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Reverse Innovation in Retrospect and Prospect Quo Vadis?

Bas Tijhof, Zenlin Kwee , and Cees van Beers

Abstract—Reverse innovation (RI) is considered as an innovation originally designed and developed for low-income customers living in severely resource-constrained environments in emerging and developing countries' markets, with the potential to be diffused in developed markets. After more than a decade of academic studies, the potential role of RI in creating higher impact global innovations has progressively advanced. With the upsurge in research on RI, there is a need for scholars and business practitioners to retrospectively reflect on existing/current research state and prospect for future research directions. In this article, we examine the existing conceptualization and research landscape of RI to further identify and map future research directions. First, through a bibliometric review of a decade of research (2009–2019), we provide insights into the evolution of research topics in the field of RI including the identification of main research streams, influential scholars and works, important scholarly associations, and collaborative networks. Second, we combine these bibliometric findings with structural hole theory, weak ties, and social network analysis to derive future research lines on RI.

Index Terms—Bibliometric analysis, developed markets (DMs), emerging and developing markets, frugal innovation, multinational corporations (MNCs), research and development, reverse innovation (RI).

I. INTRODUCTION

COINED by Immelt et al. [1], reverse innovation (RI) is referred to as an innovation that is designed, developed, and produced for and in emerging markets (EMs), and subsequently diffused or trickled back to developed markets (DMs). In this sense, RI is considered as the antithesis of glocalization. Under glocalization, multinational corporations (MNCs) initially develop products for customers in developed countries and then distribute them to the rest of the world (including emerging and developing countries) by making adjustments to match better with local preferences.

Since its introduction, RI has gained growing interests from both business practitioners and scholars. In the face of recent

global adversities, such as COVID-19 pandemic, global energy crises, Russian–Ukraine war, and volatile global economy, a frugal approach to innovation offered by RI [2] is considered to have a potential to deal with today's unprecedented situations [3], [4]. Designed under extreme resource constraints in developing countries [5], RI can provide effective solutions to sustainability and efficiency improvements in the Global North.

From the business perspective, the premise of RI is appealing for MNCs as RI can be an emerging source of sustained competitive advantage. RI enables MNCs to: 1) gain knowledge of innovative technical and design processes in countries in the Global South; 2) tap into new and large potential customer bases in emerging and developing markets (e.g., China, India, Africa, Indonesia, Brazil, Mexico); and 3) potentially transfer the innovations back to DMs or across countries globally. Despite these promising advantages, there are several challenges that MNCs may encounter to develop RIs. For instance, RI may require risk-taking and alteration of organizational structure, culture, and even potential product cannibalization [6], [7], [8].

In parallel, scholars have increasingly been studying RI and producing a vast amount of literature. This evolving literature is fragmented by various scientific disciplines trying to develop an operational definition and specifying the necessary conditions for an innovation to qualify as an RI [9]. As a result, various research challenges exist. First, literature debating and theorizing the concept of RI has been limited so far [8], [10], [11], [12]. Second, due to the newness of the concept, both conceptual and empirical research works on RI have been mostly descriptive. Third, the limited availability of RI empirical data has produced anecdotal literature, which is unsatisfactory in describing the underlying dimensions of RI that define it as a construct [9], [13]. These issues have led to scholars and practitioners struggling to reach agreement, consistency, and standardization of RI concepts and guidelines, thereby aggravating further fragmentation of the research field and hinders further advancement.

The rationale of the present article is to examine the structure of the RI research field in a systematic way in order to shed light on: 1) the conceptual issues surrounding RI; 2) how they are related to scholars, publications, and research domains; and 3) potential for future research direction. The research questions are twofold: First, how has the RI research landscape developed and evolved over time?; and second, given what we have known from the existing studies, what are potential future research directions to gain further insights into RI? Accordingly, this article has two main objectives: first, examine the conceptual development and evolving structural state of the RI research landscape, and

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second, identify future research directions that scholars need to focus on for further advancement of the field.

To this end, we conducted a bibliometric analysis of 208 articles published in the 2009–2019 period to provide a quantitative and visual framework for evaluating the research landscape of RI. Bibliometrics as a method of analysis is chosen for three reasons. First, analyzing bibliographic data gains insights into productivity, impact, influence of researchers, institutions, collaborated networks, and interrelated research areas [14]. Second, analyzing the data and visualizing patterns enable us to understand the evolution of RI research, the emergence of new subfields, and the interdisciplinary nature of RI research area [15], [16], [17]. Finally, through bibliometric findings in combination with structural hole theory, weak ties, and social network analysis, we identify research gaps and propose future research directions to effectively advance the field [18]. In essence, this article contributes to providing a systematic mapping of the RI research landscape that leads to the identification of research gaps and potential research directions.

