

Review

# Organizational Silos: A Scoping Review Informed by a Behavioral Perspective on Systems and Networks

Fabio Bento <sup>1,\*</sup>, Marco Tagliabue <sup>1</sup> and Flora Lorenzo <sup>2</sup>

<sup>1</sup> Department of Behavioural Sciences, Faculty of Health Sciences, OsloMet—Oslo Metropolitan University, 0130 Oslo, Norway; mtagli@oslomet.no

<sup>2</sup> Department of Basic Psychological Processes, Psychology Institute, University of Brasília, 70910-900 Brasília, Brazil; Flora.moura@aluno.unb.br

\* Correspondence: fabben@oslomet.no

Received: 25 June 2020; Accepted: 22 July 2020; Published: 24 July 2020



**Abstract:** In recent years, several organizations have implemented interventions aimed at integrating work processes and bridging network clusters. These are often permeated by different assumptions regarding clusters in organizational settings. There are concerns about the formation of silos and structural barriers to communication across the formal and informal network structures. Conversely, network clusters are regarded as spaces of local social reinforcement from which innovation ideas may emerge. Although terminologically and functionally different, they share some common features insofar as organizational behavior is concerned and the production of artifacts that fulfill organizational goals. The present scoping review presents an analysis of the literature on organizational silos while investigating attempts to bridge network clusters. Based on the search results, 40 studies were included in the analysis of the findings; of these, 20 were empirical studies and were included in a further quantitative analysis of methods and findings. We identified patterns of definitions of silos and variation in terms of aims, variables, and methods used to evaluate interventions among the heterogeneous studies. Special attention was dedicated to the role of consequences of siloed organizational behavior. We conclude that silos comprise barriers to achieving organizational goals insofar as they pose a threat to internal cooperation.

**Keywords:** network analysis; clusters; organizations; cooperation; communication; behavior; consequences

## 1. Introduction

Most applications of complexity theory in the organizational field assume that increases in environmental complexity usually require that organizations facilitate variation and interaction across formal levels and borders [1]. However, organizational research has also demonstrated that there is a complex relationship between formal structures and informal webs of interaction in organizational settings [2]. The emergent and evolving structure of webs of interactions is called networks in complexity studies [3]. Emergence is an important property of a social network, often leading to the formation of clusters. Interestingly, clusters are often labelled as “silos” [4,5], which is a term that implies different perceptions of value, namely a negative one, in many organizational discourses.

The term dates back to agricultural silos in the 1800s in Europe, which were trenches dug to store grains during the winter. In North America, silos are understood as storage towers separating different grains from each other [6]. Similar to their structure for storage (retention), within boundaries of steel, wood, and cement in agriculture, organizational silos are a metaphor used to illustrate pockets of interaction and knowledge in organizations. Within organizations, silos mean the presence of barriers to communication and exchange. For example, organizational silos have been considered barriers for open communication and information flow: different to their utility in separating grains,

they possess negative effects insofar as they separate employees, posing a problem for both small and large businesses alike [7]. Silos are not as much a technological phenomenon as they are a cultural phenomenon [6]. As such, they encompass a multi-perspective approach: organizational decision-making and socio-cognitive frames and economics, which are concerned with the role of incentives (and costs) [8].

As a consequence, proposers of these sorts of silos definitions infer and advance the need for breaking down or bridging silo structures; they are seen as the result of technical, but mostly cultural, barriers for information flow [6]. This has generated a whole set of recommendations about how to break down silos in organizations. Similar to their function of keeping materials completely separated in agriculture, organizational silos prevent resources and information from being shared across an organization [9]. Such sets of recommendations are permeated by the assumption of the existence of silos mentalities defined as the absence of systems thinking and vision of the overall organization [10]; this type of mentality “will reduce efficiency in the overall operation, reduce morale, and may contribute to the demise of a productive company culture” [11]. It is alleged that the silo mentality results in the reluctance to share information and cooperate across departments. For example, Tett [12] has argued that the financial crisis of 2007–2008 was partially caused by an extreme structural and cognitive fragmentation of banking institutions, leading to the absence of a holistic understanding of risks in the financial market. On the other hand, more recent research in network analysis has provided indications of the importance of network clusters as spaces of social reinforcement necessary for the spread of complex information and behavior change in organizations [5,13]. The findings suggest that although the spread of complex information requires highly densely connected networks, the dissemination of complex information and behavior change demands a balanced network structure, combining the existence of local clusters as spaces of local interaction and wide bridges through which information may flow. Interestingly, highly connected networks without subgroups tend to facilitate the spread of simple information but may lack the processes of local social reinforcement necessary for the spread of complex ideas and innovation [5].

Networks are understood as the structures of social systems. They consist of dynamic ever-changing flows of members of system, flows of information, and availability of social reinforcement. According to social network analysis, social reinforcement is defined as “the situation in which an individual requires multiple prompts from neighbors before adopting an opinion or behavior” [14] (p. 2). Thus, silos represent threats to the availability of social reinforcement, although they do not necessarily possess negative normative values outside of the organizational literature.

The novelty of the current study rests on the transdisciplinary character of the conceptual framework that we apply to analyze our findings. Bridging concepts from network theory and behavioral science has the potential to provide tools to identify organizational silos and develop interventions to facilitate information flow and cooperation.

We hereby aim at contributing to organizational research by providing a framework to analyze silos by articulating concepts from social network analysis and cognitive-behavioral science. First, we introduce the terms networks and clusters and place them in the encompassing organizational literature. Next, a definition and operationalization of the concept of silo is presented. Specifically, we regard silos as a form of boundary and in relation to the concept of metacontingency, which is a relation between interdependent agents within an organization and the selection of their produce by an external agent [15–17]. The third section introduces the methods of the present scoping review, followed by the presentation of results and the discussion. We call for a behavioral analysis of systems to provide a framework for identifying cross-functional interlocking behavioral contingencies [18] and external events provided by the receiving system demand [16,19] that is responsible for selecting and maintaining organizational silos. The effects of consequences contingent to individual behavior are also considered, which can either strengthen the combined efforts to meet external demands or compete with them by favoring incompatible patterns [20]. We conclude with some remarks on the importance and practical implications of this work for the stakeholders of an organization.

## 2. Organizational Silos: Barriers and Consequences

Network analysis is the branch of network of complexity sciences that studies emerging social structures [21]. Although much of the work in network analysis has assumed static structures, more recent research has demonstrated how temporality enhances the evolution of cooperation in social systems [22]. As previously mentioned, the term silo refers to subgroups in webs of interaction. In network analysis, clustering means assigning objects to groups in a way that properties in the same group are more similar to each other than to those in other groups [23]. In social networks, a cluster can be intuitively defined as a “collection of individuals with dense friendship patterns internally and sparse friendships externally” [24] (p. 56). The level of connectivity and overlap among different groups may vary but it is important to have in mind that the terms “cluster” and clustering do not carry the same negative connotation that silos have in organizational literature. The emergent nature of complex systems indicates the temporal existence of subgroups. However, understanding the emerging properties of such groups, and the level and content of connectivity demands transdisciplinary tools beyond those of network analysis. Networks are investigated through different perspectives [25]. On one hand, there are studies that place network structures as antecedents of individual behaviors. Those studies aim at identifying network features that play a role as independent variables or predictors of actors’ behaviors. On the other hand, there are studies that look at network structures as emerging consequences of interlocking behaviors. The emergence and maintenance of network clusters may be regarded as both antecedents and consequences of human behavior. This highlights the need for bridging network theory with behavioral sciences and cognitive theory in order to understand silos as sociocultural phenomena.

The importance of this work lies in the different understanding and conceptualizations of the concept of silos that are currently available in the organizational literature. In order to achieve a better understanding of the phenomenon, it was deemed suitable to explore and classify the research on this topic through a scoping review [26] and expand on its analysis from an organizational behavior management approach. This is the applied branch of behavior analysis concerned with learning and performance (organizational behavior) in organizations [27], which are herein broadly defined as based on the product of the work of a group of people [15]. While resorting to a behavioral approach to exchanges and flow in and across organizations, there are few publications that mention explicitly silos. For example, the silo mentality denotes an organizational situation in which there is disjointedness between resources and goals [28]. However, it seems advantageous for the leader or decision maker who aims at intervening on silos within the organization to rely on an operationalized version of exchange of information and flow of behavior.

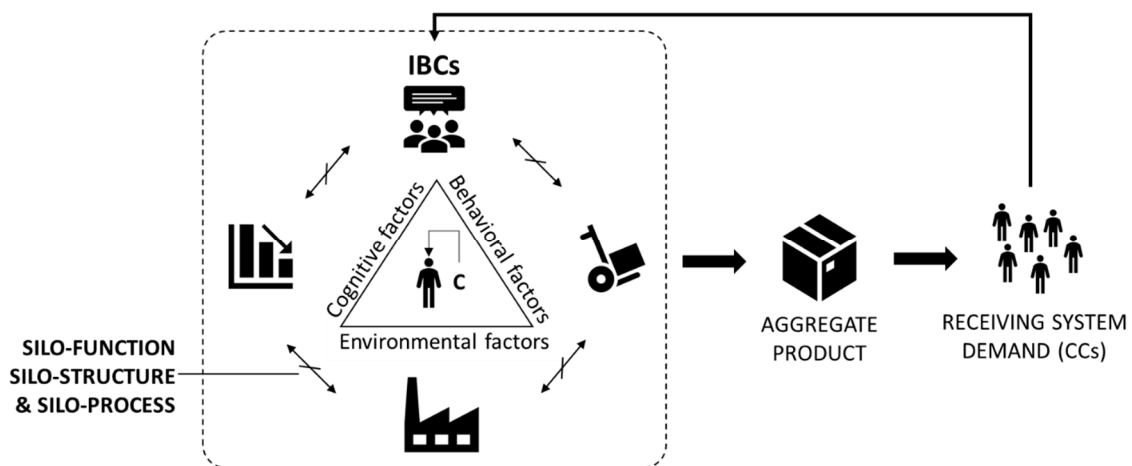
Silos have been termed based on their functional properties [18] or their structural properties [29]. In the former case, they represent a lack of coordination that is not only sufficient, but rather necessary for the behavioral contingencies of agents across functional areas or departments to interlock (i.e., be interdependent) [18]. In the latter case of organizational silos as structures, silos are able to hinder the productivity of the workers, for the structure is intended in the Weberian view of a system of reporting relationships [29], which may only be overcome by reorganization. Nevertheless, silos may also characterize the processes of information flow within and between units of an organization or system. For example, Baker and colleagues analyzed the case of silo-based decision making as a barrier for exchange and they consented to minimal feedback loops for organizational self-correction [30]. Processes are siloed when they hinder the practices of sharing between units or departments. These practices include the sharing of information, goals, tools, and other operations and resources that are vital to the organization’s survival. Thus, silos represent process barriers, for they hinder coordination and interlocking behaviors within an organization [18].

Silo effects comprise threats for the interlocking behavioral contingencies (IBCs), insofar as they limit interdependency. Consequently, a lack of interdependency may impose a threat to the presentation of the aggregate product (AP), especially in cases of tasks with high complexity. For example, a siloed functioning of the different departments or business units that comprise a manufacturing organization is not only likely to decrease communication and collaboration across the delivery of raw material,

production, the packing and inspection unit, and the warehouse, but it may hinder the degree to which the product of their produce is able to reach the consumer; for this is possible only thanks to the interdependent work of all previous roles and steps, which comprises a metacontingent relationship [31].

Lencioni [32] proposed four strategies to combat silo formations within the organization: (a) establish a thematic goal; (b) articulate defining objectives for the thematic goal; (c) specify a set of ongoing standard operating objectives; and (d) select metrics [33]. Silos are often considered a leadership problem; it requires a shift from managing silos to managing systems. Notwithstanding, we advance a cognitive-behavioral approach to silos that is able to account for the added complexity when managing not only a leadership problem, but fundamentally a systems problem, which may be tackled from its three comprising properties: structure, process, and function [34–36].

The reciprocal determinism model [37,38] can be effectively translated to siloing effects in an organization, insofar as it determines (among others) organizational behavior and its management. According to Thompson [39], cognitive/personal, environmental, and behavioral factors are necessary and interdependent elements of a theory of social cognition and the reciprocal determinism model of learning; without one of these parts, the whole model is doomed to fall apart. Cognitive or personal factors include knowledge, expectations, and attitudes in the organizations. Environmental factors include social norms, access in the organization, and influence on the encompassing physical and social environment. Behavioral factors include skills, practice, and self-efficacy. Furthermore, this interaction between agent and environment is included in the theory of social learning, whose organizational applications include examining the process of employee value [40], the diffusion of market orientation [41], and leadership to the extent that supervisors and employees think and act [42]. Thus, silos may be regarded as the determinants of personal, environmental, and behavioral factors within the organization. In particular, environmental factors contribute to the formation of silo structures; cognitive factors to the formation of silo processes; and behavioral factors to the formation of silo functions. Figure 1 depicts the reciprocal determinism model of metacontingencies adapted to the analysis of organizational silos.



