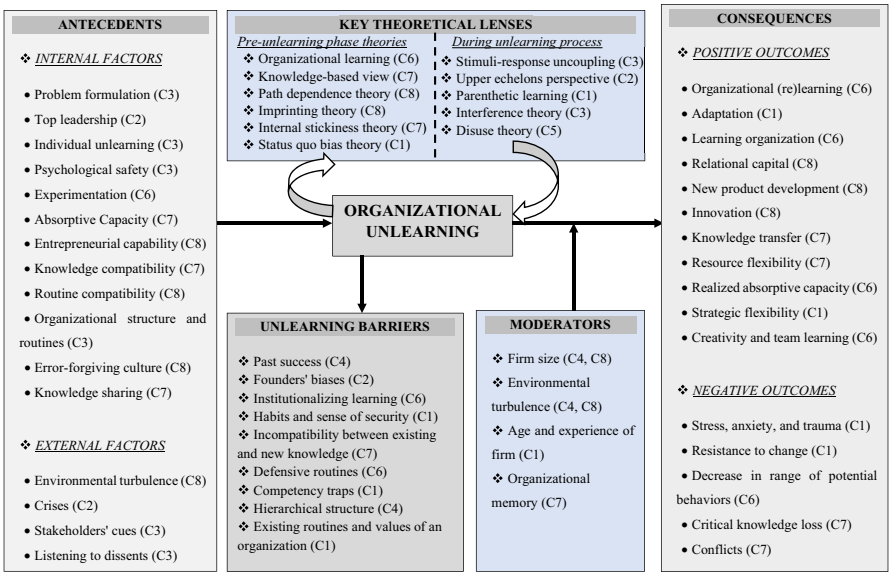

Fig. 7 An integrative framework of organizational unlearning. This framework is based on the co-occurrence of keyword analysis and eight themes derived therefrom (see Fig. 5 and Table 17). Against each antecedent, barrier, moderator, theoretical lens, and consequence, we have mentioned the respective cluster (C1, C2, C3…, C8) to which that variable belongs. *C1*–change management; *C2*–leadership; *C3*–enablers; *C4*–inhibitors; *C5*–forgetting; *C6*–organizational learning; *C7*–knowledge management; C8–new product development

Unlearning the conventional practices, routines, and competencies can also stimulate the process of *radical innovation* as it is based on entirely new technology (Escrig et al. 2019; Lyu et al. 2020; Yang et al. 2014). Sandberg and Aarikka-Stenroos (2014) enlist radical innovation barriers like restrictive mindsets, lack of competencies, and unsupportive organizational culture. These barriers can be mitigated by creating an unlearning context that promotes entrepreneurial spirit by being open to new ideas and searching for innovation opportunities (Klammer et al. 2019).

4.11 Integrative overview of organizational unlearning clusters[8]

To articulate the relationship between eight clusters of OU, we organized the major topics in each cluster into an integrative framework, as shown in Fig. 7. This framework describes the antecedents, moderators, barriers, key theoretical aspects, and consequences of unlearning. We have also included the cluster number (C1, C2…, C8) against each component. The antecedents are classified into two broad categories—*internal* and *external* (Lyu et al. 2020). As the name suggests, internal antecedents (e.g., top leadership, individual unlearning, psychological safety, and

[8] We thank an anonymous reviewer for this insightful suggestion to inform a conceptual model of unlearning.

knowledge sharing) constitute factors that operate within the organizations and initiate the unlearning process as a proactive measure to combat environmental uncertainty. External antecedents (e.g., environmental turbulence, stakeholders' cues, and crises) consist of factors that lie beyond organizations' control and instigate unlearning as a reactive measure to changing circumstances. The majority of these antecedents are derived from clusters 3, 7, and 8. However, unlearning is negatively affected by barriers like founders' biases (Hedberg 1981), knowledge institutionalization (Yildiz and Fey 2010), incompatible knowledge (Wang et al. 2017), defensive routines (Argyris and Schön 1996; Akgün et al. 2006), and hierarchical organization structure (Imai et al. 1984). Few moderating variables are also studied in unlearning research. For example, firm size (Leal-Rodríguez et al. 2015; Lyu et al. 2020), environmental turbulence (Huang et al. 2018), nature, and type of organization (Tsang 2008), and organizational memory. The consequences of OU are divided into *positive* and *negative* outcomes. Positive outcomes (e.g., relearning, adaptation, learning organizations, new product development, innovation, and change) are favorable results of unlearning, and negative outcomes (resistance to change, critical knowledge loss, and conflicts) are unfavorable by-products of unlearning.

Unlearning research is grounded on multiple theoretical lenses mainly adopted from disciplines like strategic management and cognitive psychology. We have already discussed the fundamental theories that operate within each thematic cluster of OU. However, these theories can be divided into two categories as well, depending on whether they operate in the *pre-unlearning phase* (e.g., path dependence theory, imprinting theory, knowledge-based view, internal stickiness theory, and status quo bias theory) or *during the unlearning process* (stimuli-response decoupling, parenthetic learning, interference theory, upper echelons perspective, and disuse theory). The pre-unlearning theories emphasize the need for OU. As discussed in cluster 3 of co-citation analysis (Sect. 4.9.3) and cluster 8 of co-word analysis (Sect. 4.10.7), organizations get "locked-in" in specific historical imprints or patterns that they are unable to reverse (Akgün et al. 2007b; Sydow et al. 2009). Once the need for unlearning is recognized, it is essential to contemplate the unlearning mechanism to break these persistent patterns. This function is carried out by the second set of theories—theoretical perspectives during the unlearning process—so that organizations can frame appropriate strategies during each phase of OU.