The rest of this article is organized as follows. In Section II, we provide a synthesis of existing RI research to highlight multifaceted conceptions of RI. In Section III, the data and the bibliometric methods used to analyze the literature are explained. Section IV describes the conceptual structure of the RI landscape. In addition, we use a bibliographic cluster analysis to analyze the research streams in the field and to present additional bibliometric insights into the network structures, progression of RI research, influential scholars, notable topics, and the recent trends in the literature. Section V presents the key findings of the various analyses and avenues for future research. Finally, Section VI concludes this article.

II. MULTIFACETEDNESS OF REVERSE INNOVATION

Since coined by Immelt et al. [1], research on RI has thrived over the years. The concept of RI is a multifaceted phenomenon [8], with potential multiple dimensions that can be explored in RI research. These dimensions are technological strategies, organizational attributes, and the importance of environment and RI externalities. Diverse topics are being studied both conceptually as well as real practice applications, which include topics such as RI typology [11], business models [19], drivers and barriers of RI [20], the link between RI and frugal innovation [12], and applications of RI in healthcare [21].

The key premise of RI is to create products that are technically good products at low costs (i.e., good-value instead of superior products) under severe resource-constraints environment in emerging and developing countries' markets that can further be diffused and adopted globally, including DMs [9], [12]. Compared to using traditional innovation approaches that come with relatively high prices for both producers and consumers due to overengineering, RI is appealing to MNCs as they now have an alternative to innovate differently (e.g., cost-efficient, sustainable).

Conceptually, RI is strongly related to frugal innovations that are aimed to overcome severe resource constraints in developing countries. Frugal innovations design and process products, services, and systems that include functionality requirements of

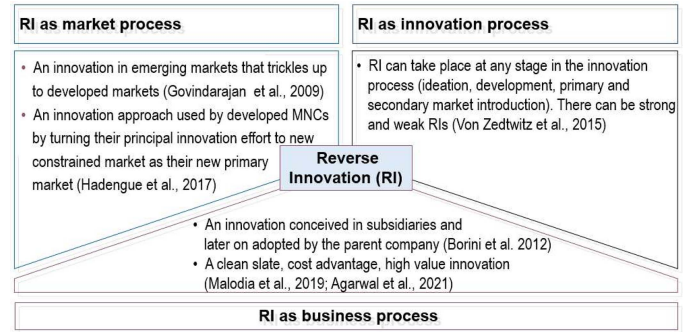


Fig. 1. Multifaceted conceptions of RI.

customers in the bottom-of-the-pyramid (BOP), i.e., those who have to live on about USD2 per day in 1990s prices [2], [22]. Successful frugal innovations have the potential to be applied beyond the market for and in which they were developed. Hence, frugal innovations can become RI. One of the most fruitful RI applications is a portable electrocardiogram MAC 400. It is an innovative healthcare device that resulted from the joint venture between American MNC General Electric Healthcare (GE Healthcare) and India-based enterprise Wipro Limited in 1990 [7]. Although originally the GE-Wipro team developed MAC 400 at an affordable price to serve patients in remote rural areas in India, the product was later successfully adopted in the U.S. market.

The frugal approach to design and innovation offered by RI [2] is considered to have a potential to deal with dominant economic and societal problems today. First, it can be a remedy against the declining efficiency in innovation processes observed in many developed country markets due to overengineering [23], [24]. Second, the increasing potential of frugal innovation as a prestige of RI can fulfil the preferences of new low-income customers in developed countries. Further, the recent unprecedented situations created by the COVID-19 pandemic and the Ukraine War in the global economy have revealed the importance of RI [3], [4]. For example, both the COVID-19 pandemic and the Ukraine War disturbed the proper functioning of global value chains, leading to shortages of essential intermediate and final goods and consequently rising prices. These events have stimulated a call to invest in resilience of global value chains by, for example, shifting production away to politically less sensitive areas. However, this shift comes at the expense of higher production costs. In this respect, the frugal characteristics of RI as a way of technically and organizationally innovating can help build resilient and cost-effective value chains.

The present confusion surrounding the topic of RI stems from its complex and multifaceted nature. There are varying interpretations and understandings of the RI concept (see Fig. 1) leading to different perspectives in the literature. RI is described as a market process focusing on the products delivered to different markets in the Global South and North. Another one is the focus on the innovation process itself, which can constitute strong and weak forms of RI (depending on how many stages in the innovation process have RI characteristics). As a business