**Figure 1.** Reciprocal determinism model adapted to an analysis of metacontingencies in a siloed organization example (included in the dashed square). The interrupted bidirectional lines represent the effects of silos depending on the system property derived from the model of social learning (callouts in bold). The metacontingency is comprised of interlocking behavioral contingencies (IBCs), one or more aggregate product(s) (AP), and the receiving system demand. Note: C = consequence at the individual level; CCs = cultural consequences.

A behavior analytic approach of systems gives support for the search of mechanisms that select and maintain structures of interactions within the boundaries of specific groups, but likewise recognizes the influence of consequences contingent to individual behaviors that constitute networks [43]. From a selectionist standpoint, behavior is sensitive to reinforcer distribution, which influences one's probability

of responding in accordance with signals of accessing certain consequences [44]. Environmental events gain their signaling functions from each individual learning history with previous consequences in similar contexts [45]. Hence, the consistency between environmental events and the precedent behavior influences the probability of its recurrence over time [46], and, therefore, accounts for a large proportion of learning processes and behavioral patterns. Undervaluing the effects from behavior–consequence functional relationship over both intra- and intergroup collaboration can lead to incomplete premises to explain malfunctioning interactions within a system. For instance, analysis of organizational hinderers with a restrictive focus on structure, internal demands, personal interests, and behavioral topographies [47]. Failing to address the pivotal role of consequences at both individual and group levels in favoring the coordination of actions across units can, therefore, hamper initiatives of either bridging, breaking, or maintaining organizational silos.

### 3. Materials and Methods

The materials and methods section of this study is based on previous cases of scoping reviews published in *Societies* (e.g., [48]). The literature search for the present scoping review was conducted on 6 April 2020. The following databases were interrogated: Academic Search Ultimate, Business Source Elite, PsycINFO, Scopus, and Web of Science. Google Scholar and ResearchGate were also manually checked for any non-indexed result. An example of how the search words were identified and combined is contained in Box 1. In order to maintain the breadth of a scoping review and a structures search strategy, two main search terms were resorted to: (1) silo\*, which constitutes the truncated version of the terms, used both as a singular or plural substantive (e.g., silos, siloes, silo), adjective (e.g., siloed), and verb (e.g., siloing, silo-ing); and (2) organi\$ation\*, which features both truncation and a wild card encompassing both American (“z”) and British (“s”) spelling versions. Next, the search terms were combined with the Boolean operator “AND”. For each of the five databases, the search was performed in title, abstract, and keyword fields. The only limiter set as a part of the search strategy was limiting the results to publications contained in peer reviewed journals. The search strategy used in PsycINFO is reported in full in Appendix A.

**Box 1.** Example of the search strategy of the scoping review.

<p>Example of the search strategy in PsycINFO:  S1: silo*.mp. (743)  S2: exp organizations/(114,398)  S3: organi?ation*.mp. (325,202)  S4: 2 or 3 (341,475)  S5: 1 and 4 (210)  S6: limit 5 to peer reviewed journal (128)</p>
--

#### 3.1. Inclusion and Exclusion Criteria

The timeframe for the inclusion of studies was limited to the last 20 years. Thus, the publications range of inclusion ranged between 2000 and 2020. For when the term organization was included in the search strategy, studies addressing organizational silos or any other form of siloing effect within organizational boundaries were included in the selection criteria. We included both empirical literature with an initial interest in identifying interventions at the organizational level and conceptual literature aiming at grasping definitions and theoretical developments in the field. We included conceptual, review, empirical, and experimental studies. Among empirical articles, both quantitative and qualitative studies were included. Furthermore, we did not limit our search to any specific sector or geographical area.

During the analysis, it became clear that some articles did not address silos in organizations or social groups and were, therefore, excluded. Although we acknowledge that networks of cooperation do not always correspond to formal organizational boundaries, we delimited our search to articles investigating silos within formal structures instead of including inter-organizational silos. We excluded

other forms of publications such as books, book chapters, and abstracts in conference proceedings. Moreover, we restricted our search to articles in English, thereby establishing a language delimitation.

### 3.2. Search Results and Analysis

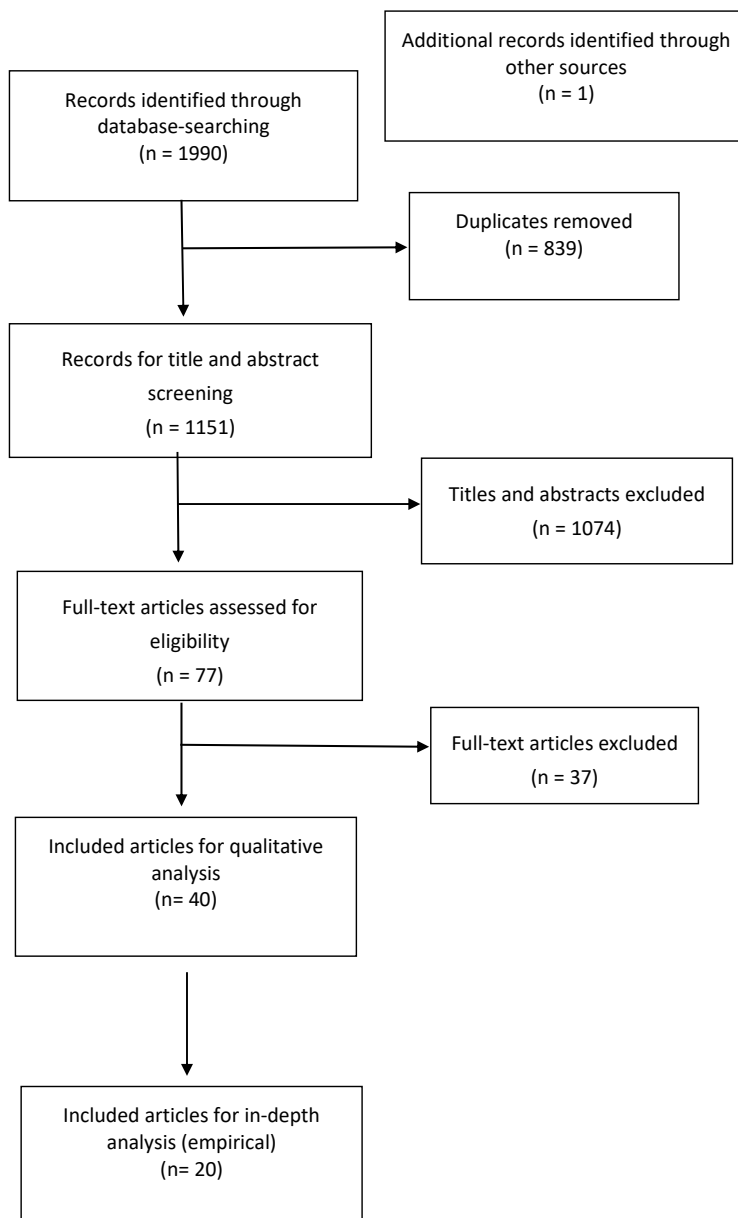
The results of each of the five independent database searches were divided in the following way: 327 studies from Academic Search Ultimate, 266 studies from Business Source Elite, 127 studies from PsycINFO, 829 studies from Scopus, and 427 studies from Web of Science. In total, 1990 search results were found and imported in EndNote v.9.2. After duplicates were removed (819 studies), the number of studies was reduced to 1171, which were exported to Rayyan [49] for critical appraisal.

This process was performed by the first two authors, who worked independently and with a blind on each other's decision of inclusion and exclusion. The appraisal was limited to the screening of titles, abstracts, and keywords. It yielded 979 excluded studies, 68 included studies, 5 undecided, and 99 studies for which agreement was not reached. Some of the reasons behind the decision to exclude were wrong topic (meaning that the study was not primarily concerned with the study of organizational silos or silos in organizations), wrong outcome (e.g., secondary outcome, no measure or operationalization of silos), wrong publication type (non-peer reviewed, book chapter), and studies that were older than 20 years. After the blind review option was removed, agreement was reached on 1156 studies by consensus of the first two authors: of these, 1066 were excluded and 68 were included. The reasons why these studies were excluded in this phase are based on the same criteria as previously identified. Because the analysis was more sensitive to other descriptions of silos that were not the main focus of the present scoping review, silos mentality and thinking were excluded based on their "wrong" outcome [50,51], or because silos were identified between or across organizations, rather than as barriers within [52,53]. The remaining 17 were sent to the third author for an independent appraisal against the same criteria of inclusion and exclusion, resulting in 77 included studies.

Next, full-text versions were assessed, and this process resulted in further 37 studies that were excluded from analysis. Some of the most frequent reasons for exclusion during this phase were the unavailability of full-text versions ( $n = 9$ ), the absence of peer-review ( $n = 5$ ), silos as secondary measures or collateral to some other main outcome ( $n = 14$ ), no definition, measure or another type of account of silos ( $n = 12$ ), and spanning across organizations instead of within ( $n = 4$ ).

In total, 40 studies were included in the scoping review. The results for each phase of the search results is summarized in the Prisma diagram [54] contained in Figure 2. The data extraction, which is also referred to as charting the data in a scoping review, was partially performed by organizing the resources on Endnote [55], resorting to JBI's template sources of evidence details [56], and manually, in accordance with the aims of the present study.

First, each study was classified as either theoretical (including review studies) or empirical, based on whether they reported or elaborated on any data. Among the empirical studies, a further classification was operated distinguishing between applied studies, which consisted of first-hand studies and included at least a section on methods and results, and interpretative studies that contained data, although collected or available through secondary sources. Next, we extracted descriptive information (author(s) and year, country, sector), aims of the study, and definition of silos for each included study. The analysis of definitions of silos followed a data-driven approach meaning that the five categories emerged from our observation of similarities across the articles rather than any pre-existing theory. As a result, we created five categories of definitions (as units, functions, technology, knowledge, and broad).



**Figure 2.** Flowchart of search strategy for literature review.

Next, we coded inferred information on the silo factors, availability of reported consequences and their type. Resorting to the three-term factor analysis of the reciprocal determinism model, we coded the classification of silos based on their structure, process, or function, which were paired with the threefold analysis of factors in the mutual determinism model: respectively, environmental, cognitive, and behavioral factors. Consequences presented straightforwardly or referred to in equivalent terms were considered, and later classified in terms of attributed relevance and level of delivery. The types of consequence were registered in accordance with the terms used by the authors or through broad categories to which they referred. Lastly, further information from the studies classified as “empirical” was extracted and reported separately in the empirical findings section: this included methods, variables, participants, and findings. Because of the heterogeneity of findings, we used a qualitative narrative synthesis (e.g., [57,58]). The categorization of types of and reported findings in the selected articles followed the data-driven approach. After categorizing information from the studies, the extracted data was analyzed in the light of network theory and behavioral sciences literature, aiming at identifying potential concepts and variables that can add value to organizational research in terms

of disregarded mechanisms of change. Correlations across categories were also sought, in an attempt to broaden the understanding of patterns in the literature on silo-related phenomena. Appendix B lists the 40 articles selected for analysis.

#### 4. Results

Overall, the studies were almost equally divided between theoretical ( $n = 19$ ), of which two were reviews) and empirical ( $n = 21$ ); of the latter, the majority ( $n = 16$ ) were applied, the rest being labeled as interpretative ( $n = 5$ ). The next section presents descriptive findings common to all studies included, whereas the following section includes more detail on the characteristics of the empirical (applied and interpretative) studies only.

##### 4.1. Descriptive Findings

Table 1 summarizes the main characteristics of all studies included in the present scoping review. In addition to author(s) and year, general characteristics data extracted from the studies included country and sector. Of the 40 studies, 25 were performed in North America (applied) or featured North America as the region in which the authors' principal affiliation was based, followed by the United Kingdom ( $n = 8$ ), and Western European countries ( $n = 4$ ).

There is a variety in terms of sectors approached in the selected articles. However, we observe that the studies that focused on the health sector composed the largest group ( $n = 13$ ). Several articles ( $n = 9$ ) provided a cross-sectoral focus looking at organizations at different areas of activity. Other sectors that are either discussed or empirically investigated are education ( $n = 2$ ), the water industry ( $n = 2$ ), the public sector ( $n = 2$ ), IT ( $n = 2$ ), food ( $n = 2$ ), pharmaceuticals ( $n = 2$ ), the civil service [59], manufacturing [60], energy [61], and consulting [62]. Two articles did not focus in any specific area ( $n = 2$ ).