5 Discussion and conclusions

5.1 Discussion

This study has provided an in-depth examination of the unlearning literature published in leading management journals by incorporating a combination of systematic literature review and bibliometric analysis. The rationale for selecting leading management journals is based on the quality and rigor employed by these outlets in publishing articles (Gomes et al. 2016; Sergeeva and Andreeva 2016). Hence, Aguinis et al. (2020) consider publications in top-rated journals as the new bottom line for valuing academic research. An umpteen number of journal ranking lists are

available that classify journals based on merit and impact (e.g., JCR, ABDC, CABS, etc.). However, due to competing methodologies adopted by these quality lists, a particular journal is ranked very high in one list and moderately ranked in another quality list. To do away with this limitation, we have used an extensive criterion for selecting leading journals. This has ensured coverage of more unlearning articles and maintained the rigor in selecting these outlets.

Certainly, unlearning is no longer playing second fiddle in OL research. Instead, learning discourses embrace the importance of unlearning to the extent that it is described as one of the seven significant contributions that have been influential since 1978 in the field of OL (Easterby-Smith et al. 2004). However, critics of unlearning envisage that it should be dropped from scholarly discourse because it is "allegedly imported from psychology literature" and lacks conceptual rigor (Howells and Scholderer 2016: p. 443). Since "organizational unlearning helps researchers describe certain phenomena," it then stands to reason that "how far the concept of organizational unlearning has a firm root in the psychology literature should not significantly affect its usefulness in advancing organizational research" (Tsang 2017: p. 40). Moreover, we believe that the relevance of unlearning will intensify during the ongoing crisis of SARS-CoV-2 (Covid-19). For instance, most companies have either shifted or contemplating a shift towards a substantially remote workforce. This ensues adopting new digital technologies for office collaboration (like group videoconferencing) as well as unlearning the past methods of doing work (e.g., in-person office interactions and informal conversations).[9] The employees will have to unlearn the prior working norms and understand that previous work experience will hold minimal value in the new work setting. Similarly, as the manufacturing facilities are relocated and regulatory regimes are overhauled (e.g., changes in stock market listing requirements), organizations have to unlearn much of the pre-crisis knowledge that will no longer hold valid once the catastrophic effect of the pandemic has subdued. Unlearning will also play a dominant role because the leaders of major behemoths do not expect that organizations will revert to pre-Covid-19 levels.[10] Hence, employees' learning and development needs must shift the focus from skills development to capabilities development to help people adapt and cope well with a similar crisis in the future (Lundberg and Westerman 2020).

This review has also uncovered the intellectual territory of unlearning, which comprises eight research clusters that have addressed various aspects of organizational studies like change management, leadership, OL, new product development, radical innovation, and knowledge management. These clusters practically summarize the entire gamut of unlearning research and *mutually constitutive* because one theme of OU affects another theme in one sense or another. For instance, cluster 8 (unlearning and new product development) is related to cluster 7 (unlearning and aspects of knowledge management) and cluster 1 (unlearning and change

[9] https://www.wsj.com/articles/facebook-to-shift-permanently-toward-more-remote-work-after-coronavirus-11590081300.

[10] https://www.mckinsey.com/industries/pharmaceuticals-and-medical-products/our-insights/gsks-brian-mcnamara-on-the-business-impact-of-covid-19.