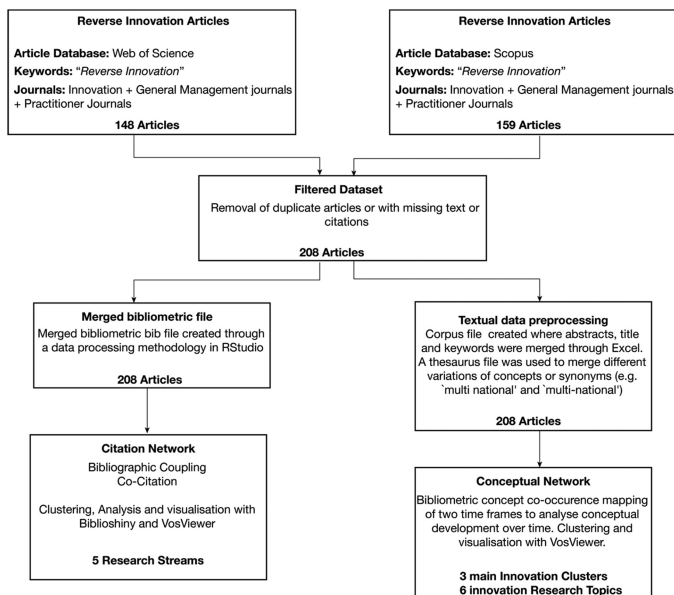


Fig. 2. Data collection and analysis of articles on RI.

process, RI is related to the places in the MNC's organization where it can occur. We utilize a bibliometric analysis entailing bibliometric activity indicators and visualization of similarities (VOS) to examine this multifacetedness and classify the RI research landscape. This includes mapping conceptual issues and structural trends and relating them to research fields and clusters. Such a comprehensive and detailed examination of the literature on RI enables us to identify promising research areas/clusters.

III. BIBLIOMETRIC REVIEW PROCESS: DATA AND METHODS

Our review and analysis is based on concept density mapping, a bibliometric analysis of bibliometric activity indicators and the VOS. We use a five-step process to explore the RI literature and present bibliometric results.

As a first step, the literature on RI was browsed in April 2020 from two key bibliographic databases: ISI Web of Science and Elsevier's Scopus (see Fig. 2). Although there are other databases available for bibliometric analysis, Web of Science and Scopus are often favored due to their comprehensive coverage, high-quality data, citation tracking capabilities, advanced analysis tools, and established reputation in the academic community [25]. However, when reviewing the articles in each database, the coverage was quite different. Scopus had a strong focus on publications related to healthcare, whereas ISI Web of Science does not contain any conference proceedings. To ensure comprehensiveness, we decided to use data from both databases for this study. To do this, we developed a merging and formatting procedure.

In the second step, we defined the search query and collected the data. Due to RI being a fairly new topic, we decided to have the term "Reverse Innovation" in titles, abstracts, and keywords by applying the operator "TS" to retrieve all the relevant materials. The period 2009–2019 is chosen to reflect on

a decade of RI research and also to ensure sufficient timespan for proper citation data. The search documents were further confined to the English language and to the "articles" classification but without distinguishing scientific disciplines. After defining these boundaries, we conducted the data collection procedure in early May 2020. Our search query resulted in 148 publications from the ISI Web of Science Core Collection database. For the same search query, Scopus yielded 189 publications. As two databases were used with overlapping publications and with different output file formats, a cleaning and formatting procedure was done [26]. To start, we exported all the resulting data to Excel and ordered all publications based on their DOI to identify duplicates in both datasets. To merge all the data into one dataset for VOSviewer readable text file, Rstudio software and the Bibliometrix package were used. When testing the file, some errors were given: proclaiming missing data (e.g., publication year of documents). These missing data points were manually added resulting in a file containing 208 publications.

The third step was creating a corpus file for VOSviewer to develop concept density maps. Concept density maps offer a visually intuitive and comprehensive approach to explore research trends. The maps provide researchers with a powerful tool to identify, analyze, and interpret the dynamics of knowledge generation within a specific research domain. We conducted this third step by extracting all abstracts, titles, and keywords of publications obtained from the previous collection method and merging them into one text file. For VOSviewer to recognize the file, we opened the saved file and removed the first line in the original plain text file: FN Thomson Reuters Web of Science VR and replaced it with FN ISI Export Format VR. Furthermore, we changed the encoding to ANSI. Here, the only difference is that the merged file contains all bibliometric data, whereas the corpus file contains only text found in the corpus of the literature. A thesaurus file was created and used to merge different variations of concepts or synonyms (e.g., "multi national" and "multi-national"). This is useful when certain concepts are spelled differently or when various terms have the same meaning. Additionally, the thesaurus file was used to remove terms that distorted the maps and did not add any conceptual meaning (e.g., articles like "a," "an," "the"). We further divided the selected time period into two distinct timeframes. The first timeframe, the 2009–2014 period, was created to analyze the growth phase of RI, indicating a period when the concept gained traction and generated increased scholarly interest. The second timeframe, the 2015–2019 period, was created to represent a more stabilized phase in the literature of RI and identify an evolution in conceptual interest.