The selected studies present different understandings of what organizational silos are and how they are related to formal organizational units, functions, areas of expertise, and technology. Our review shows that silos are conceptualized in five different ways. In 16 articles, silos were defined in terms of formal organizational units or departments. This indicates a spatial definition of silos and barriers for communication among formally designed units. Other studies ( $n = 10$ ) conceptualized silos as groups of individuals working in functions with little communication or cooperation working in other functions in the same organization. This indicates a temporal perspective towards silos. Knowledge silos were presented in six articles that discussed limits in interaction among different areas of expertise. One article discussed silos as barriers for communication among groups using different technologies. We observe that seven articles presented broad definitions encompassing more than one or even all of the above definitions.

The stated aims of each study are summarized in Table 1. Although they vary greatly depending on the type of article and other characteristics of both study and authors, it was possible to identify some patterns. Specifically, the most frequently recurring aim shared by both theoretical and empirical articles was the cluster of studies aimed at breaking down, or removing or bridging silos ( $n = 13$ ). The next most widely shared aim was to explore and increase our understandings of the concept and role of organizational silos ( $n = 9$ ), followed by sharing and enhancing both communication and information flow ( $n = 7$ ). Of these, one study stated the clear aim of avoiding harm [61]. Other studies stated that the aim was to analyze the concepts of silos in conjunction with performance and leadership dynamics ( $n = 4$ ), and with organizational culture design ( $n = 4$ ). With respect to the three-term factor analysis of the reciprocal determinism model, we found that 18 studies described and analyzed silos based on their structure within the organization; thus, as an environmental factor. Other studies ( $n = 18$ ) were based on the process or cognitive factor: they defined silos on the grounds of their function or relating them to the behavioral factor in the mode that was less frequent ( $n = 10$ ). However, it needs be noted that there were some studies ( $n = 6$ ) that considered silos in a broader way than belonging to one property or factor; for example, based on both process (cognitive factor) and structure (environmental factor) [59,63,64].



**Table 1.** Overview of included articles with a qualitative account of silos in organizations. For each study, general information, operationalization of the concept and aims are reported.

Author(s), Year	County	Sector	Article Type	Definition	Aims	Factor	Reported Consequences	Type/value of Consequences
Aaker, 2008	USA	Cross-sectors	Theoretical	Silos as units/departments	Silos issues and solutions for marketing	Environmental (structure)	Secondary relevance	Incentive
Baird, 2013	USA	Water industry	Theoretical	Silos as units/departments	Break down silos and save costs	Cognitive (process)	Primary relevance	Benefits
Bannister, 2001	Ireland	Civil Service	Theoretical	Broad definition	Dismantling silos in public administration	Environmental (structure) and cognitive (process)	Secondary relevance, group	Risk avoidance, short-term political benefits
Bates and Atkins, 2017	USA	Manufacturing	Empirical (applied)	Functional silos	Design cultural change from silos to “pipes”	Environmental (structure)	Primary relevance, individual	Reward, praise
Bathurst and Galloway, 2018	New Zealand	Food	Theoretical	Silos as units/departments	Explore invitational discourse o elicit interaction across silos	Cognitive (process)	Primary relevance, individual	Support, reinforce, constraint, blame
Briody and Erickson, 2014	USA	Cross-sectors	Empirical (applied)	Silos as units/departments	Explore and overcome silos	Environmental (structure)	Primary relevance	Reward, evidence of benefit
Buchman et al., 2018	Canada	Health	Empirical (applied)	Broad definition	Bridging silos for integrated care	Behavioral (function)	Secondary relevance; individual	Motivators
Bundred, 2006	UK	Public sector	Theoretical	Knowledge silos	Share knowledge across the public sector	Cognitive (process)	Primary relevance; individual	Reward, praise
Casciaro et al., 2019	North America	Cross-sectors	Theoretical	Silos as units/departments	Breaking down silos to prioritize horizontal collaboration	Environmental (structure)	Primary relevance; individual	Aversive control, endorsement
Cromity and de Stricker, 2011	North America	Cross-sectors	Theoretical	Broad definition	Review primary technical and behavioral barriers hindering the use of collaborative technology	Cognitive (process) and behavioral (function)	Primary relevance; individual	Reward systems, evidence of benefit, social reinforcers
De Waal et al., 2019	UK, Netherlands, Belgium, China	Cross-sectors	Empirical (applied)	Silos as units/departments and functional silos	Increase performance by busting silo mentality	Cognitive (process)	Primary relevance; individual and group	Reward
Dell, 2005	USA	Water industry	Theoretical	Silos as units/departments	Remove barriers to performance	Environmental (structure)	Primary relevance; individual, group	Reward
Doerr and Kang, 2015	USA	Public sector	Theoretical	Silos as units/departments	Investigate cross-domain solutions to for breaking silos and collaboration	Environmental (structure)	Secondary relevance; group	Incentives
Forsten-Astikainen et al., 2017	Finland	Energy	Empirical (interpretative)	Silos as units/departments and functional silos	Avoid harmful outcomes of silos with competence management	Behavioral (function) and environmental (structure)	Secondary relevance; individual and group	Aversive control, endorsement

Table 1. Cont.

Author(s), Year	County	Sector	Article Type	Definition	Aims	Factor	Reported Consequences	Type/value of Consequences
Fralicx, 2012	USA	Health	Theoretical	Functional silos	Break down silos between financial and clinical leaders	Cognitive (process)	Primary relevance; group	Reward, feedback
Gyrd-Jones et al., 2013	Australia, UK, Denmark	Food	Empirical (interpretative)	Functional silos	Explore the impact of silos on brand orientation	Behavioral (function)	No relevance	-
Hallowell and Turiso, 2009	USA	Health	Theoretical	Technology silos	Break down IT silos to improve customer experience	Environmental (structure)	Primary relevance; group	Timely payment
Hemon et al., 2019	France, Ireland	IT	Empirical (interpretative)	Functional silos	Remove functional silos through DevOps	Behavioral (function)	Primary relevance; individual	Feedback
Hwang and Krackhardt, 2020	USA	Consulting	Empirical (applied)	Knowledge silos	Online knowledge community in sustaining knowledge silos	Cognitive (process)	Primary relevance	Support, social reinforcers, reputation, incentives
Kowalski, 2017	USA	(Education) Libraries	Theoretical	Silos as units/departments	Breaking down silo walls across library departments	Cognitive (process)	Primary relevance; individual and group	Uncertainty avoidance, evidence of benefit, praise
Kreindler et al., 2012	Canada	Health	Theoretical (review)	Broad definition	Review of social identity approach to overcoming silos	Environmental (structure)	Primary relevance; individual	Reward, sanction, social acceptance, power, resources
Lank et al., 2008	USA; UK	Cross-sectors	Empirical (interpretative)	Silos as units/departments	Connect organizational silos through communities of practice	Environmental (structure)	Secondary relevance; group	Evidence of benefit, feedback
Mace-Vadjunec et al., 2015	USA	Health	Empirical (applied)	Silos as units/departments	Determine silo effects in employees' common goals and communication	Cognitive (process)	Secondary relevance; individual	Incentives
Marren et al., 2003	USA	Health	Theoretical	Broad definition	Acknowledge silos as cultural obstacles to health quality	Environmental (structure)	Primary relevance, individual and group	Financial reward, peer review, retaliation, social status, malpractice avoidance
McAdam, 2001	UK	Cross-sectors	Empirical (interpretative)	Functional silos	Determine the role of process benchmarking on silos	Cognitive (process)	Secondary relevance	Risk avoidance, reward, recognition
Miller et al., 2010	USA	Health	Empirical (applied)	Knowledge silos	Merge information silos in nursing-librarian collaboration	Cognitive (process) and behavioral (function)	Primary relevance	Rewards, incentives
Mitchell et al., 2004	Australia	Health	Theoretical	Knowledge silos	Understand uniprofessional silos and interprofessional health care	Behavioral (function)	Secondary relevance, individual	Job satisfaction, threat to expertise, social status

Table 1. Cont.

Author(s), Year	County	Sector	Article Type	Definition	Aims	Factor	Reported Consequences	Type/value of Consequences
Mohamed et al., 2004	USA	Not specified	Theoretical	Functional silos	Enhance cross-functional (team performance)	Cognitive (process)	Primary relevance, group	Reward, feedback, punishment
Mohler, 2013	USA	Health	Theoretical	Functional silos	Foster collaboration (i.e., integration) across clinical silos	Behavioral (function)	Secondary relevance, individual and group	Incentives, federal penalties
Neill and Jiang, 2017	USA	Cross-sectors	Empirical (applied)	Functional silos	Reduce functional silos through corporate communication	Behavioral (function)	Secondary relevance	Reward and coercion
Oksanen-Ylikoski and Yiloski, 2015	Finland	Education	Empirical (applied)	Knowledge silos	Break silos to build a co-learning innovation environment	Environmental (structure)	Secondary relevance, individual	Immediate rewards, praise, joy, evidence of benefit
Overton, 2017	Germany	Pharma	Theoretical	Silos as units/departments	Break down silo mentality in drug development	Cognitive (process)	No relevance	-
Paquin et al., 2018	Canada	Health	Empirical (applied)	Knowledge silos	Define leadership and merge interdisciplinary silos in crisis situations	Cognitive (process)	Secondary relevance, individual	Feedback, peer support
Porck et al., 2020	USA, Netherlands, Turkey	IT	Empirical (applied)	Functional silos	Understand what influences intergroup strategic consensus	Environmental (structure) and cognitive (process)	No relevance	-
Scott and Hawkins, 2008	UK	Health	Empirical (applied)	Broad definition	Explore the unintentional formation of internal functional barriers	Behavioral (function)	Secondary relevance, group	Limited resources
Silvestro and Westley, 2002	UK	Cross-sectors	Empirical (applied)	Functional silos	Explore operational changes from re-engineering companies' process (cf. function)	Behavioral (function) and cognitive (process)	Secondary relevance	Reward
Stoller et al., 2010	USA	Health	Empirical (applied)	Silos as units/departments	Foster teamwork through team building and change management	Environmental (structure)	Primary Relevance, individual and group	Rewards and recognition, evidence of benefits
Vatanpour et al., 2013	Iran	Pharma	Theoretical	Broad definition	Investigate silo effects in integrate supply chain	Cognitive (process)	Secondary relevance; individual and group	Financial rewards, risk avoidance, social reinforcers
Walton, 2019	UK	Not specified	Theoretical	Silos as units/departments and functional silos	Use principles of information to design and organization change	Environmental (structure) and cognitive (process)	Secondary relevance; individual and group	Incentives, attention, selection pressure, short-term wins
Wolak et al., 2012	USA	Health	Empirical (applied)	Silos as units/departments	Break down departmental silos to improve healthcare	Environmental (structure)	Secondary relevance, group	Evidence of benefit

Note: Reviews were included in the article type "interpretative".

In terms of recognition of the critical role of consequences in the strength of interactions within or across groups, studies were classified according to the degree of relevance attributed to consequences, as well as to the level of selection that they referred to. Our analysis identified three levels of relevance designated to behavioral consequences, depending on how much they are referred to in the articles, whether their selective effect is considered, and to what extent. Only three articles addressed hinderers and/or facilitators to behavioral change in organizations with no reference to the role of consequences ( $n = 3$ ), whereas the remaining 37 articles had a similar distribution of stating primary ( $n = 19$ ) and secondary ( $n = 18$ ) relevance. Whether the delivery of consequences was considered at the individual or group level, it was unclear for eight out of the 37 studies. The most observed occurrence was relative to the individual behavior ( $n = 12$ ), followed by the dual delivery at individual and group levels ( $n = 9$ ), and then by the group level only ( $n = 8$ ).

Although encompassed by the same concept of consequence as environmental events that influence behavior recurrence, authors differed regarding the type of consequences and used terms. The most common type of reported consequences were rewards ( $n = 14$ ), with the immediacy of their delivery emphasized in one article [65]. The second most cited category of consequences comprises social reinforces ( $n = 10$ ), referred to as social acceptance, status, attention, and peer support, followed by a broad category of incentives ( $n = 7$ ). Four categories account for the same quantity of mentions in the studies: evidence of benefits ( $n = 6$ ), aversive control in favoring avoidance behaviors ( $n = 6$ ), praise and endorsement ( $n = 6$ ), and punishment ( $n = 6$ ). The latter is specified as sanctions, retaliation, penalties, coercion, blame, and by the term punishment. Among the less cited types of consequences were the use of feedbacks ( $n = 5$ ), financial rewards ( $n = 3$ ) and job satisfaction ( $n = 2$ ), as well as terms that do not repeat across studies.