Table 17 Directions for future research based on research clusters of unlearning

S. No.	Cluster theme	Coding	Key theory	Key topics in cluster	Directions for future research
1	Unlearning and change management		Lewin's model of change, Path dependance, Imprinting theory	Organizational change, change, resistance to change, culture change, strategic resilience, metamorphosis, continuous change, planned change	Difference in enablers, outcomes, barriers, type, intensity, and degree of unlearning during radical (transformational) and incremental (continuous) change, role of unlearning to reduce employees' resistance to change
2	Unlearning and leadership		Upper echelon theory, Imprinting theory, Threat Rigidity Effects theory	Leadership, decision making, strategy	Role, type, and leadership style in motivating various echelons of management to identify, report, and question obsolete and misleading knowledge; how does the leadership experience in one organization affect organizational performance in the presence and absence of unlearning prior experience
3	Enablers of unlearning		Stimuli-response decoupling, Parenthetic learning theory, Interference theory	Individual unlearning, organizational change	Enablers and barriers of unlearning, difference in unlearning process in business and non-business organizations, methods that can spur unlearning process, develop a scale for measuring unlearning in organizations, cases of organizations that succeeded due to unlearning, practitioners' oriented viewpoints on unlearning process, moderating and mediating variables affecting unlearning, role of HR practices in unlearning, linkages between unlearning and financial performance, 'hard' methods to detect the need for unlearning (like financial statement analysis, value added reporting etc.)
4	Inhibitors of unlearning			Routines, organizational learning, organizational memory	
5	Unlearning and forgetting		Theory of disuse, Interference or inhibition theory, Overlearning	Unlearning, organizational unlearning, individual unlearning, unlearning context, forgetting, organizational forgetting, intentional forgetting, accidental forgetting, knowledge loss, intentional unlearning, accidental unlearning	Differentiate between organizational unlearning and organizational forgetting, is unlearning a part of broader framework of organizational forgetting or both processes entirely different, functional and dysfunctional outcomes of unlearning and forgetting, contextual factors governing the adequacy of unlearning and forgetting in organizations
6	Unlearning and organizational learning		Organizational learning theory, Situated learning, Experiential learning, Action learning	Learning, organizational learning, double-loop learning, learning organizations, team learning, continuous learning, organizational relearning, individual relearning, action learning, deinstitutionalization, learning climate, deutero-learning, systems thinking, organizational learning capability	Establish the linkage between unlearning and higher order learning (deuterolearning, double loop learning, and triple loop learning), investigate the outcome of unlearning: is unlearning always followed by acquisition of new learning, modifications needed in learning climate and organizational learning mechanisms to spur the process of unlearning, enabling factors to help transfer of individual and team unlearning to organizational level, role of unlearning in developing a learning organization
7	Unlearning and knowledge aspects		Knowledge-based view, Internal stickiness theory, Congruence theory	Knowledge, knowledge management, knowledge transfer, organizational memory, tacit knowledge, knowledge compatibility, counter knowledge, knowledge creation, knowledge discard, knowledge sharing, knowledge stickiness, knowledge processes, obsolete knowledge, exploration and exploitation of knowledge, actionable knowledge	Incorporating unlearning aspect in knowledge management systems, role of unlearning in institutionalizing transfer of knowledge from one unit/department to another unit/department, developing knowledge structures that help organizations to challenge obsolete knowledge, role of unlearning in ambidextrous organizations (exploration and exploitation of knowledge), difficulties faced by organizations to unlearn incompatible pieces of knowledge, unlearning and its linkage to organizational memory, differences between unlearning, knowledge leakage, and deinstitutionalization
8	Unlearning and new product development		Path dependence theory, Imprinting theory, Adaptation theory	Innovation, radical innovation, open innovation, path-dependence, soft innovation, incremental innovation, innovation capability, technology evaluation, technology identification, innovation outcomes	Role of unlearning in learning from failures during innovation process, role of unlearning in open innovation, drivers and barriers of unlearning during business model innovation, industry-specific (e.g. manufacturing, services, small and medium size enterprises) understanding of unlearning during innovation

management). This is because organizations cannot rely on their existing knowledge structure during radical innovation and need to change the mental models and outdated paradigms of getting things done (Lyu et al. 2020). Moreover, the role of the top management team in radical innovation is exemplified in PepsiCo's *Performance with Purpose* program (Nooyi and Govindarajan 2020). Accordingly, an integrative framework of unlearning is proposed in Fig. 7, which will help the researchers to connect these research clusters. This analysis will also help researchers converge the knowledge from disparate knowledge sources and engender a new perspective of OU. Moreover, the credulity of this argument remains intact because "knowledge in management studies often times develop along disciplinary lines resulting in different theoretical perspectives not sufficiently informing and drawing from each other" (Post et al. 2020: p. 352).

Another theoretical implication of this study is that unlearning lies at the intersection of organizational persistence and organizational adaptation theories. Persistence theories like organizational path dependence and imprinting theory explain

how organizations' previous history affects their future decision-making and limits organizations' vision to exploitative learning at the expense of explorative learning (March 1991; Sydow et al. 2009). Once these rigid paths develop, organizations find it challenging to change and improvise. In this way, persistence theories answer the 'why' of unlearning, i.e., reasons that trigger an organization's unlearning process. In contrast, adaptation theory lies at the other end of the unlearning continuum. Organizations unlearn to adapt to a changing environment by discarding obsolete knowledge and routines that are no longer suited for the current competitive landscape. Moreover, theories like stimuli-response uncoupling (Hedberg 1981), parenthetic learning (Klein 1989), and upper echelons perspective (Hambrick and Mason 1984) explain the 'how' of unlearning, i.e., enablers which contribute to this transition from organizational persistence to organizational adaptation.

5.2 Directions for future research

The bibliometric review helped uncover several research directions that can serve as a possible avenue for future investigations. Table 17 presents the future research directions based on the broad clusters discovered using a thematic analysis of unlearning research. Conclusively, these research avenues are based on the construct of unlearning per se, linkages of unlearning with change management, innovation, knowledge management, OL, and other strategic aspects that share a close association with OU.

5.3 Limitations

There are certain limitations to be addressed. First, this study was limited to 42 leading business and management journals, and it might lead to neglecting articles published in several other management journals. Moreover, the exclusion of non-English articles and conference papers can also lead to the loss of valuable information. Second, other bibliometric indicators like bibliographic coupling and certain performance indicators like *h*-index and altmetrics were not used in this study. Third, although our findings are indispensable for scholars interested in undertaking future research on unlearning, it is less likely to benefit practitioners directly. Lastly, in identifying the research clusters of OU, we used the author-supplied keywords as a representative to uncover the intellectual structure of the field. While the earlier bibliometric studies in other areas have acknowledged the merit of this method (Ferreira et al. 2014; Xi et al. 2015). However, an in-depth content analysis of papers can provide additional insights.

Appendix 1

See Tables 18 and 19.