The fourth step is the bibliometric analysis of the 208 papers. The bibliometric analysis and visualization was done by using Bibliometrix/Biblioshiny and VOSviewer. We used VOSviewer for its great visualization capabilities [16], [27]. Additionally, we also used Bibliometrix and its user interface Biblioshiny as they provide the most extensive suite of techniques for various bibliometric networks and multiple analytical methods [27], [28]. We performed three types of bibliometric analyses: concept cooccurrence analysis, cocitation analysis, and bibliographic

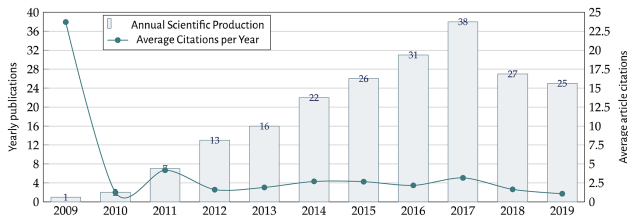


Fig. 3. Yearly publications and the average citation count per year on RI.

coupling analysis. Cooccurrence analysis, a quantitative method using a corpus file, identifies associations between coupled words in a source text. It employs cluster detection algorithms to create conceptual maps, revealing the research field's central concepts and their interrelationships. This helps in understanding the knowledge flow and evolution within a research domain. Cocitation analysis clusters citations based on cocitations in source papers, offering insights into the intellectual structure and emerging trends. Bibliographic coupling analysis identifies similarities by examining common references between publications, shedding light on research streams.

In the fifth step, the key research topics for each of the five clusters were identified through a qualitative review. All 208 papers were independently read. A list of potential topics summarizing the cluster content was created. Internally, we had team meetings to reach a consensus on the research topic for each cluster. In relation to the conceptual descriptions in clusters, we reviewed each paper in the dataset to find out how the clusters are related to our conceptual findings. We then compiled a comprehensive summary of the most influential findings during the review period. This enables us to uncover promising future research directions.

IV. RESULTS: RI IN RETROSPECT (2009–2019)

A. Decade of Development in RI Research Based on Publication Year, Journal, and Country

Fig. 3 shows the number of RI publications published per year in our datasets and the annual average citation count. The first paper published on RI was the one by Immelt et al. [1], which has the highest average citation count per year. Since then, the number of publications has experienced steady growth. However, as of 2018, a decline can be observed. External phenomena have been proposed to affect the advancement of scientific research [29] but the reason for the decrease in publications remains unclear.

Table I lists the top ten journals in which RI papers were published. These account for 54 out of 208 papers or 26% of all RI publications in our database. *Globalization and Health* is the most prominent journal with 20 papers. The remaining 154 publications were published in 136 different journals.

Fig. 4 visualizes that 107 publications of all 208 publications (47%) were from the top three countries: i.e., U.S., U.K., and Germany. In total, 501 authors had published on RI and a high degree of collaboration exists as on average 2.41 authors wrote a single publication. The source publications featured citations to 8834 different works.

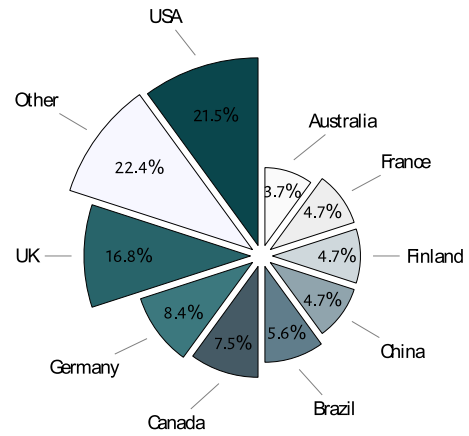


Fig. 4. Publications based on contributing countries.

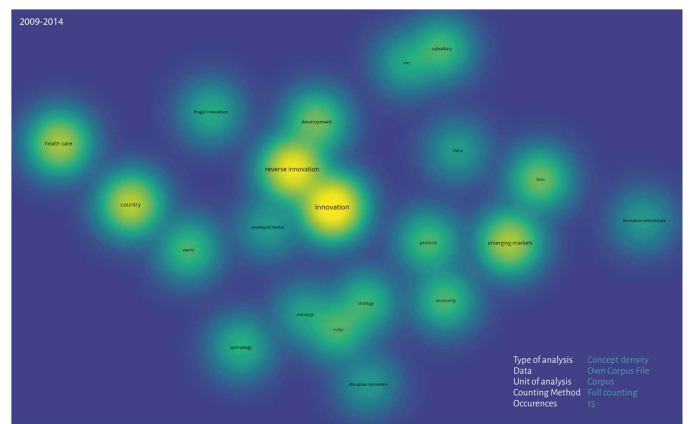


Fig. 5. Concept density map of RI literature (2009–2014) with a keyword occurrence of 15 included in the map (Constructed with VOSviewer).