#### 4.2. Empirical Findings

Table 2 contains further detail on the empirical (applied and interpretative) studies included. Most of the studies ( $n = 15$ ) followed a qualitative approach. Among those, we identify case studies ( $n = 8$ ), basic interpretative approaches ( $n = 3$ ), descriptions of meetings or change initiatives ( $n = 3$ ), and one ethnographic study. Two studies had a quantitative character by analyzing data gathered through surveys and two studies mixed quantitative and qualitative methods. One study applied multiple networks analysis techniques to investigate interaction in an online knowledge community.

In most studies, identifying variables was not a straightforward task. In the case of the qualitative studies ( $n = 15$ ), the answer to main questions consisted of descriptions of organizational settings or processes that were not clearly framed in terms of relationships between independent and dependent variables. The variety of concepts explored in the selected articles proved to be difficult to be labelled and grouped in categories. Therefore, in Table 2 we present the concepts explored in each study and thereby illustrate the lack of common variables explored across the studies. Variables of changes in interactions among individuals previously belonging to different silos were presented in only two studies [62,66]. In some studies, the variables focus on results of different initiatives such as the number of home care visits [67], efficiency in discharging patients [68] and the rate in sepsis mortality [69]. However, in most studies, there is there an explicit concern in investigating factors that need to be addressed in order to overcome silos. In most cases, such variables seem to be related to participants' experiences gathered by either qualitative interviews, surveys, interviews, or descriptions of change processes.

**Table 2.** Quantitative analysis of included empirical studies (experimental and applied) with measures and outcomes.

Author(s), Year	Methods	Variables	Participants	Type of Findings	Reported Findings
Bates and Atkins, 2017	Qualitative case-study	Leadership character, substance and styles	Manufacturing company	Silos bridging with positive outcomes	Reduced operational risk, fast delivery
Briody and Erickson, 2014	Three ethnographic studies	Robustness in the links of the value chain; relationship between customer preferences and practices on corporate strategy; ideas for improving program performance; positive and negative experiences of patient experience	Apparel managers, automotive employees, and hospital personnel	Additional variables to collaboration	Cross-silo collaboration associated with leadership buy-in, structural change, work practice change and evidence of benefit
Buchman et al., 2018	Mixed methods. Analysis of site-level administrative data, pre- and post-implementation surveys, interviews, and a cost-effectiveness evaluation using a matched cohort.	Confidence to initiate ACP (Advance Care Planning) conversations; use of palliative care tools; number of home care visits	Four cancer centers and four primary care practices	Silos bridging with positive outcomes	Improved health care quality to patients
De Waal et al., 2019	Survey	35 silo-busting factors and techniques subgrouped along values; collaborative operating model; collaborative environment; leadership; reward and development, and collaboration results. Participants' perceptions on the quality of collaboration and coordination in the organization	11 large organizations	Silos busting with positive outcomes	Improved collaboration, internal strength
Forsten-Astikaenen et al., 2017	Qualitative case study	Participants' experience cross three themes; self-interest behind silos; invisible walls, missing business understanding and "search for battering" rams (HR initiatives to overcome silos)	Energy sector company with international offices	Ineffective silos bridging	Maintenance of silos; agent of change (HR) as a siloed unit
Gyrd_Jones et al., 2013	Qualitative case study	Perceptions on silos relevant to brand strategy implementation, impact of those on the implementation and challenges in overcoming these silos	Senior managers from a large food-manufacturing company (c. 1000 employees)	Silos as hinderers to organizational outcomes	Failure of brand alignment
Hemon et al., 2019	Qualitative case study	Perceptions of changes in relation to soft and hard skills as a result of DevOp; quantitative analysis of the number of interactions across different roles	Senior managers from a large food-manufacturing company (c. 1000 employees)	Silos bridging with positive outcomes	Evolved collaboration, faster and better deliveries
Hwang and Krackhardt, 2020	Multiple networks analysis techniques	Network analysis of interaction on an online knowledge community and thereby investigating the existence of silos by geography and domain	Fortune 500 information technology company, global	Ineffective silos bridging	Domain and location herding tendency, increase of domain fragmentation
Lank et al., 2008	Multiple case studies	Connectivity in different governance forms; building of communities of practice	Four global organizations	Silos bridging with positive outcomes	Improvement of global knowledge flows; professionals support

Table 2. Cont.

Author(s), Year	Methods	Variables	Participants	Type of Findings	Reported Findings
Mace-Vadjunec et al., 2015	Survey	Perceptions of interdepartmental relationships	Trauma center	Silos as hinderers to organizational outcomes	Low assistance from indirectly related units
McAdam, 2001	Multiple case studies	Process, Benchmarking; interfaces; dynamic for change	30 large organizations in the manufacturing and service sectors	Additional variables to collaboration	Progressive levels towards network-process development; benchmarking as key element
Miller et al., 2010	Description of workshops	Nursing-library communication; Information literacy	Librarians and nursing educators	Silos bridging with positive outcomes	Evolved collaboration, better application of literacy skills in nursing practice
Neill and Jiang, 2017	Basic interpretive study	Participants' motivation and reasoning over communication strategies	28 organizations with regional and global offices	Silos bridging with mixed outcomes	(+) Combined efforts, (–) encroachment, remained barriers, ownership conflicts
Oksanen-Ylikoski and Yiloski, 2015	Qualitative case study	Community borders; community culture; structures; leadership	Multi-sector education provider (700 staff, 10,000 students)	Silos bridging with mixed outcomes	(+) Meeting reinforcers at individual level, (–) organization as a silo, lack of leadership
Paquin et al., 2017	Basic interpretive study	Distributed role; aligning roles; alignment of expectations at level of experience; aligning expectations of personal and disciplinary attributes; coordinative leadership; formally designating a leader; spatial contexts and the alignment of sub-specialty perspectives	27 physicians from three different specialties in pediatric centers	Additional variables to collaboration	Case predictability as a moderator for coordinated or task-based leadership for merging specialties
Porck et al., 2020	Mixed methods (human resources data, qualitative interviews and survey)	Group identification (GI) in an intergroup dyad; organizational identification (OI); intergroup strategic consensus (ISC)	Gas and electricity transportation company (large); Information and communications technology company (midsize)	Silos as hinderers to organizational outcomes	ISC negatively correlated with GI and positively correlated with OI for low levels of GI
Scott and Hawkins, 2008	Basic interpretive study	Perceptions of internal and external boundaries of effectively discharging patients	Medical and elderly care wards in an NHS Acute Trust	Silos as hinderers to organizational outcomes	Delays in discharges
Silvestro and Westley, 2002	Latitudinal case study	Organizational re-structuring; organizational culture; relations with customers and suppliers; intra-and inter-departmental communication; employee involvement and morale; product and service delivery; control and performance measurement systems; business performance	Electronics company Retail company	Silos bridging with mixed outcomes	(+) Improved market responsiveness, (–) transitory, decrease of efficiency, costly
Stoller et al., 2010	Series of meetings directed at developing a scorecard	Quality, risk management, and innovation; Service; Productivity and financial; Employee engagement	Respiratory therapy departments within a hospital	Silos bridging with positive outcomes	Sharing knowledge, cross-staffing, lower turnover
Wolak et al., 2012	Description of a multidisciplinary quality improvement initiative	Multidisciplinary approach in identifying and treating septic patients; rate in sepsis mortality	Multidisciplinary/multidepartment team at a non-profit healthcare system	Silos bridging with positive outcomes	Decrease in severe-septic mortality rates

The codification of research findings resorted to different parameters due to the considerable variety in aims, variables, and methods amongst the selected publications. Data from reports of interventions involving the promotion of collaboration across units ( $n = 13$ ) were labelled in three categories in terms of effectivity and outcomes of bridging organizational silos. The majority reported bridging with positive outcomes ( $n = 8$ ), specific to each organizations' needs, as improved health care quality [67], lower turnover [70], faster and better deliveries [66], and so on. Silos bridging with mixed outcomes were described in three publications and comprised the combination of positive and negative implications for organizations that invested in facilitating cross-silo organizational processes. For instance, the increase of market responsiveness balanced with the decrease of efficiency [71] and combined efforts from different sectors, correlated with function encroachment and ownership conflicts [72]. Two studies reported little or no bridging across silos [61,62], despite the strategies in place. The remaining empirical articles ( $n = 7$ ) presented descriptive organizational processes. In four of these studies, silos were reported as hinderers to organizational outcomes, whereas the remaining studies ( $n = 3$ ) referred to highlighting additional variables relevant to cross-silos collaboration.

## 5. Discussion

One of the challenges that we encountered since the earliest phases of this scoping review was the inconsistency of the use of terms. It appeared that the substantive silos and its corresponding verb and adjective forms are used in many different ways and limited our search uniquely to the organizational context and delimited only partially its scope of use. For example, we found cases of budget silos [73], information silos, [74–77], cultural silos [78], tribal silos [79], siloed thinking or mentality [80], research silos [81], and silo-effects [82].

Silo-focused employees [83], silo-based budgeting [84], silos approaches to risk management and risk assessment, silos as pillars [85], and siloed strategy [86] have been found to mean ways or characteristics according to which compartmentalization may affect other operational areas. Furthermore, it was possible to classify the domains in which silos represented conceptual or applied instances of inquiry. Thus, we found records of historical silos [87], disciplinary silos [88], justice silos [89], geographical silos [90], HR silos [91], and governance silos [92].

Lastly, functional silos [93] are particularly interesting for the aims of this study, insofar as they are defined as a hierarchical management style [94], rather than the structure of exchanges underlying the management or leadership practices. For example, this view is in contrast with other views of organizational silos: data silos [95,96] and knowledge silos [97,98], according to which the boundaries lie in the content and are not just formal or arbitrary ones.

### 5.1. Definitions and Methods

The range of definitions of silos as formal departments, functions, knowledge areas, and technologies leaves us with important questions related to how we operationalize the concept from the perspective of complexity. Earlier in this article, we presented emergence as a central property of complex systems. This means that we look at organizations as evolving patterns of interactions which can never be fully understood by looking only at formal structures and processes. If silos are a product of emergence, it seems fair to expect that these may assume different forms. The seven articles ( $n = 7$ ) that present broad definitions [6,59,67,68,99–101] encompassing all four qualitative kinds seem to provide the conceptual flexibility necessary to analyze organizational silos. A more unified conceptual perspective to organizational silos may derive more from the structural analysis of interactions than from the qualitative character of silos.

The large share of qualitative case and ethnographic studies among the selected articles has provided, in many cases, rich descriptions of organizational settings and the opportunity to explore experiential accounts of participants. This partially explains the wide range of variables approached by such of the studies. However, although the variety of research methods applied to investigate organizational silos enables analyzing the phenomenon at different levels, there is a need for research

methods that open the space for the structural analysis of interactions. In this regard, the concept of clustering usually applied in social network analysis moves from the often-normative connotation attributed to silos and permeates network measures of social interaction. For instance, homophily [102] measures what individual attributes (same department, shared function, common expertise, or the use of common technology) predict interaction in a certain social group and is particularly useful in identifying the dynamics behind silo formation. This may explain the reason why a group of individuals is more connected to each other than other individuals. In recent years, there has been an increasing interest in methods of community detection which is the identification of sets of nodes are more connected among each other than to other clusters in the same network [103]. In other words, the formation of silos may be a dependent variable of different nodes attributes seen as independent variables. Nevertheless, understanding the temporal and evolutionary character of complex system demands tools beyond graphic representations and network analytical measures. Webs of interactions are, indeed, networks of contingencies, and, therefore, there is the need for an evolutionary and behavioral account of organizational silos.

### 5.2. Properties and Consequences

Going beyond the boundaries of silos calls for a behavioral engineering approach that is able to account for structure, processes, and functions of its analyses. Similarly to the lack of information, silo formations can impose a cost (in terms of control) on the variability within an organization and limit the evolution of reciprocal relations among its members [104]. Similar to silo thinking, silo mentality is presented as a mindset against information flow within the same organization, which by definition should align each of its members' behavior towards a common stated purpose [105]. In other words, they both comprise a description of non-cooperative behavior with the organization due to a lack of reinforcement of interdepartmental exchanges.

Conversely, the concept of metacontingency focuses on interdependent relations that are often cooperative to go beyond the level of analysis of individual mentalities. It is a particularity useful concept and tool to capture the complexity of organizational behavior, insofar as (i) it is perpetuated by several agents whose efforts are needed to fulfil the organizational goals, and (ii) it is recurrent, in the sense that agents and practices may evolve and change as time elapses. Given this scenario, silo effects can possibly disrupt the interrelations necessary for producing the aggregate product (e.g., knowledge silos that ought to be overcome by enhancing sharing [106]). Similarly, silo effects can manifest themselves to the extent that the receiving system demand may not be continuously met if the agents and relations comprising the interlocking behavior contingencies change to such an extent that the aggregate product is no longer attractive [17]. Although some of the studies herein included did include an account of silos in relation to some aspects of the culture of an organization (e.g., [60,65,100]), we maintain that a cultural behavioral account of silos can prevent their negative effects of hindering cooperation, while retaining the positive value of clusters as spaces of co-creation and exchange. Although they both share similar topographical properties (i.e., safeguarding information, enhancing creativity, etc.), they influence and are influenced by the encompassing culture, determining judgments of value among its members. Thus, non-cooperative practices that are rejected in the former may be selected and transmitted further in the organization in the latter case; for example, through the generation of rules (see [107]) depicting silos as "bad" and clusters as "good".