Table 18 Summary of past review articles on organizational unlearning

Study title	Author(s)	Year	Source Title[Ω]	Database search strategy details					
				Method	Period of review	No. of papers analyzed	Search terms used	Database covered	Remarks
Individual and organizational unlearning: Directions for future research	Becker	2005	*IJOB*	Narrative Review	–	–	–	–	Develops a model of unlearning based on literature of adult learning, knowledge management, and individual and organizational learning
Organizational unlearning	Tsang and Zahra	2008	*HR*	Narrative Review	–	–	–	–	Defines and articulates the salient features of organizational unlearning, role of unlearning during episodic and continuous change, and distinguishes organizational unlearning from organizational learning
Exploring types of individual unlearning by local health-care managers: An original empirical approach	Coombs et al	2013	–*	Systematic Review	2000–2012	34	'unlearning,' 'abandoning behaviour or knowledge,' and 'giving up behaviour or knowledge'	Emerald, Business Source Complete, PsycINFO, MEDLINE, and ERIC	Links the concept of unlearning to the health-care organizations. Based on qualitative interviews of 29 health-care managers, this study identifies certain factors that influences unlearning of health care managers

Table 18 (continued)

Study title	Author(s)	Year	Source Title[Ω]	Database search strategy details					
				Method	Period of review	No. of papers analyzed	Search terms used	Database covered	Remarks
The process of individual unlearning: A neglected topic in an under-researched field	Hislop et al	2014	*ML*	Systematic Review	2000–2012	35	'unlearning,' 'abandoning behaviour or knowledge,' and 'giving up behaviour or knowledge'	Emerald, Business Source Complete, PsycINFO, MEDLINE, and ERIC	This review articulates that change involves both learning and unlearning. However, unlearning–especially individual unlearning is less examined in literature. Lastly, *fading*, *wiping*, and *deep unlearning* are three types of individual unlearning
Forget unlearning? How an empirically unwarranted concept from psychology was imported to flourish in management and organisation studies	Howells and Scholderer	2016	*ML*	Systematic Review	–	45	'unlearn,' and sources citing 'Hedberg B*' and 'Nystrom and Starbuck'	PsycINFO and Web of Science	Provide a critique of unlearning concept by reviewing the psychology literature. The authors assert that it is difficult to distinguish unlearning from theory change, discard of practice and extinction

Table 18 (continued)

Study title	Author(s)	Year	Source Title[Ω]	Database search strategy details					
				Method	Period of review	No. of papers analyzed	Search terms used	Database covered	Remarks
Unlearning and forgetting in organizations: a systematic review of literature	Klammer and Gueldenberg	2019	*JKM*	Systematic Review	1980–2015	63	'organization* AND unlearn*,' 'organization* AND forget*,' 'organization* AND individual AND unlearn*,' and 'organization* AND individual AND forget*.'	EBSCOHost, ABI/INFORM, EconBiz, ScienceDirect, Emerald Insight, JSTOR, SAGE, and Google Scholar	Provide a systematic assessment of antecedents, consequences, and barriers of unlearning and forgetting. In addition, based on the typology of organizational forgetting developed by Martin de Holan and Phillips 2004a, b, this study develops a framework of unlearning in terms of *intentionality* (forgetting or unlearning) and *depth of knowledge loss* (shallow or deep)

[*]Signifies a research report published in *Heath Services and Delivery Research* (National Institute for Health Research)

[Ω]Abbreviations of source titles (journals) available in Table 4 except for *IJOB–International Journal of Organizational Behavior*

Table 19 Description of unlearning articles included in analysis

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
1	Camping on seesaws: Prescriptions for a self-designing organization	*ASQ*	Hedberg et al	1976	C	–	✓	Org	M	#2
2	To avoid organizational crisis, unlearn	*OD*	Nystrom and Starbuck	1984	O	✓	–	Org	O	#2
3	The new new product development game	*HBR*	Takeuchi and Nonaka	1986	O	–	✓	Org	M	#8
4	For successful organization culture, honor your past	*AME*	Wilkins and Bristow	1987	C	–	✓	Org	M	#1
5	Between myth and action	*Scan.JM*	Hedberg and Jönsson	1989	C	–	✓	Org	M	#3
6	Parenthetic learning in organizations: Toward the unlearning of the unlearning model	*JMS*	Klein	1989	C	✓	–	Org	O	#4
7	Competition for competence and interpartner learning within international strategic alliances	*SMJ*	Hamel	1991	E	–	✓	IJV	M	#6
8	Organizational learning: The contributing processes and the literatures	*OS*	Huber	1991	C	–	✓	Org	M	#6
9	Unlearning the organization	*OD*	McGill and Slocum, Jr	1993	C	✓	–	Org	O	#3
10	Organizational forgetting and information systems	*Scan.JM*	Carmona and Perez-Casanova	1993	O	✓	–	Org	O	#5
11	Organizational unlearning	*CIM*	Johannessen and Hauan	1994	O	✓	–	Org	O	#3
12	What happens after success: The perils of excellence	*JMS*	Miller	1994	C	–	✓	Org	M	#6
13	The social construction of organizational learning: Conceptual and practical issues in the field	*HR*	Nicolini and Meznar	1995	C	–	✓	Org	M	#6
14	The dominant logic: Retrospective and extension	*SMJ*	Bettis and Prahalad	1995	C	–	✓	Org	M	#6