B. Conceptual Structure of RI Research

This section describes the conceptual structure of the field and the evolution of the field over the last decade. Here, we divided the period 2009–2019 into two timeframes: 2009–2014 and 2015–2019. The first timeframe (2009–2014) was considered as the growth phase of the RI concept, whereas the second timeframe (2015–2019) is the period when the literature of RI became more stabilized. The division of these two timeframes enables us to analyze the conceptual development of RI over time.

In order to determine the conceptual structure of the RI field, we conducted a cooccurrence analysis. The relatedness of the words is calculated by counting the number of times the respective words occur together in the titles, abstracts, and keywords. The greater the number of cooccurrences, the stronger their relationship becomes. Visualization is done by positioning the words based on similarity on a two-dimensional map. The size of the word is the occurrence and defines the importance of an item. The distance between the words in the visualization indicates their relatedness. The closer two items appear, the stronger their relatedness is.

1) *Conceptual Structure of the First Timeframe (2009–2014):* The concept density map of 2009–2014 (see Fig. 5) shows 21

TABLE I
TOP TEN JOURNALS PUBLISHING ON RI (2009–2019)

Journal	Articles (#)	Percentage (#/208)	H- index	JIF 2019	Citations	First publication year
1. Globalization and Health	20	9.62 %	12	2.650	340	2013
2. Research Technology Management	10	4.81 %	4	2.650	116	2012
3. Journal of Cleaner Production	5	2.40 %	5	2.650	155	2016
4. International Journal of Automotive Technology And Management	3	1.44 %	3	0.740	14	2014
5. Journal of Product Innovation Management	3	1.44 %	3	5.270	134	2012
6. Harvard Business Review	3	1.44 %	2	13.210	272	2009
7. International Journal of Innovation Management	3	1.44 %	2	1.300	5	2015
8. Journal of Innovation Economics and Management	3	1.44 %	2	1.059	14	2012
9. BMJ Innovations	2	0.96 %	2	1.760	13	2017
10. Future Medicinal Chemistry	2	0.96 %	2	3.040	25	2010
Total represented in journals	54	25.96%				

terms with an occurrence greater than 15. Note that by default, VOSviewer reduces the terms to the most relevant 60% and this gives a cooccurrence threshold of 15. We used this as a default option in order to reduce subjectivity in the results. In the first timeframe of 2009–2014, the field had a scattered conceptual structure and there was no clear structural division among the clusters. The central part of the map (RI, innovation, and development) contains the most frequently occurring and related terms. Also, some market characteristics can be seen in the map: “EMs,” “country,” and “DMs.” This is as expected as these terms describe the fundamental basis of RI, i.e., the reverse pattern of introduction and diffusion.

Other innovation types have also been relevant in this first period. “*Disruptive innovation*” and “*Frugal innovation*” can be observed as separate terms. These types were related to RI early on, as efforts were directed at exploring how RI is connected to other innovation types [7], [12], [30], [31], [32], [33].

A major research domain appears to form around healthcare but it is quite separate on the map. Interestingly, also the relationship between an MNC and its subsidiary is indicated. This relates to research on how RI should be managed within large organizations. China and India are the only countries represented on the map. China is found somewhat separate, whereas India has a more interesting position on the map. The position of India is related to the initial conceptualization of RI [1]. They describe RI as a strategy to face the challenges in EMs and

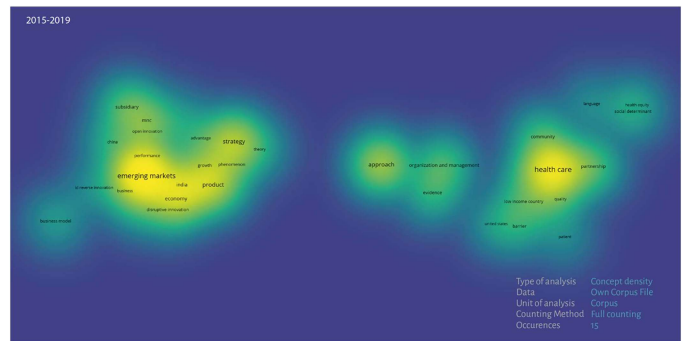


Fig. 6. Concept density map of RI literature (2015–2019) with a keyword occurrence of 15 included in the map (Constructed with VOSviewer).

use predominantly case studies in India. Finally, the higher occurrence of the terms *technology* and *product* indicates that RI mostly describes innovations that are technological products.

2) *Conceptual Structure of the Second Timeframe (2015–2019)*: Reviewing the map of the 2015–2019 period in Fig. 6 reveals some structural changes. In particular, the map displays a more distinct conceptual structure that can be categorized into three clusters: 1) the *conceptual development of RI* on the left-hand side; 2) *organizing for RI* in the middle; and 3) the *healthcare sector* on the right-hand side.