Overall, most conceptual and empirical studies did mention environmental events that were or could be presented in a conditional relationship with professional engagement in collaborative practices. Notwithstanding, since more than half of the references were presented as peripheral to the discussion of silo phenomena, it seems that a behavioral approach can be better emphasized. Most empirical studies (see Table 2) referred to the role of consequences. This allowed tracing for connections between the attributed degree of relevance to environmental events contingent to behaviors, their delivery level (at individual or combined efforts), and the observed findings. The only two studies with absent references to environmental consequences had descriptive findings stating silos as hinderers to the



achievement of organizational outcomes [64,108]. Although this is no evidence to suggest a parallel between not addressing contingent or metacontingent relations, and stressing the deleterious effects of silos, it raises the issue of how the systematic delivery of consequences could have affected the expected alignment between groups within the organizations.

Some correlations were found between references to consequences, bridging effectivity, and outcomes from cross-silo collaboration. The eight studies that reported bridging silos with positive outcomes [60,66,67,69,70,109–111] made reference to the use of consequences. Whereas five studies stated their primary relevance [60,66,70,109,111], three discussed the role of environmental contingent events as a secondary matter [67,69,110]. Reward [60,70,109,111], evidence of benefit [69,110], and feedback [66,110] were the most prevalent types of consequences cited by these studies. Regarding the findings of mixed positive and negative outcomes from attempts of bridging silos, the role of behavioral consequences were not as strategic mediators to organizational change [65,71,72].

Even without a clear framework regarding the role of conditional relations between environmental events and the strength of cultural practices in organizations, the analyzed literature indirectly signals their participation in contributing or inhibiting collaboration and cohesion. With respect to the level of delivery of consequences, only six of the empirical works referred to contingent events to the coordination of efforts towards organizational goals, but most were associated with silos bridging with positive outcomes [61,68–70,110,111]. However small, this correlation might indicate promising complements to the organizational field by harnessing, from a cultural behavior perspective, to favor the selection, strength, and maintenance of effective organizational IBCs over time [16].

To some extent, the studies on silos herein encountered failed to stress the critical role of the encountered environmental consequences. Silos are driven by consequences, which, from a relational frame perspective, refers to socially mediated consequences [112]. Differently to tracking consequences that allow the agents to experience directly the consequences of their action, silos do not program for aligning incentives to effective contributions according to a proportional credit system [113]. In fact, the consequences of behaving in silos drive the performance of the individual or group independently from those of the rest of the organization. Conversely, reducing the contingencies that lead to interdependently achieved consequences to the individual level of analysis (e.g., linking them to incentive-based systems of remuneration) may reduce the silo mentality, possibly by better aligning resources with goals [28]. The decoupling of internal and external contingencies may lead to the formation of silos, which, in turn, represents an issue of organizational adaptability. More information should be available to more individuals, in order to change more rapidly the internal IBCs of their interrelations (cf. external IBCs) [114].

### *5.3. Limitations and Suggestions for Further Research*

This work features some limitations, starting from the breadth of the scoping review. In fact, the analysis of silos within an origination was preferred to the analysis of inter-organizational silos, or silos that span across organizations that formally belong the same system (e.g., multiple service-delivery or treatment centers within the health sector). Not differently from virtually all other reviews of the literature, this work does not take into account the grey literature [115], which consists of unpublished studies following peer review. For example, some of these studies may fail to report statistically significant results, they may not be indexed, or they may have been written in any other language than English. Similarly, the reason for excluding from the current review nine studies whose full-text versions were not available, was not based on their content, but rather on their unavailability. In fact, not only were these not accessible, but missing altogether, which may be due to incorrect online indexing (e.g., [116]).

Second, although half of the studies were empirical, insofar as they reported on some data or measure of silos, only a small part of them was applied, in the sense that they featured first-hand collected measures. Moreover, none of the studies included were experimental (i.e., performed in a rigorously controlled setting, such as a lab); thus, this category was dropped when categorizing

article type. By engaging in the present work, we examined the size, variety, and characteristics of the current literature and summarized our findings in a qualitative and quantitative account. Furthermore, it was possible to identify and point out some of the possible gaps in the interdisciplinary research and set the grounds for a forthcoming systematic review [117,118] on the behavioral determinants of organizational silos.

As discussed earlier, further research on organizational silos can benefit from a network structural analysis of interactions. This can provide a more unified basis to identify silos and structural barriers for communication. However, the nature of the problem requires a multidisciplinary endeavor. There is a necessity for methods to qualitatively address the content of communication flow in organizational settings ranging from simple information to complex ideas and behavioral changes. The further definition of what is the object of communication in different organizational settings is not articulated in the analyzed articles. Thereby, the different outcomes of communication being that efficient exchange of information and/or the emergence of innovative ideas, raise questions about reinforcements at different levels.

Moreover, if silos are to be avoided or bridged as much as possible to enhance instances of cooperation within organizations, both their designs and policies should be addressed by the management team. In fact, designing working environments free of barriers to communication flow and information exchange can be affected by the architecture of spaces and relations: this is referred to as the choice architecture [119] and usually targets the antecedents of organizational behavior. At the same time, programming new or amended consequences should be embedded in the policymaking of the organization, so that they are aligned with the fulfillment of goals and ensuring that the receiving system's demand is met. Forthcoming research and practitioners could take this standpoint for identifying the antecedent and consequence terms of organizational silos and how they can be addressed depending on the factor on which they rest (i.e., cognitive, behavioral, or environmental). It is possible that what are referred to as silos, in some occasions, are the product of simpler environmental-behavior-consequence relationships that may undergo functional analyses (see [120]).

## 6. Conclusions

Silos comprise barriers to achieving organizational goals insofar as they pose a threat to internal cooperation. However, the analysis of selected articles reveals a wide variety in terms of definitions, operationalization of the concept, research methods, and findings. Conceptualizations varied as silos were intended as formal units, functions, areas of expertise, and technology. This calls for highlighting the importance of observing that organizational silos may assume different forms. Hence, a structural analysis of an emergent network of interactions may pave the way for the further identification of silos.

Moreover, this work focused on the availability and the effects of consequences on organizational silos. Although referring to the role of consequences is not a novelty in the field, their role in stablishing conditional relations for behaviors in organizations and favoring processes of change is. Similar to adapting a reciprocal determinism model from the individual to the community level [121], we analyzed the behavioral, cognitive, and environmental factors of silo functioning in organizational behavior, which includes goal-setting, self-efficacy, performance and management, and organizational complexity, among other factors [122]. Thus, the analysis of consequences was extended from single to system, wherein cultural consequences select the recurrence of organizational practices (e.g., communication, data sharing, delivering feedback, and coordinating action among departments). Regarding the relevance of group-level consequences for fostering coordination between processes, functions, or structures, the literature that was analyzed in the current work did not explore the advancement of knowledge on the selection and maintenance of IBCs. We maintain that adopting these concepts enables one to both seek an improved understanding of organizational patterns and design interventions based on stronger connections between professionals.

By engaging in a scoping review, our aim was to provide a cross-sector and interdisciplinary overview of what silos are and how are they intended in the organizational literature. Taken together, the finding of this work highlighted the need of a more unified approach to defining silos and their

effects on the functioning of an organization. Nevertheless, they reflected a certain lack of empirical studies on silos, which may partly be explained by the difficulty of measuring and operationalizing them based on their consequences in the organization.

**Author Contributions:** Conceptualization, F.B. and M.T.; methodology, F.B.; investigation, M.T.; resources, F.B. and M.T.; data curation, F.L.; writing—original draft preparation, F.B. and M.T.; writing—review and editing, F.B., M.T. and F.L. All authors have read and agreed to the published version of the manuscript.

**Funding:** Article Processing Charges (APC) were financed by OsloMet—Oslo Metropolitan University. This research was partially financed by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior—Brasil (Capes)—Finance Code 001.

**Acknowledgments:** The authors are grateful to academic librarian Lilja Johannessen for the assistance with the literature search process.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

**Table A1.** Complete search strategy on Academic Search Ultimate (completed on 6 April 2020). Interface—EBSCOhost Research Databases Search Screen—Advanced Search Database—Academic Search Ultimate.

Search ID	Search Terms	Search Options	Results
S1	(DE "SILOS") OR (DE "SILO mentality")	Search modes—Boolean/Phrase	485
S2	TI (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) OR AB (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) OR KW (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) OR SU (silos OR siloes OR silo OR siloed OR siloing OR silo-ing)	Search modes—Boolean/Phrase	4221
S3	S1 OR S2	Search modes—Boolean/Phrase	4221
S4	DE "ORGANIZATION" OR DE "ORGANIZATIONAL centralization" OR DE "ORGANIZATIONAL change" OR DE "ORGANIZATIONAL effectiveness" OR DE "ORGANIZATIONAL response" OR DE "ORGANIZATIONAL structure" OR DE "ORGANIZATIONAL ecology" OR DE "ORGANIZATIONAL research" OR DE "ORGANIZATIONAL sociology"	Search modes—Boolean/Phrase	31,507
S5	TI (organi?ation*) OR AB (organi?ation*) OR KW (organi?ation*) OR SU (organi?ation*)	Search modes—Boolean/Phrase	831,605
S6	S4 OR S5	Search modes—Boolean/Phrase	831,605
S7	S3 AND S6	Search modes—Boolean/Phrase	429
S8	S3 AND S6	Limiters—Scholarly (Peer Reviewed) Journals Search modes—Boolean/Phrase	340
S9	S3 AND S6	Limiters—Scholarly (Peer Reviewed) Journals Search modes—Boolean/Phrase	327
S10	S3 AND S6	Limiters—Scholarly (Peer Reviewed) Journals Search modes—Boolean/Phrase	327

Complete search strategy on Academic Search Ultimate (completed on 6 April 2020). Interface—EBSCOhost Research Databases Search Screen—Advanced Search Database—Academic Search Ultimate.

**Table A2.** Complete search strategy on Business Source Elite (completed on 6 April 2020). Interface—EBSCOhost Research Databases Search Screen—Advanced Search Database—Business Source Elite.

Search ID	Search Terms	Search Options	Results
S1	DE "SILO mentality"	Search modes—Boolean/Phrase	38
S2	TI (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) OR AB (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) OR KW (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) OR SU (silos OR siloes OR silo OR siloed OR siloing OR silo-ing)	Search modes—Boolean/Phrase	3326
S3	S1 OR S2	Search modes—Boolean/Phrase	3326
S4	DE "ORGANIZATION" OR DE "ORGANIZATIONAL centralization" OR DE "ORGANIZATIONAL change" OR DE "ORGANIZATIONAL effectiveness" OR DE "ORGANIZATIONAL response" OR DE "ORGANIZATIONAL structure" OR DE "ORGANIZATIONAL research" OR DE "ORGANIZATIONAL sociology"	Search modes—Boolean/Phrase	84,116
S5	TI (organi?ation*) OR AB (organi?ation*) OR KW (organi?ation*) OR SU (organi?ation*)	Search modes—Boolean/Phrase	882,714
S6	S4 OR S5	Search modes—Boolean/Phrase	882,714
S7	S3 AND S6	Search modes—Boolean/Phrase	701
S8	S3 AND S6	Limiters—Scholarly (Peer Reviewed) Journals Search modes—Boolean/Phrase	286
S9	S3 AND S6	Limiters—Scholarly (Peer Reviewed) Journals Search modes—Boolean/Phrase	266

**Table A3.** Complete search strategy on Scopus (completed on 6 April 2020). Interface—scopus-com.ezproxy.hioa.no.

1	(TITLE-ABS-KEY (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) AND TITLE-ABS-KEY (organi?ation*)) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (LANGUAGE, "English"))	829
---	--	-----

**Table A4.** Complete search strategy on Web of Science (completed on 6 April 2020). Interface—webofknowledge.com.ezproxy.hioa.no.