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
15	Organizational learning curves: Persistence, transfer and turnover	*IJTM*	Argote	1996	C	–	✓	Org	M	#6
16	Unlearning ineffective or obsolete technologies	*IJTM*	Starbuck	1996	C	✓	–	Org	O	#6
17	New employee development: A review and reconceptualization	*HRDQ*	Holton	1996	R	–	✓	Indiv	M	#3
18	Organizational learning and the learning organization: A dichotomy between descriptive and prescriptive research	*HR*	Tsang	1997	C	–	✓	Org	M	#6
19	Emotions and unlearning in Amway recruitment techniques: Promoting change through 'safe' ambivalence	*ML*	Pratt and Barnett	1997	O	–	✓	Org	M	#1
20	Learning from forgetting: An experiential study of two European car manufacturers	*ML*	Carmona and Grönlund	1998	O	✓	–	Org	O	#5
21	Strategic learning: The continuous side of discontinuous strategic change	*OS*	Kuwada	1998	O	–	✓	Org	M	#4
22	The second-generation learning organizations: New tools for sustaining competitive advantage	*OD*	Fulmer et al	1998	C	–	✓	Org	M	#3
23	Designing organizations for competitive advantage: The power of unlearning and learning	*OD*	Lei et al	1999	C	✓	–	Org	O	#3
24	The synergistic effect of market orientation and learning orientation on organizational performance	*JAMS*	Baker and Sinkula	1999	E	–	✓	Org	M	#6

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
25	Knowledge transfer through technological hyper learning in five industries	*Techno*	Carayannis	1999	O	✓	–	Org	M	#7
26	Organizational learning: Debates past, present and future	*JMS*	Easterby-Smith et al	2000	C	–	✓	Org	M	#6
27	Managerial learning in foreign-invested enterprises of China	*MIR*	Tsang	2001	E	–	✓	IJV	M	#6
28	The effects of worker learning, forgetting, and heterogeneity on assembly line productivity	*MS*	Shafer et al	2001	E	✓	–	Indiv + Org	O	#5
29	The anxiety of learning	*HBR*	Coutu	2002	O	–	✓	–	–	#6
30	Organizational learning: A socio-cognitive framework	*HR*	Akgün et al	2003	C	–	✓	Org	M	#6
31	Remembrance of things past: Dynamics of organizational forgetting	*MS*	Martin de Holan and Phillips	2004	O	✓	–	Org	O	#5
32	Organizational forgetting as strategy	*SO*	Martin de Holan and Phillips	2004	O	✓	–	Org	O	#5
33	Managing organizational forgetting	*MIT Sloan*	Martin de Holan et al	2004	C	✓	–	Org	O	#5
34	Business performance management and unlearning process	*KPM*	Navarro and Moya	2005	E	✓	–	Org	O	#3
35	Factors influencing knowledge creation and innovation in an organisation	*JEIT*	Merx-Chermin and Nijhof	2005	E	✓	–	Org	M	#3
36	Learning shock: The trauma of return to formal learning	*ML*	Griffiths et al	2005	O	–	✓	Indiv	M	#4
37	Learning and forgetting-based worker selection for tasks of varying complexity	*JORS*	Nembhard and Osotsilp	2005	E	✓	–	Org	M	#6

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
38	Organizational DNA for strategic innovation	*CMR*	Govindarajan and Trimble	2005	C	–	✓	Org	M	#3
39	Considering unlearning in HRD practices: An Australian study	*EJIT*	Becker et al	2006	E	✓	–	Org	O	#6
40	The role of knowledge management in the innovation process	*CIM*	Basadur and Gelade	2006	O	–	✓	Org	M	#3
41	Learning process in new product development teams and effects on product success: A socio-cognitive perspective	*IMM*	Akgün et al	2006	E	–	✓	Team	M	#8
42	Antecedents and consequences of unlearning in new product development teams	*JPIM*	Akgün et al	2006	E	✓	–	Team	O	#8
43	Fostering innovation by unlearning tacit knowledge	*Kybernetes*	Rebernik and Širec	2007	C	✓	–	Org	O	#8
44	Organizational unlearning as changes in beliefs and routines in organizations	*JOCM*	Akgün et al	2007	C	✓	–	Org	O	#1
45	Critical management education in action: Personal tales of management unlearning	*AMLE*	Learmonth	2007	O	✓	–	–	M	#6
46	How much did the liberty shipbuilders forget?	*MS*	Thompson	2007	E	✓	–	Org	O	#5
47	(Un) Learning and (Mis) education through the eyes of Bill Starbuck: An interview with pandora's playmate	*AMLE*	Barnett	2007	O	–	✓	–	–	#6