In the first cluster, the term “frugal innovation” that was found in the first timeframe (2009–2014) has disappeared, whereas “disruptive innovation” and “open innovation” have emerged indicating that their connection with RI has gained increasing interest among scholars. The location of the term “open innovation” is positioned near MNC and subsidiary. The idea of open innovation, i.e., the use of information inflows and outflows to drive internal innovation and extend markets to use technologies externally [34], is apparently of interest to the organizational relationships between an MNC and its subsidiary. It refers to the idea of using local market knowledge obtained through a subsidiary in other areas of an organization.

Furthermore, consistent with the findings of the first timeframe, China and India are represented again as the most common countries where RI comes from. This signifies that most case studies are based on RIs in India and China. Both India and China are large markets of many potential BOP users. The size of the markets mitigates the risks of RI as compared to smaller markets of BOP customers. As the seminal paper by Immelt et al. [1] builds upon this GE example, this may also explain the emergence of India and China in the healthcare sector.

An interesting notion is that in recent years, RI has not only been described as a strategy but also as a phenomenon. This suggests a conceptual indistinctness, i.e., whether RI is something that can be pursued (strategy) or occurs (phenomenon). The term “strategy,” however, is still more dominant than the term “phenomenon.” Within the structural domain, some business terms are also represented: growth, performance, and business. These terms are closely related to the term “EMs” indicating business possibilities in these markets. The term “product” in the map is also consistent with product innovations being commonly described in the RI literature. Separate from this cluster is the term “business model,” which implies the need of different business models for RI as compared to standard innovation.

The second cluster shows associations between the terms “approach,” “organization and management,” and “evidence.” For RI to emerge, research on management and organizations is important and still not yet studied intensively. There are also some studies that aim at identifying and developing a global approach to RI as well as gathering empirical evidence from RI practices.

“Healthcare”—the third cluster—has many occurrences in Fig. 6. Since the introduction of RI, healthcare products have been associated with the first products of RI. In recent years, this research interest has increased in importance and also extended to healthcare services due to their cost-effectiveness and efficient and adaptable solutions used in EMs [35], [36]. This extension is relevant as health systems in DMs endure intensifying resource constraints (e.g., safety and reliability regulations), which foster the adoption of innovations and practices from EMs [37], [38]. In relation to healthcare, the terms “community” and “partnership” have the most occurrences. Besides revolutionary cost savings, RI is also a source of innovative ideas for DMs (e.g., portable heart cardiographs in USA), which can be achieved more effectively through partnerships with communities in EMs. The terms “barrier” and “quality” are also highly occurring in Fig. 6 and closely positioned to healthcare. General barriers to RI include

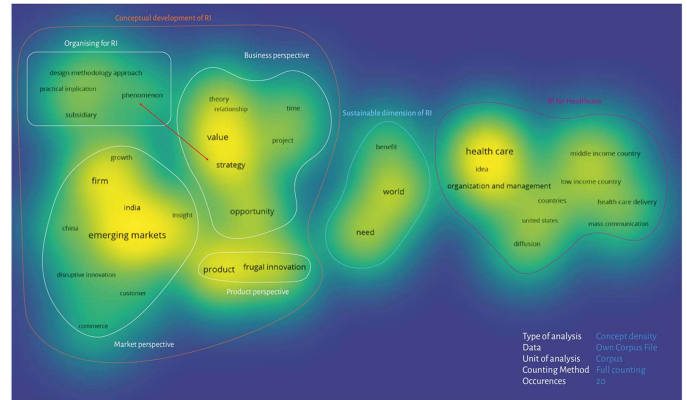


Fig. 7. Concept density map 2009–2019.

challenges in recognizing the potential and adoption of these innovations, for instance, the idea that low-resource countries’ technologies are not appropriate for high-income settings [37], [38], [39].

In sum, the structural associations in the RI field have become more distinct in the 2015–2019 period. Emerging new research areas appear to be healthcare and further conceptual development of RI as open innovation and disruptive innovation seem to have more scholarly interest than frugal innovation. Conceptual clarification is required where RI is described either as a phenomenon or as a strategy.

3) *Overall Conceptual Structure of the RI Field (2009–2019): Three Distinctive Clusters:* Fig. 7 shows the combined two timeframes (2009–2019), i.e., an overall view of the RI research field. Due to the data aggregation of the two timeframes, this time the concept occurrence has been set to a threshold value of 20 for items to be included in the map.

There are three main distinctive clusters identified in the 2009–2019 period: 1) conceptual development of RI, 2) sustainable dimension of RI, and 3) RI for healthcare. Compared to Fig. 6 (2015–2019 period), there are some differences in the occurrence of the concepts and their structural associations, as can be observed in Fig. 7.

Cluster 1 is the *conceptual development* cluster and can be divided into three perspectives and one main part of organizing for RI.