#3	<b>TOPIC:</b> (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) <b>AND TOPIC:</b> (organi?ation*) <b>Refined by: DOCUMENT TYPES:</b> (ARTICLE OR REVIEW) <b>AND LANGUAGES:</b> (ENGLISH) <i>Indexes=SCI_EXPANDED, SSCI, A%HCI, ESCI Timespan=All years</i>	427
#2	<b>TOPIC:</b> (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) <b>AND TOPIC:</b> (organi?ation*) <b>Refined by: DOCUMENT TYPES:</b> (ARTICLE OR REVIEW) <i>Indexes=SCI_EXPANDED, SSCI, A%HCI, ESCI Timespan=All years</i>	438
#1	<b>TOPIC:</b> (silos OR siloes OR silo OR siloed OR siloing OR silo-ing) <b>AND TOPIC:</b> (organi?ation*) <i>Indexes=SCI_EXPANDED, SSCI, A%HCI, ESCI Timespan=All years</i>	462

## Appendix B

Table A5. Articles included for analysis in the scoping review.

1. Aaker, D.A. Marketing in a silo world: The new CMO challenge. <i>Calif. Manag. Rev.</i> <b>2008</b> , <i>51</i> , 144–156, doi:10.2307/41166473.
2. Baird, G.M. The future of water infrastructure asset management, Part 3: Breaking down organizational silos as barriers to cost savings. <i>Am. Water Works Assoc.</i> <b>2013</b> , <i>105</i> , 16–20, doi:10.5942/jawwa.2013.105.0128.
3. Bannister, F. Dismantling the silos: Extracting new value from IT investments in public administration. <i>Inf. Syst. J.</i> <b>2001</b> , <i>11</i> , 65–84, doi:10.1046/j.1365-2575.2001.00094.x.
4. Bates, A. Bridge the gap from strategy to execution: Culture change that sticks. <i>Strateg. HR Rev.</i> <b>2017</b> , <i>16</i> , 222–228, doi:10.1108/SHR-07-2017-0048.
5. Bathurst, R.; Galloway, C. Invitational discourse: Towards a spirituality of communication. <i>Soc. Responsib. J.</i> <b>2018</b> , <i>14</i> , 336–350, doi:10.1108/SRJ-05-2016-0089.
6. Briody, E.K.; Erickson, K.C. Success despite the silos: System-wide innovation and collaboration. <i>Int. J. Bus. Anthropol.</i> <b>2014</b> , <i>5</i> , 30–54, doi:10.33423/ijba.v5i1.1141.
7. Buchman, S.; Evans, J.M.; Mackinnon, M.; Gradin, S.; Wright, F.C. Bridging silos: Delivering integrated care to patients with cancer in Ontario, Canada. <i>Psycho-Oncology</i> <b>2018</b> , <i>27</i> , 2673–2676, doi:10.1002/pon.4858.
8. Bundred, S. Solutions to silos: Joining up knowledge. <i>Public Money Manag.</i> <b>2006</b> , <i>26</i> , 125–130, doi:10.1111/j.1467-9302.2006.00511.x.
9. Casciaro, T.; Edmondson, A.C.; Jang, S. Cross-silo leadership: How to create more value by connecting experts from inside and outside the organization. <i>Harv. Bus. Rev.</i> <b>2019</b> , <i>97</i> , 130–139.
10. Cromity, J.; de Stricker, U. Silo persistence: It's not the technology, it's the culture! <i>New Rev. Inf. Netw.</i> <b>2011</b> , <i>16</i> , 167–184, doi:10.1080/13614576.2011.619924.
11. de Waal, A.; Weaver, M.; Day, T.; van der Heijden, B. Silo-busting: Overcoming the greatest threat to organizational performance. <i>Sustainability</i> <b>2019</b> , <i>11</i> , 21, doi:10.3390/su11236860.
12. Dell, R.K. Breaking organizational silos: Removing barriers to exceptional performance. <i>J. Am. Water Works Assoc.</i> <b>2005</b> , <i>97</i> , 34–37, doi:10.1002/j.1551-8833.2005.tb10902.x.
13. Doerr, K.H.; Kang, K. Bi-criteria risk analysis of domain-specific and cross-domain changes in complex systems. <i>Comput. Ind. Eng.</i> <b>2014</b> , <i>73</i> , 51–60, doi:10.1016/j.cie.2014.04.009.
14. Forsten-Astikainen, R.; Hurmelinna-Laukkanen, P.; Lämsä, T.; Heilmann, P.; Hyrkäs, E. Dealing with organizational silos with communities of practice and human resource management. <i>J. Workplace Learn.</i> <b>2017</b> , <i>29</i> , 473–489, doi:10.1108/JWL-04-2015-0028.
15. Fralix, R. Strange bed(side) fellows physician-finance collaboration. <i>Healthc. Financ. Manag.</i> <b>2012</b> , <i>66</i> , 90–96.
16. Gyrd-Jones, R.I.; Helm, C.; Munk, J. Exploring the impact of silos in achieving brand orientation. <i>J. Mark. Manag.</i> <b>2013</b> , <i>29</i> , 1056–1078, doi:10.1080/0267257X.2013.811283.
17. Hallowell, B.; Turisco, F. Breaking down IT silos a “connected” way to improve customer experience and the bottom line. <i>Healthc. Financ. Manag.</i> <b>2009</b> , <i>63</i> , 58–64.
18. Hemon, A.; Lyonnet, B.; Rowe, F.; Fitzgerald, B. From agile to DevOps: Smart skills and collaborations. <i>Inf. Syst. Front.</i> <b>2019</b> , doi:10.1007/s10796-019-09905-1.
19. Hwang, E.H.; Krackhardt, D. Online knowledge communities: Breaking or sustaining knowledge silos? <i>Prod. Oper. Manag.</i> <b>2020</b> , <i>29</i> , 138–155, doi:10.1111/poms.13098.
20. Kowalski, M. Breaking down silo walls: Successful collaboration across library departments. <i>Libr. Leadersh. Manag.</i> <b>2017</b> , <i>31</i> , doi:10.5860/llm.v31i2.7202.
21. Kreindler, S.A.; Dowd, D.A.; Dana Star, N.; Gottschalk, T. Silos and social identity: The social identity approach as a framework for understanding and overcoming divisions in health care. <i>Milbank Q.</i> <b>2012</b> , <i>90</i> , 347–374, doi:10.1111/j.1468-0009.2012.00666.x.

Table A5. Cont.

22. Lank, E.; Randell-Khan, J.; Rosenbaum, S.; Tate, O. Herding cats: Choosing a governance structure for your communities of practice. <i>J. Chang. Manag.</i> <b>2008</b> , <i>8</i> , 101–109, doi:10.1080/14697010701838771.
23. Mace-Vadjunec, D.; Hileman, B.M.; Melnykovich, M.B.; Hanes, M.C.; Chance, E.A.; Emerick, E.S. The lack of common goals and communication within a level I trauma system. <i>J. Trauma Nurs.</i> <b>2015</b> , <i>22</i> , 274–281, doi:10.1097/JTN.0000000000000153.
24. Marren, J.P.; Feazell, G.L.; Paddock, M.W. The hospital board at risk and the need to restructure the relationship with the medical staff: Bylaws, peer review and related solutions. <i>Ann. Health Law</i> <b>2003</b> , <i>12</i> , 179–234.
25. McAdam, R. Fragmenting the function-process interface: The role of process benchmarking. <i>Benchmarking Int. J.</i> <b>2001</b> , <i>8</i> , 332–349, doi:10.1108/EUM0000000005953.
26. Miller, L.C.; Jones, B.B.; Graves, R.S.; Sievert, M.C. Merging silos: Collaborating for information literacy. <i>J. Contin. Educ. Nurs.</i> <b>2010</b> , <i>41</i> , 1–6, doi:10.3928/00220124-20100401-03.
27. Mitchell, R.; Parker, V.; Giles, M.; White, N. Toward realizing the potential of diversity in composition of interprofessional health care teams: An examination of the cognitive and psychosocial dynamics of interprofessional collaboration. <i>Med. Care Res. Rev.</i> <b>2010</b> , <i>67</i> , 3–26, doi:10.1177/1077558709338478.
28. Mohamed, M.; Stankosky, M.; Murray, A. Applying knowledge management principles to enhance cross-functional team performance. <i>J. Knowl. Manag.</i> <b>2004</b> , <i>8</i> , 127–142, doi:10.1108/13673270410541097.
29. Mohler, M.J. Collaboration across clinical silos. <i>Front. Health Serv. Manag.</i> <b>2013</b> , <i>29</i> , 36–44.
30. Neill, M.S.; Jiang, H. Functional silos, integration & encroachment in internal communication. <i>Public Relat. Rev.</i> <b>2017</b> , <i>43</i> , 850–862, doi:10.1016/j.pubrev.2017.06.009.
31. Oksanen-Ylikoski, E.; Ylikoski, T. Tensions in creating an innovative community of vocational education and entrepreneurship. <i>Int. J. Innov. Creat. Chang.</i> <b>2015</b> , <i>2</i> , 76–82.
32. Overton, P. Breaking down silos in drug development why interdisciplinary integration is fundamental for pharma's future. <i>Drug Discov. World</i> <b>2017</b> , <i>18</i> , 49–52.
33. Paquin, H.; Bank, I.; Young, M.; Nguyen, L.H.P.; Fisher, R.; Nugus, P. Leadership in crisis situations: Merging the interdisciplinary silos. <i>Leadersh. Health Serv.</i> <b>2018</b> , <i>31</i> , 110–128, doi:10.1108/LHS-02-2017-0010.
34. Porck, J.P.; van Knippenberg, D.; Tarakci, M.; Ateş, N.Y.; Groenen, P.J.F.; de Haas, M. Do group and organizational identification help or hurt intergroup strategic consensus? <i>J. Manag.</i> <b>2020</b> , <i>46</i> , 234–260, doi:10.1177/0149206318788434.
35. Scott, J.M.; Hawkins, P. Organisational silos: Affecting the discharge of elderly patients. <i>J. Health Organ. Manag.</i> <b>2008</b> , <i>22</i> , 309–318, doi:10.1108/14777260810883567.
36. Silvestro, R.; Westley, C. Challenging the paradigm of the process enterprise: A case-study analysis of BPR implementation. <i>Omega Int. J. Manag. Sci.</i> <b>2002</b> , <i>30</i> , 215–225, doi:10.1016/S0305-0483(02)00028-2.
37. Stoller, J.K.; Sasidhar, M.; Wheeler, D.M.; Chatburn, R.L.; Bivens, R.T.; Priganc, D.; Orens, D.K. Team-building and change management in respiratory care: Description of a process and outcomes. <i>Respir. Care</i> <b>2010</b> , <i>55</i> , 741–748.
38. Vatanpour, H.; Khorramnia, A.; Forutan, N. Silo effect a prominence factor to decrease efficiency of pharmaceutical industry. <i>Iran. J. Pharm. Res.</i> <b>2013</b> , <i>12</i> , 203–212.
39. Walton, P. Information evolution and organisations. <i>Information</i> <b>2019</b> , <i>10</i> , 29, doi:10.3390/info10120393.
40. Wolak, E.; Ballard, A.; Thomas, M.; Newell, E.; Livingston, B.; Finch, D.; Hawkins, R.; Pickett, J. Breaking down departmental silos for a common purpose. <i>Nurse Lead.</i> <b>2012</b> , <i>10</i> , 32–36, doi:10.1016/j.nml.2012.05.004.