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
48	Mapping the learn-unlearn-relearn model: Imperatives for strategic management	*EBR*	Azmi	2008	C	✓	–	Org	O	#6
49	The effects of workforce heterogeneity on productivity in an experiential learning environment	*IJPR*	Nembhard and Shafer	2008	E	✓	–	Indiv + Org	O	#5
50	Unlearning as a driver of sustainable change and innovation: three Australian case studies	*IJTM*	Becker	2008	O	✓	–	Org	O	#1
51	Organizational unlearning	*HR*	Tsang and Zahra	2008	R	✓	–	Org	O	#6
52	Transferring knowledge to acquisition joint ventures: An organizational unlearning perspective	*ML*	Tsang	2008	O	✓	–	IJV	M	#7
53	Managing knowledge transfer in international alliances	*TIBR*	Inkpen	2008	O	–	✓	Org	M	#7
54	Object-mediated learning and strategic renewal in a mature organization	*ML*	Macpherson and Jones	2008	E	–	✓	Org	M	#3
55	Impact and scholarship: Unlearning and practising to co-create actionable knowledge	*ML*	Antonacopoulou	2009	O	✓	–	Indiv	O	#6
56	Organizational forgetting and its causes: an empirical research	*JOCM*	Fernandez and Sune	2009	O	✓	–	Org	O	#5
57	Unlearning what we knew and rediscovering what we could have known	*Scan. JM*	Starbuck	2009	O	–	✓	–	M	#3
58	Depreciation and transfer of knowledge: An empirical exploration of a shipbuilding process	*IJPR*	Kim and Seo	2009	E	✓	–	Org	O	#7

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
59	Learning, unlearning and internationalisation: Evidence from the pre-export phase	*IJInfoM*	Casillas et al	2010	E	✓	–	Org	M	#6
60	Facilitating unlearning during implementation of new technology	*JOCM*	Becker	2010	E	✓	–	Org	O	#1
61	Compatibility and unlearning in knowledge transfer in mergers and acquisitions	*Scan. JM*	Yildiz and Fey	2010	C	✓	–	Int. M&A	O	#7
62	The effects of failure and success on organizational learning in the global orbital launch vehicle industry	*AMJ*	Madsen and Desai	2010	E	–	✓	Org	M	#6
63	Organizational forgetting, unlearning, and memory systems	*JMI*	Martin de Holan	2011	O	✓	–	Org	O	#5
64	Reflexivity, stress, and unlearning in the new product development team: The moderating effect of procedural justice	*R&D M*	Lee and Sukoco	2011	E	✓	–	Team	O	#8
65	Reflections on organizational memory and forgetting	*JMI*	Casey and Olivera	2011	C	✓	–	Org	O	#5
66	Balancing exploration and exploitation of knowledge through an unlearning context: An empirical investigation in SMEs	*MD*	Cegarra-Navarro et al	2011	E	✓	–	Org	M	#7
67	Agency in voluntary organizational forgetting	*JMI*	Martin de Holan	2011	O	✓	–	Org	O	#5

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
68	Change from below: The role of middle managers in mediating paradoxical change	*HRMJ*	Conway and Monks	2011	O	–	✓	Indiv	M	#1
69	Balancing technology and physician–patient knowledge through an unlearning context	*IJInfoM*	Cegarra-Navarro et al	2011	E	✓	–	Org	M	#7
70	Emerging multinationals venturing into developed economies: Implications for learning, unlearning, and entrepreneurial capability	*JMI*	Zahra et al	2011	C	–	✓	IJV	M	#6
71	In Praise of Organizational Forgetting	*JMI*	Easterby-Smith and Lyles	2011	C	✓	–	Org	O	#5
72	Linking organizational learning with technical innovation and organizational culture	*JKM*	Sanz-Valle et al	2011	E	–	✓	Org	M	#8
73	Corporate social responsibility and individual resistance: Learning as the missing link in implementation	*ML*	Blackman et al	2012	C	–	✓	Org	M	#6
74	Learning patterns in venture capital investing in new industries	*ICC*	Dimov et al	2012	E	–	✓	Org	M	#3
75	Reversal of strategic change	*AMJ*	Mantere et al	2012	O	–	✓	Indiv + Org	M	#1
76	Inter-firm knowledge diffusion, market power, and welfare	*JEE*	Colombo and Labrecciosa	2012	E	✓	–	Org	O	#5
77	Knowledge transfer across projects: Codification in creative, high-tech and engineering industries	*ML*	Cacciatori et al	2012	E	–	✓	Org	M	#3
78	Continuity and change in a spin-off venture: The process of reimprinting	*ICC*	Ferriani et al	2012	O	✓	–	Org	O	#1

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
79	Organisational unlearning, organisational flexibility and innovation capability: An empirical study of SMEs in China	*IJTM*	Wang et al	2013	E	✓	–	Org	O	#8
80	Do firms forget about their past acquisitions? Evidence from French acquisitions in the united states (1988–2006)	*JoM*	Meschi and Métais	2013	E	✓	–	Org	O	#5
81	Organizational unlearning and organizational relearning: A dynamic process of knowledge management	*JKM*	Zhao et al	2013	C	✓	–	Org	O	#7
82	Turnover-induced forgetting and its impact on productivity	*Br JM*	López and Sune	2013	O	✓	–	Org	O	#5
83	Counter-knowledge and realised absorptive capacity	*EMJ*	Cegarra-Navarro et al	2014	E	✓	–	Org	M	#7
84	The process of individual unlearning: A neglected topic in an under-researched field	*ML*	Hislop et al	2014	R	✓	–	Indiv	O	#3
85	How unlearning affects radical innovation: The dynamics of social capital and slack resources	*TFSC*	Yang et al	2014	E	✓	–	Org	M	#8
86	Learning from peers: Knowledge transfer and sales force productivity growth	*Mkt Sci*	Chan et al	2014	E	–	✓	Org	O	#3
87	Mitigating the impact of member turnover in information systems development projects	*IEEE*	Pee et al	2014	E	✓	–	Team	O	#5