- 1) *Product perspective:* The terms “product” and “frugal innovation” are closely associated with Fig. 7, indicating that RI is a process of product innovations with frugal characteristics.
- 2) *Business perspective:* Within the business perspective cluster, the term “strategy” has a high occurrence in which RI is viewed as a strategy that enables competitive advantage opportunities. Next, “value” has a high occurrence, which suggests the notion of value creation in RI. The product perspective and business perspective are largely associated with the term “opportunity,” i.e., RIs provide business opportunities [7], [11], [12], [37], [40], [41].
- 3) *Market perspective:* Regarding the market perspective, geographic keywords, such as India, China, and Ems, are clearly present. Another notable term is “disruptive

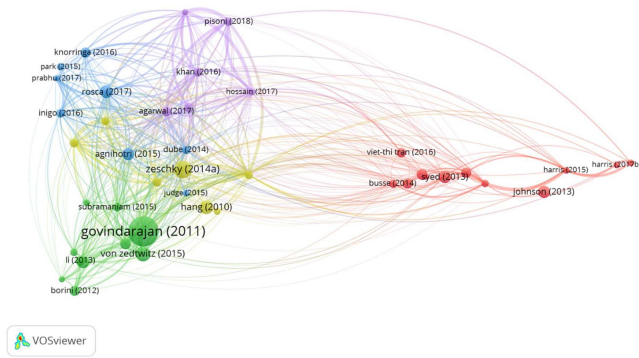


Fig. 8. Bibliographic coupling network.

innovation” which indicates an emerging research idea to explore how disruptive RI is in existing markets.

- 4) *Organizing for RI*: In this part, the terms “design methodology approach” and “practical implications” of RI are two notable terms shown. RI is referred to as a phenomenon, whereas in the business perspective cluster, RI is considered as a strategy. The difference is that from a business perspective, RI needs to be an outlined strategy to reduce the risk, whereas from an organizing perspective, researchers are more interested in the causes or explanations of why RI happens. Furthermore, the term “subsidiary” is apparent in the map which suggests that an interest exists in describing the organizational relationships between MNC and subsidiaries.

Cluster 2 contains terms relating to the *sustainable dimension of RI*. Terms, such as “benefit,” “world,” and “need” describe the possibility of enhancing sustainability through RI. Despite the smaller size of the cluster, as a central theme in the map, the sustainable dimension is of importance to both healthcare and the conceptual development of RI.

Cluster 3 relates to *RI for healthcare*. The term “idea” has a large occurrence which exemplifies that within healthcare, scholars indicate that EMs are not merely interesting for resource-constrained product innovations but also for resource-constrained ideas (regarding technologies, processes, models, and/or policies). Interesting to note here is that while RI means the transfer of an innovation in the industrial/managerial domain, RI in the context of healthcare may also mean the reversal of flow of ideas and policies [35], [42]. It is not only the production and use of low-cost equipment but also the adaption of (too) stringent policies for application of the reversed engineered equipment. This is coherent with the size of the term “organization and management” (of ideas).

C. Bibliographic Network of RI Research

1) *Bibliographic Coupling Analysis*: The bibliometric method in Section IV-B has not yet included the information about scholars and their connection to the previously identified conceptual structures. Therefore, we conduct a bibliographic coupling analysis that distinguishes similarities in the field.

As shown in Fig. 8, five clusters can be observed: red, green, yellow, blue, and purple. The distance between the clusters

indicates how (dis)similar one cluster is to another. For instance, the red cluster is highly dissimilar to the other clusters and has a higher relative similarity with the yellow (relation RI to other innovation typologies) and purple (frugal innovation). Also, the red cluster has a great dissimilarity with the blue cluster (frugal product characteristics) that suggests healthcare being mostly invested in organizational practices and less in product characteristics.

The red cluster is the largest cluster and represents scholars whose research stream focuses on healthcare applications for RI. Syed et al. [38] were the first to describe the value of RI for healthcare as they emphasized that the developed world could learn greatly from the knowledge and practices in the developing world. Other papers [43], [44], [45] discuss how to manage human resources in healthcare based on practices in EMs. This confirms our earlier conceptual findings, i.e., the healthcare research stream does not only entail the reversal of information flows to medical product innovations only (e.g., [46]) but also indicates and studies the value of EM organizational practices and ideas for DMs. Within the healthcare cluster, EM innovations encounter quality biases where people deem these innovations as inferior on the basis of their country of origin. Examples are studies that focus on policies for RI, biases, and perception barriers [47], [48], [49], [50].

The green cluster in Fig. 8 (the second largest cluster) represents scholars who study the foundational aspects of RI and thus corresponds to its conceptual development. The biggest dot represents the founding paper by Govindarajan et al. [10]. Later on, Von Zedtwitz et al. [11] have enhanced the theoretical concept of RI by indicating that the reversal can occur at any stage in an innovation process. It is important to note that this research stream is associated primarily with technological product innovations [51], [52], [53], [64]. Other papers [53], [54], [55] have described the value of RI and why RI has value for MNCs.