## References

- Sandaker, I. A selectionist perspective on systemic and behavioral change in organizations. *J. Organ. Behav. Manag.* **2009**, *29*, 276–293. [CrossRef]
- Clement, J.; Puranam, P. Searching for structure: Formal organization design as a guide to network evolution. *Manag. Sci.* **2018**, *64*, 3879–3895. [CrossRef]
- Bento, F.; Garotti, L. Resilience beyond formal structures: A network perspective towards the challenges of an aging workforce in the oil and gas industry. *J. Open Innov. Technol. Mark. Complex.* **2019**, *5*, 15. [CrossRef]
- Burke, W.W. *Organization Change: Theory and Practice*; SAGE: London, UK, 2014; Volume 4.
- Centola, D. *How Behavior Spreads: The Science of Complex Contagions*; Princeton University Press: Princeton, NJ, USA, 2018; Volume 3.
- Cromity, J.; de Stricker, U. Silo persistence: It's not the technology, it's the culture! *New Rev. Inf. Netw.* **2011**, *16*, 167–184. [CrossRef]
- Sessoms, G. What Are Organizational Silos? Available online: <https://yourbusiness.azcentral.com/organizational-silos-8237.html> (accessed on 4 May 2020).
- Lessard, D.R.; Zaheer, S. Breaking the silos: Distributed knowledge and strategic responses to volatile exchange rates. *Strateg. Manag. J.* **1996**, *17*, 513–533. [CrossRef]
- McPherson, L. 5 Ways to Break Down Organizational Silos: How to Overcome the Silo Mentality and Encourage Team Collaboration. Available online: <https://zapier.com/blog/organizational-silos/> (accessed on 16 May 2020).
- Cilliers, F.; Greyvenstein, H. The impact of silo mentality on team identity: An organisational case study. *J. Ind. Psychol.* **2012**, *38*, 75–84. [CrossRef]
- Silo Mentality. *BusinessDictionary.com*. 2020. Available online: <http://www.businessdictionary.com/definition/silo-mentality.html> (accessed on 3 April 2020).
- Tett, G. *The Silo Effect: Why Putting Everything in Its Place Isn't Such a Bright Idea*; Little Brown Group: London, UK, 2015.
- Guilbeault, D.; Becker, J.; Centola, D. Complex Contagions: A Decade in Review. In *Complex Spreading Phenomena in Social Systems*; Lehmann, S., Ahn, Y.-Y., Eds.; Springer: Cham, Switzerland, 2018; pp. 3–25.
- Zheng, M.; Lü, L.; Zhao, M. Spreading in online social networks: The role of social reinforcement. *Phys. Rev. E* **2013**, *88*, 012818. [CrossRef]
- Glenn, S.S.; Malott, M.E. Complexity and selection: Implications for organizational change. *Behav. Soc. Issues* **2004**, *13*, 89–106. [CrossRef]
- Glenn, S.S.; Malott, M.E.; Andery, M.A.P.A.; Benvenuti, M.F.L.; Houmanfar, R.A.; Sandaker, I.; Todorov, J.C.; Tourinho, E.Z.; Vasconcelos, L.A. Toward consistent terminology in a behaviorist approach to cultural analysis. *Behav. Soc. Issues* **2016**, *25*, 11–27. [CrossRef]
- Malott, M.E.; Glenn, S.S. Targets of intervention in cultural and behavioral change. *Behav. Soc. Issues* **2006**, *15*, 31–56. [CrossRef]
- Ludwig, T.D. Process safety behavioral systems: Behaviors interlock in complex metacontingencies. *J. Organ. Behav. Manag.* **2017**, *37*, 224–239. [CrossRef]
- Houmanfar, R.A.; Rodrigues, N.J. The metacontingency and the behavioral contingency: Points of contact and departure. *Behav. Soc. Issues* **2006**, *15*, 13–30. [CrossRef]
- Borba, A.; Tourinho, E.Z.; Glenn, S.S. Effects of cultural consequences on the interlocking behavioral contingencies of ethical self-control. *Psychol. Rec.* **2017**, *67*, 399–411. [CrossRef]
- Borgatti, S.P.; Mehra, A.; Brass, D.J.; Labianca, G. Network analysis in the social sciences. *Science* **2009**, *323*, 892–895. [CrossRef] [PubMed]
- Li, A.; Zhou, L.; Su, Q.; Cornelius, S.P.; Liu, Y.-Y.; Wang, L.; Levin, S.A. Evolution of cooperation on temporal networks. *Nat. Commun.* **2020**, *11*, 2259. [CrossRef] [PubMed]
- Emmons, S.; Kobourov, S.; Gallant, M.; Börner, K. Analysis of network clustering algorithms and cluster quality metrics at scale. *PLoS ONE* **2016**, *11*, e0159161. [CrossRef]
- Mishra, N.; Schreiber, R.; Stanton, I.; Tarjan, R.E. *Clustering Social Networks*; Springer-Verlag: Heidelberg, Germany, 2007; pp. 56–67.
- Carpenter, M.A.; Li, M.; Jiang, H. Social network research in organizational contexts: A systematic review of methodological issues and choices. *J. Manag.* **2012**, *38*, 1328–1361. [CrossRef]

26. Arksey, H.; O'Malley, L. Scoping studies: Towards a methodological framework. *Int. J. Soc. Res. Methodol.* **2005**, *8*, 19–32. [[CrossRef](#)]
27. Dickinson, A.M. The Historical Roots of Organizational Behavior Management in the Private Sector. *J. Organ. Behav. Manag.* **2001**, *20*, 9–58. [[CrossRef](#)]
28. Grigsby, R.K. Enhancing the behavioral science knowledge and skills of 21st-century leaders in academic medicine and science. *J. Organ. Behav. Manag.* **2015**, *35*, 123–134. [[CrossRef](#)]
29. Abernathy, W.B. Implications and Applications of a Behavior Systems Perspective. *J. Organ. Behav. Manag.* **2008**, *28*, 123–138. [[CrossRef](#)]
30. Baker, T.; Schwenk, T.; Piasecki, M.; Smith, G.S.; Reimer, D.; Jacobs, N.; Shonkwiler, G.; Hagen, J.; Houmanfar, R.A. Cultural Change in a Medical School: A Data-Driven Management of Entropy. *J. Organ. Behav. Manag.* **2015**, *35*, 95–122. [[CrossRef](#)]
31. de Carvalho, L.C.; Sandaker, I. Interlocking behavior and cultural selection. *Nor. Tidsskr. Atferdsanalyse* **2016**, *43*, 19–25.
32. Lencioni, P. *Silos, Politics and Turf Wars: A Leadership Fable about Destroying the Barriers that Turn Colleagues into Competitors*; Jossey-Bass: San Francisco, CA, USA, 2006.
33. Serrat, O. *Bridging Organizational Silos*; Springer: New York, NY, USA, 2017.
34. Parsons, T. *The Social System*; Routledge: London, UK, 1951.
35. Von Bertalanffy, L. *General System Theory: Foundations, Development, Applications*; G. Braziller: New York, NY, USA, 1968.
36. Skyttner, L. *General Systems Theory: Problems, Perspectives, Practice*, 2nd ed.; World Scientific: Hackensack, NJ, USA, 2005.
37. Bandura, A. *Social Learning Theory*; General Learning Press: New York, NY, USA, 1977.
38. Bandura, A. Toward a psychology of human agency. *Perspect. Psychol. Sci.* **2006**, *1*, 164–180. [[CrossRef](#)] [[PubMed](#)]
39. Thompson, S. Social Learning Theory. In *Encyclopedia of Special Education*; Reynolds, C.R., Vannest, K.J., Fletcher-Janzen, E., Eds.; Wiley: Hoboken, NJ, USA, 2014. [[CrossRef](#)]
40. Weiss, H.M. Social learning of work values in organizations. *J. Appl. Psychol.* **1978**, *63*, 711–718. [[CrossRef](#)]
41. Lam, S.K.; Kraus, F.; Ahearne, M. The diffusion of market orientation throughout the organization: A social learning theory perspective. *J. Mark.* **2010**, *7*, 61–79. [[CrossRef](#)]
42. Sims, H.P.; Lorenzi, P. *The New Leadership Paradigm: Social Learning and Cognition in Organizations*; Sage Publications: Thousand Oaks, CA, USA, 1992.
43. Diener, L.H.; McGee, H.M.; Miguel, C.F. An integrated approach for conducting a behavioral systems analysis. *J. Organ. Behav. Manag.* **2009**, *29*, 108–135. [[CrossRef](#)]
44. Todorov, J.C.; de Oliveira Castro, J.M.; Hanna, E.S.; Bittencourt de Sa, M.C.; Barreto, M.Q. Choice, experience, and the generalized matching law. *J. Exp. Anal. Behav.* **1983**, *40*, 99–111. [[CrossRef](#)]
45. Sérgio, T.M.A.P.; Andery, M.A.; Gioia, P.S.; Micheletto, N. *Controle de Estímulos e Comportamento Operante: Uma (nova) Introdução [Stimulus Control and Operant Behavior: A (New) Introduction]*; EDUC: São Paulo, Brazil, 2004.
46. Baum, W.M. *Understanding Behaviorism: Behavior, Culture, and Evolution*, 2nd ed.; Blackwell: Hoboken, NJ, USA, 2005.
47. Gusso, H.L.; De Luca, G.G. Organizações como Sistemas Comportamentais: Considerações para a Delimitação do campo de Atuação [Organizations as Behavioral Systems: Considerations for the Delimitation of the Field of Action]. In *Comportamento em foco [Behavior in Focus]*; Vilas-Boas, D.L.O., Cassas, F., Gusso, H.L., Eds.; Associação Brasileira de Psicologia e Medicina Comportamental [Brazilian Association of Psychology and Behavioral Medicine]: São Paulo, Brazil, 2017; Volume 5, pp. 28–40.
48. Eriksson, A.; Orvik, A.; Strandmark, M.; Nordsteien, A.; Torp, S. Management and leadership approaches to health promotion and sustainable workplaces: A scoping review. *Societies* **2017**, *7*, 14. [[CrossRef](#)]
49. Ouzzani, M.; Hammady, H.; Fedorowicz, Z.; Elmagarmid, A. Rayyan—A web and mobile app for systematic reviews. *Syst. Rev.* **2016**, *5*, 210. [[CrossRef](#)]
50. Moore, R.; Hamilton, P. 'Silo Mentalities' and Their Impact on Service Delivery in Prison-Community Transitions: A Case Study of Resettlement Provision at a Male Open Prison. *Howard J. Crime Justice* **2016**, *55*, 111–130. [[CrossRef](#)]
51. Seemann, J.; Gustafsson, J. Inter-organizational management and coordination in Danish health care. *Int. J. Integr. Care* **2013**, *13*, 1. [[CrossRef](#)]



52. Gough, M.Z.; Reece, J. The Impact of the Sustainable Communities Initiative on Engagement and Collaboration in Planning: Experiences from Four U.S. Regions. *Cityscape* **2017**, *19*, 115–134.
53. van der Jagt, A.P.N.; Lawrence, A. Local government and urban forest governance: Insights from Scotland. *Scand. J. For. Res.* **2019**, *34*, 53–66. [[CrossRef](#)]
54. Liberati, A.; Altman, D.G.; Tetzlaff, J.; Mulrow, C.; Gotzsche, P.C.; Ioannidis, J.P.; Clarke, M.; Devereaux, P.J.; Kleijnen, J.; Moher, D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *PLoS Med.* **2009**, *6*, e1000100. [[CrossRef](#)]
55. Peters, M.D.J. Managing and Coding References for Systematic Reviews and Scoping Reviews in EndNote. *Med. Ref. Serv. Q.* **2017**, *36*, 19–31. [[CrossRef](#)]
56. Aromataris, E.; Munn, Z. *Joanna Briggs Institute Reviewer's Manual*; The Joanna Briggs Institute: Adelaide, Australia, 2017.
57. Heinecke Thulstrup, S.; Eklund Karlsson, L. Children of imprisoned parents and their coping strategies: A systematic review. *Societies* **2017**, *7*, 15. [[CrossRef](#)]
58. Kitchenham, B.; Charters, S. *Guidelines for Performing Systematic Literature Reviews in Software Engineering*; Keele University: Keele, UK; Durham University: Durham, UK, 2007.
59. Bannister, F. Dismantling the silos: Extracting new value from IT investments in public administration. *Inf. Syst. J.* **2001**, *11*, 65–84. [[CrossRef](#)]
60. Bates, A. Bridge the gap from strategy to execution: Culture change that sticks. *Strateg. HR Rev.* **2017**, *16*, 222–228. [[CrossRef](#)]
61. Forsten-Astikainen, R.; Hurmelinna-Laukkanen, P.; Lämsä, T.; Heilmann, P.; Hyrkäs, E. Dealing with organizational silos with communities of practice and human resource management. *J. Workplace Learn.* **2017**, *29*, 473–489. [[CrossRef](#)]
62. Hwang, E.H.; Krackhardt, D. Online knowledge communities: Breaking or sustaining knowledge silos? *Prod. Oper. Manag.* **2020**, *29*, 138–155. [[CrossRef](#)]
63. Walton, P. Information evolution and organisations. *Information* **2019**, *10*, 393. [[CrossRef](#)]
64. Porck, J.P.; van Knippenberg, D.; Tarakci, M.; Ateş, N.Y.; Groenen, P.J.F.; de Haas, M. Do group and organizational identification help or hurt intergroup strategic consensus? *J. Manag.* **2020**, *46*, 234–260. [[CrossRef](#)]
65. Oksanen-Ylikoski, E.; Ylikoski, T. Tensions in creating an innovative community of vocational education and entrepreneurship. *Int. J. Innov. Creat. Chang.* **2015**, *2*, 76–82.
66. Hemon, A.; Lyonnet, B.; Rowe, F.; Fitzgerald, B. From agile to DevOps: Smart skills and collaborations. *Inf. Syst. Front.* **2019**, 1–19. [[CrossRef](#)]
67. Buchman, S.; Evans, J.M.; Mackinnon, M.; Gradin, S.; Wright, F.C. Bridging silos: Delivering integrated care to patients with cancer in Ontario, Canada. *Psycho-Oncology* **2018**, *27*, 2673–2676. [[CrossRef](#)]
68. Scott, J.M.; Hawkins, P. Organisational silos: Affecting the discharge of elderly patients. *J. Health Organ. Manag.* **2008**, *22*, 309–318. [[CrossRef](#)] [[PubMed](#)]
69. Wolak, E.; Ballard, A.; Thomas, M.; Newell, E.; Livingston, B.; Finch, D.; Hawkins, R.; Pickett, J. Breaking down departmental silos for a common purpose. *Nurse Lead.* **2012**, *10*, 32–36. [[CrossRef](#)]
70. Stoller, J.K.; Sasidhar, M.; Wheeler, D.M.; Chatburn, R.L.; Bivens, R.T.; Priganc, D.; Orens, D.K. Team-building and change management in respiratory care: Description of a process and outcomes. *Respir. Care* **2010**, *55*, 741–748.
71. Silvestro, R.; Westley, C. Challenging the paradigm of the process enterprise: A case-study analysis of BPR implementation. *Omega Int. J. Manag. Sci.* **2002**, *30*, 215–225. [[CrossRef](#)]
72. Neill, M.S.; Jiang, H. Functional silos, integration & encroachment in internal communication. *Public Relat. Rev.* **2017**, *43*, 850–862. [[CrossRef](#)]
73. Holmes, R.D.; Steele, J.G.; Exley, C.; Vernazza, C.R.; Donaldson, C. Use of programme budgeting and marginal analysis to set priorities for local NHS dental services: Learning from the north east of England. *J. Public Health* **2018**, *40*, E578–E585. [[CrossRef](#)]
74. Lara, P.; Sánchez, M.; Villalobos, J. OT Modeling: The Enterprise Beyond IT. *Bus. Inf. Syst. Eng.* **2019**, *61*, 399–411. [[CrossRef](#)]
75. Jones, H. Risking knowledge management. An information audit of risk management activities within the Hobart City Council. *Libr. Manag.* **2005**, *26*, 397–407. [[CrossRef](#)]