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
88	Does organizational forgetting affect vendor quality performance? An empirical investigation	*M&SOM*	Agrawal and Muthulingam	2015	E	✓	–	Org	M	#3
89	Linking unlearning with service quality through learning processes in the Spanish banking industry	*JBR*	Cepeda-Carrión et al	2015	E	✓	–	Org	M	#3
90	Linking unlearning with quality of health services through knowledge corridors	*JBR*	Gutiérrez et al	2015	E	✓	–	Org	M	#3
91	Overcoming knowledge loss through the utilization of an unlearning context	*JBR*	Wensley and Navarro	2015	E	✓	–	Org	M	#7
92	Organizational unlearning, innovation outcomes, and performance: The moderating effect of firm size	*JBR*	Leal-Rodríguez et al	2015	E	✓	–	Org	M	#8
93	Organizational oscillation between learning and forgetting: The dual role of serious errors	*OS*	Haunschild et al	2015	E	✓	–	Org	O	#5
94	Experience matters? The impact of prior CEO experience on firm performance	*HRM*	Hamori and Koyuncu	2015	E	–	✓	Indiv + Org	M	#2
95	Evidence of organizational learning and organizational forgetting from financial statement audits	*Auditing*	Causholli	2016	E	✓	–	Org	O	#5
96	How existing organizational practices affect the transfer of practices to international joint ventures	*MIR*	Tsang	2016	E	–	✓	IJV	M	#7

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
97	Investigating knowledge management: Can KM really change organisational culture?	*JKM*	Corfield and Paton	2016	O	–	✓	Org	M	#1, #7
98	On stopping doing those things that are not getting us to where we want to be: Unlearning, wicked problems and critical action learning	*HR*	Brook et al	2016	E	✓	–	Indiv	O	#3
99	Unlearning troubled business models: From realization to marginalization	*LRP*	Mehrizi and Lashkarbolouki	2016	O	✓	–	Org	O	#3
100	Why the problem with learning is unlearning	*HBR*	Bonchek	2016	O	✓	–	–	O	#6
101	Organizational learning with forgetting: Reconsidering the exploration–exploitation tradeoff	*SO*	Miller and Martignoni	2016	E	✓	–	Org	O	#5
102	Organisational and individual unlearning in identification and evaluation of technologies	*IJInnM*	Scheiner et al	2016	E	✓	–	Org. + Indiv	O	#1
103	Forget unlearning? How an empirically unwarranted concept from psychology was imported to flourish in management and organisation studies	*ML*	Howells and Scholderer	2016	R	✓	–	Org	O	#4
104	The dynamics of organizational routines in a startup: The Ereda model	*EMR*	Mariano and Casey	2016	O	–	✓	Org	M	#3
105	Managers' exploration activities and individual unlearning: The mediating role of learning orientation and reflection	*IJHRM*	Matsuo	2017	E	✓	–	Indiv	O	#6

Table 19 (continued)

S. No	Title	Journal[†]	Authors	Year	Type[‡]	Focus on unlearning				
						Primary	Secondary	Level of analysis[¶]	Means or outcome[§]	Cluster[Ω]
106	Organizational unlearning and knowledge transfer in cross-border M&A: Role of routine and knowledge compatibility	*JKM*	Wang et al	2017	E	✓	–	Int. M&A	O	#7
107	Production with learning and forgetting in a competitive environment	*IJPE*	Kogan et al	2017	E	✓	–	Org	O	#5
108	The unlearning of managerial skills: A qualitative study of executive officers	*EMR*	Matsuo	2017	E	✓	–	Indiv	O	#2
109	Organizational strategic learning capability: Exploring the dimensions	*JEIT*	Moon, Ruona and Valentine	2017	E	–	✓	Org	M	#6
110	What factors drive organizational learning from crisis? Insights from the Dutch food safety services' response to four veterinary crises	*JCCM*	Broekema et al	2017	O	–	✓	Org	M	#6
111	Organizational forgetting, absorptive capacity, and innovation performance: A moderated mediation analysis	*MD*	Huang et al	2018	E	✓	–	Org	O	#5
112	Goal orientation, critical reflection, and unlearning: An individual-level study	*HRDQ*	Matsuo	2018	E	✓	–	Indiv	O	#6
113	Investigating the influence of unlearning on knowledge management in sport organizations	*Kybernetes*	Delshab and Boroujerdi	2018	E	✓	–	Org	M	#7
114	The effect of absorptive capacity on green customer capital under an organizational unlearning context	*Sustain*	Martelo-Landroguez et al	2018	E	✓	–	Org	M	#7

Table 19 (continued)

S. No	Title	Journal†	Authors	Year	Type‡	Focus on unlearning				
						Primary	Secondary	Level of analysis¶	Means or outcome§	Cluster$^{\Omega}$
115	Critical reflection, unlearning, and engagement	*ML*	Matsuo	2019	E	✓	–	Indiv	M	#3
116	Individual unlearning, organizational unlearning and strategic flexibility: The down-up change perspective	*BJM*	Wang et al	2019	E	✓	–	Org. + Indiv	M	#3
117	From organizational learning to organizational mnemonics: Redrawing the boundaries of the field	*ML*	Coraiola and Murcia	2019	O	✓	–	Org	O	#6
118	Once bitten, not necessarily shy? Determinants of foreign market reentry commitment strategies	*JIBS*	Surdu et al	2019	E	–	✓	Org	M	#6
119	Investigating the role of strategic thinking in establishing organizational excellence model: A moderating role of organizational forgetting	*TQM*	Ershadi and Dehdazzi	2019	E	–	✓	Org	M	#3
120	Introducing a 'stop-doing' culture: How to free your organization from rigidity	*BH*	Klammer et al	2019	O	✓	–	Org	O	#3
121	Mapping knowledge risks: Towards a better understanding of knowledge management	*KMRP*	Durst and Zieba	2019	R	✓	–	Org	M	#7
122	Processes underlying MNE subsidiary absorptive capacity: Evidence from emerging markets	*MIR*	Zeng et al	2019	E	–	✓	Org	M	#3
123	Knowledge acquisition and firm competitiveness: The role of complements and knowledge source	*JKM*	Bloodgood	2019	O	–	✓	Org	M	#3

Table 19 (continued)

S. No	Title	Journal[†]	Authors	Year	Type[‡]	Focus on unlearning				
						Primary	Secondary	Level of analysis[¶]	Means or outcome[§]	Cluster[Ω]
124	Business model innovation of international new ventures: An empirical study in a Swedish context	*JoIE*	Abrahamsson et al	2019	E	–	✓	Org	M	#3
125	Unlearning and forgetting in organizations: A systematic review of literature	*JKM*	Klammer and Gueldenberg	2019	R	✓	–	Org	O	#3, #4
126	Honor the old, welcome the new: An account of unlearning and forgetting in NPD teams	*EJIM*	Klammer and Gueldenberg	2019	O	✓	–	Org	O	#3, #4, #8
127	Promoting intentional unlearning through an unlearning cycle	*JOCM*	Cegarra-Navarro and Wensley	2019	C	✓	–	Org	O	#3

[†]Journal abbreviations available in Table 4

[‡]C = conceptual; R = review; E = empirical; O = others (case studies, interviews, commentaries, viewpoint, dialog, invited articles)

[¶]Org. = organizational; indiv. = individual; IJV = international joint ventures; Int. M&A = international mergers and acquisitions

[§]M = means to an end; O = outcome

[Ω]Refer Fig. 5. Eight clusters with different color coding are: *cluster 1* include articles with focus on unlearning and change management (coded in red), *cluster 2* comprise of articles that relates leadership aspects with unlearning (coded in green), *cluster 3* and *4* (coded in dark blue and yellow respectively) comprises of articles that deal with enabling and inhibiting forces of unlearning, *cluster 5* talks about unlearning and forgetting (coded in purple), *cluster 6* establish relationship between unlearning and organizational learning (coded in sky blue), *cluster 7* relates unlearning with knowledge management (coded in orange), and *cluster 8* focus on articles establishing relationship between unlearning and new product development (coded in pink)

Appendix 2

Mathematical calculation of collaboration coefficients

This appendix describes the mathematical calculations behind three collaboration indices—degree of collaboration (DC), collaborative index (CI), collaborative coefficient (CC). The representative calculations are shown for the first phase (1976–1990) only.

Degree of collaboration

DC is defined as a ratio of the number of multi-authored papers in the field during a year to the total number of papers (either single- or multi-authored) published during the same year (Subramanyam, 1983). It is expressed mathematically as,

$$DC_{year} = \frac{Number\ of\ multi-authored\ papers\ in\ a\ field}{Number\ of\ single\ authored + multi-authored\ papers}$$

During 1976–1990, there was only one single authored paper (Klein 1989) and five multi-authored papers on unlearning. Therefore,

$$DC_{(1976-1990,OU)} = \frac{5}{1+5}$$

$$DC_{(1976-1990,OU)} = 0.833$$

Collaborative index

CI is defined as the average number of authors per paper for a given set of articles (Lawani 1986). Mathematically, it is expressed as,

$$CI_{year} = \sum_{j=1}^{k} \frac{jAj}{N}$$

where Aj is the number of j-authored articles produced in a discipline during a year, and N = total number of articles in a year

$$CI_{(1976-1990,OU)} = \frac{\{(1*1)+(4*2)+(1*3)\}}{5}$$

$$CI_{(1976-1990,OU)} = 2.400$$

Collaborative coefficient

CC is based on the credit allocation method. Thus, if a paper has a single author, the paper receives a credit of 1.00, and in general, papers with X authors, receive 1/X credit (Ajiferuke et al., 1988). Therefore,

$$CC_{year} = 1 - \frac{f1 + (1/2)f2 + \cdots + (1/k)fk}{N}$$

where *f1* is the single-authored papers; *f2* is the papers with two authors; *fk* is the number of k-authored papers; N = total number of papers.

During 1976–1990, there was one single-authored paper, four articles by two-authors, and one by three authors. Therefore,

$$CC_{(1976-1990,OU)} = 1 - \frac{1 + (1/2)4 + (1/3)1}{6}$$

$$CC_{(1976-1990,OU)} = 0.445$$

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Declarations

Conflict of interest The authors declared no potential conflict of interest with respect to the authorship and/or publication of this article.

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