76. Jardine, E. The Library Leading: Knowledge Management Supporting Community College Institutional Strategy. *New Rev. Acad. Librariansh.* **2018**, *24*, 394–405. [[CrossRef](#)]
77. Jessop, J. Optimizing mining operations: Integration across the mining enterprise is key to increased productivity. *ABB Rev.* **2012**, *3*, 39–43.
78. Wanberg, J.; Javernick-Will, A.; Chinowsky, P.; Taylor, J.E. Spanning Cultural and Geographic Barriers with Knowledge Pipelines in Multinational Communities of Practice. *J. Constr. Eng. Manag.* **2015**, *141*, 10. [[CrossRef](#)]
79. Braithwaite, J.; Clay-Williams, R.; Vecellio, E.; Marks, D.; Hooper, T.; Westbrook, M.; Westbrook, J.; Blakely, B.; Ludlow, K. The basis of clinical tribalism, hierarchy and stereotyping: A laboratory-controlled teamwork experiment. *BMJ Open* **2016**, *6*, 1–10. [[CrossRef](#)]
80. Schmidt, R.; Lange, O. Account Management 2.0: From Silo Thinking to Integrated Account Development. *J. Bus. Chem.* **2014**, *11*, 77–86.
81. Hansen-Ketchum, P.A.; Halpenny, E.A. Engaging with nature to promote health: Bridging research silos to examine the evidence. *Health Promot. Int.* **2011**, *26*, 100–108. [[CrossRef](#)]
82. Paine, L.A.; Baker, D.R.; Rosenstein, B.; Pronovost, P.J. The Johns Hopkins Hospital: Identifying and addressing risks and safety issues. *Jt. Comm. J. Qual. Saf.* **2004**, *30*, 543–550. [[CrossRef](#)]
83. Sy, T.; D’Annunzio, L.S. Challenges and Strategies of Matrix Organizations: Top-Level and Mid-Level Managers’ Perspectives. *Hum. Resour. Plan.* **2005**, *28*, 39–48.
84. Towse, A. The efficient use of pharmaceuticals: Does Europe have any lessons for a medicare drug benefit? *Health Aff.* **2003**, *22*, 42–45. [[CrossRef](#)]
85. Sagarik, D.; Chansukree, P.; Cho, W.; Berman, E. E-government 4.0 in Thailand: The role of central agencies. *Inf. Polity* **2018**, *23*, 343–353. [[CrossRef](#)]
86. Parks, R.; Wigand, R.T.; Othmani, M.B.; Serhier, Z.; Bouhaddou, O. Electronic health records implementation in Morocco: Challenges of silo efforts and recommendations for improvements. *Int. J. Med. Inform.* **2019**, *129*, 430–437. [[CrossRef](#)]
87. Berndt, A.E.; Parsons, M.; Golightly-Jenkins, C. Evaluating an Innovative Educational Strategy for Health Care Organizations. Building Bridges Across Historical Silos for Quality. *Perioper. Nurs. Clin.* **2012**, *7*, 315–325. [[CrossRef](#)]
88. Gray, B. Enhancing Transdisciplinary Research Through Collaborative Leadership. *Am. J. Prev. Med.* **2008**, *35*, S124–S132. [[CrossRef](#)]
89. Kelty, S.F.; Julian, R.; Ross, A. Dismantling the Justice Silos: Avoiding the pitfalls and reaping the benefits of information-sharing between forensic science, medicine and law. *Forensic Sci. Int.* **2013**, *230*, 8–15. [[CrossRef](#)]
90. Livingstone, M.; Dibkey, B. Utilising performance measurement to drive operational excellence in a post-merger environment. *J. Facil. Manag.* **2002**, *1*, 131–141. [[CrossRef](#)]
91. Harris, P. Holistic skills management comes of age. *T AND D* **2007**, *61*, 46–51.
92. Sayles, J.S.; Baggio, J.A. Who collaborates and why: Assessment and diagnostic of governance network integration for salmon restoration in Puget Sound, USA. *J. Environ. Manag.* **2017**, *186*, 64–78. [[CrossRef](#)] [[PubMed](#)]
93. Fisher Iii, W.W.; Oberholzer-Gee, F. Strategic management of intellectual property: An integrated approach. *Calif. Manag. Rev.* **2013**, *55*, 157–183. [[CrossRef](#)]
94. Thong, R.; Lotta, T. Creating a Culture of Productivity and Collaborative Innovation. *Res. Technol. Manag.* **2015**, *58*, 41–50. [[CrossRef](#)]
95. Garrido, A.L.; Sangiao, S.; Cardiel, O. Improving the Generation of Infoboxes from Data Silos through Machine Learning and the Use of Semantic Repositories. *Int. J. Artif. Intell. Tools* **2017**, *26*, 28. [[CrossRef](#)]
96. Scholtz, B.; Calitz, A.; Haupt, R. A business intelligence framework for sustainability information management in higher education. *Int. J. Sustain. High. Educ.* **2018**, *19*, 266–290. [[CrossRef](#)]
97. Güngör, K.; Hotez, P.J.; Özdemir, V.; Aynacıoğlu, Ş. Glaucomics: A Call for Systems Diagnostics for 21st Century Ophthalmology and Personalized Visual Health. *Omics J. Integr. Biol.* **2014**, *18*, 275–279. [[CrossRef](#)]
98. Connell, J.; Voola, R. Strategic alliances and knowledge sharing: Synergies or silos? *J. Knowl. Manag.* **2007**, *11*, 52–66. [[CrossRef](#)]
99. Kreindler, S.A.; Dowd, D.A.; Dana Star, N.; Gottschalk, T. Silos and social identity: The social identity approach as a framework for understanding and overcoming divisions in health care. *Milbank Q.* **2012**, *90*, 347–374. [[CrossRef](#)]

100. Marren, J.P.; Feazell, G.L.; Paddock, M.W. The hospital board at risk and the need to restructure the relationship with the medical staff: Bylaws, peer review and related solutions. *Ann. Health Law* **2003**, *12*, 179–234.
101. Vatanpour, H.; Khorramnia, A.; Forutan, N. Silo effect a prominence factor to decrease efficiency of pharmaceutical industry. *Iran. J. Pharm. Res.* **2013**, *12*, 203–212.
102. Borgatti, S.P.; Everett, M.G.; Johnson, J.C. *Analyzing Social Networks*; Sage: Thousand Oaks, CA, USA, 2018.
103. Jokar, E.; Mosleh, M. Community detection in social networks based on improved Label Propagation Algorithm and balanced link density. *Phys. Lett. A* **2019**, *383*, 718–727. [[CrossRef](#)]
104. Krapfl, J.E.; Cooke, J.; Sullivan, T.; Cogar, W. Iterative Processes and Reciprocal Controlling Relationships in a Systemic Intervention. *J. Organ. Behav. Manag.* **2009**, *29*, 136–154. [[CrossRef](#)]
105. Vasu, M.L.; Stewart, D.W.; Garson, G.D. *Organizational Behavior and Public Management, Revised and Expanded*; Taylor & Francis: Abingdon, UK, 2017.
106. Bundred, S. Solutions to silos: Joining up knowledge. *Public Money Manag.* **2006**, *26*, 125–130. [[CrossRef](#)]
107. Houmanfar, R.A.; Rodrigues, N.J.; Smith, G.S. Role of communication networks in behavioral systems analysis. *J. Organ. Behav. Manag.* **2009**, *29*, 257–275. [[CrossRef](#)]
108. Gyrd-Jones, R.I.; Helm, C.; Munk, J. Exploring the impact of silos in achieving brand orientation. *J. Mark. Manag.* **2013**, *29*, 1056–1078. [[CrossRef](#)]
109. Miller, L.C.; Jones, B.B.; Graves, R.S.; Sievert, M.C. Merging silos: Collaborating for information literacy. *J. Contin. Educ. Nurs.* **2010**, *41*, 1–6. [[CrossRef](#)] [[PubMed](#)]
110. Lank, E.; Randell-Khan, J.; Rosenbaum, S.; Tate, O. Herding cats: Choosing a governance structure for your communities of practice. *J. Chang. Manag.* **2008**, *8*, 101–109. [[CrossRef](#)]
111. de Waal, A.; Weaver, M.; Day, T.; van der Heijden, B. Silo-busting: Overcoming the greatest threat to organizational performance. *Sustainability* **2019**, *11*, 6860. [[CrossRef](#)]
112. Tagliabue, M.; Squatrito, V.; Presti, G. Models of cognition and their applications in behavioral economics: A conceptual framework for nudging derived from behavior analysis and relational frame theory. *Front. Psychol.* **2019**, *10*, 2418. [[CrossRef](#)]
113. Abernathy, W.B. Walden Two Rrvisited: Optimizing behavioral systems. *J. Organ. Behav. Manag.* **2009**, *29*, 175–192. [[CrossRef](#)]
114. Krispin, J.V. Rules, consequences, and feedback dynamics: Putting principles of behavior systems analysis and complexity to work in designing adaptable organizations. In Proceedings of the 46th Annual Conference of the Association of Behavior Analysis International, Washington, DC, USA, 24 May 2020.
115. Rothstein, H.R.; Hopewell, S. Grey Literature. In *The Handbook of Research Synthesis and Meta-Analysis*, 2nd ed.; Russell Sage Foundation: New York, NY, USA, 2009; pp. 103–125.
116. Diamond, M.A.; Stein, H.F.; Allcorn, S. Organizational silos: Horizontal organizational fragmentation. *J. Psychoanal. Cult. Soc.* **2002**, *7*, 280–296.
117. Grimshaw, J. *A Guide to Knowledge Synthesis: A Knowledge Synthesis Chapter*; Canadian Institutes of Health Research: Ottawa, ON, Canada, 2010. Available online: [www.cihr-irsc.gc.ca/e/41382.html](http://www.cihr-irsc.gc.ca/e/41382.html) (accessed on 4 May 2020).
118. Tricco, A.C.; Lillie, E.; Zarin, W.; O'Brien, K.K.; Colquhoun, H.; Levac, D.; Moher, D.; Peters, M.D.J.; Horsley, T.; Weeks, L.; et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann. Intern. Med.* **2018**, *169*, 467–473. [[CrossRef](#)] [[PubMed](#)]
119. Thaler, R.H.; Sunstein, C.R.; Balz, J.P. Choice architecture. *SSRN Electron. J.* **2010**, 1–17. [[CrossRef](#)]
120. Daniels, A.C. *Performance Management: Changing Behavior that Drives Organizational Effectiveness*, 5th ed.; Performance Management Publications: Atlanta, GA, USA, 2014.
121. Baranowski, T. Reciprocal determinism at the stages of behavior change: An integration of community, personal and behavioral perspectives. *Int. Q. Community Health Educ.* **1990**, *10*, 297–327. [[CrossRef](#)] [[PubMed](#)]
122. Wood, R.; Bandura, A. Social cognitive theory of organizational management. *Acad. Manag. Rev.* **1989**, *14*, 361–384. [[CrossRef](#)]