The yellow cluster focuses on scholars who identify relations of RI to other innovation typologies. This is either done through overarching qualitative reviews of literature [8], [56] or examining direct relations. Within this stream, disruptive innovation theory plays an important role and various scholars relate RI theory to disruptive innovation theory [30], [33]. Reverse knowledge flows and open innovation are also part of this research stream [57]. It also contains publications that investigate EM business models [58], [59].

The blue cluster represents scholars who focus on frugal innovation, i.e., mostly on frugal product characteristics [41], [60]. Within this cluster, the sustainable dimension of frugal and RI is also studied [19], [61], [62], [63].

The purple cluster is the smallest one and overlaps with the blue cluster. It contains scholars who review the concept of frugal innovation [2], [64], [65] and their possible diffusion patterns [66]. Other researchers in this stream [2], [67], [68] describe the sustainable performance of frugal innovations.

When we cross link these five-color clusters with the previous three clusters in Fig. 7, we observe the linkage of the two categories of clusters (see Table II). The red cluster is closely associated with Cluster 3 (RI for healthcare). The green and

TABLE II
LINKAGES BETWEEN THE FIVE-COLOR CLUSTERS BASED ON THE BIBLIOGRAPHIC COUPLING ANALYSIS (SEE FIG. 8) AND THE THREE CLUSTERS BASED ON THE OVERALL CONCEPTUAL STRUCTURE OF THE RI FIELD (SEE FIG. 7)

Clusters based on the bibliographic coupling analysis (see Section IV-C2)	Clusters based on the overall conceptual structure of the RI field (see Section IV-B3)
Red cluster: Healthcare application for RI	Cluster 3: RI for healthcare
Green cluster: Conceptual development of RI	Cluster 1: Conceptual development of RI
Yellow cluster: RI and other innovation typologies (disruptive and open innovations)	
Blue cluster: Frugal innovation	Cluster 2: Sustainable dimension of RI
Purple cluster: Frugal innovation and its sustainable performance	

TABLE III
TOP TEN MOST IMPACTFUL AUTHORS (2009–2019)

Author	H-index	Total citations	Publications	First publication year	Research Interest
Harris	7	133	12	2013	RI for healthcare
Govindarajan	5	532	8	2009	RI conceptualization
Bhatti	4	39	6	2017	Frugal innovation and RI
Borini	2	43	5	2012	RI antecedents and managerial implications
Darzi	4	39	5	2017	RI for healthcare
Brem	3	124	4	2012	Frugal innovation and RI
Hossain	4	80	4	2015	Frugal innovation and RI
Macinko	4	63	4	2015	RI for healthcare
Prime	3	21	4	2017	Frugal innovation and RI for healthcare
Von Zedwitz	2	88	4	2015	RI

yellow clusters are closely linked to Cluster 1 (conceptual development of RI). The blue and purple clusters are closely linked to Cluster 2 (sustainable dimension of RI). Accordingly, with this consistency, we will build on the three structural clusters identified in Fig. 7 to identify directions for future research.

2) *Citation and Cocitation Analysis*: Citation analysis is a method of calculating the relative significance or influence of an author, journal, or publication by counting the number of times that author, article, or publication has been cited by other works [69]. The unit of analysis is documents. Based on the citation analysis, Table III lists the most impactful authors. Impact is based on the Hirsch index (H-index), which measures the impact of a scholar's publications on both productivity and citations

[70]. An H-index with value n refers to n publications that have each been cited at minimum n times by other authors. The higher the H-index, the greater the impact of the author in the field. The H-index is a rough measure of scientific performance because it does not regard the size of the scientific field and hence the potential to get cited. Hence, it may overestimate the impact of an author. To account for this potential bias (a higher H-index), Table III also presents the total citation scores of the authors (i.e., the total number of citations to their RI papers in the bibliometric databases) and their research interests. For example, literature describing RI for healthcare and the relation between RI and frugal innovation may create higher impact values.

TABLE IV
TOP TEN MOST INFLUENTIAL ARTICLES IN THE CITATION NETWORK (RANKING BASED ON NORMALIZED CITATIONS FOR THE TIMESPAN 2009–2019)

Publication	Title	Year	LC	TC	Aim / main topic
[6]	<i>“Reverse innovation, emerging markets, and global strategy”</i>	2011	27	222	First article structuring the various theoretical underpinnings of RI
[12]	<i>“Organising for reverse innovation in West-ern MNCs: the role of frugal product innovation capabilities”</i>	2014	13	34	This article investigates how MNCs of the healthcare and electronics industries can organize their international R&D practices for RI.
[41]	<i>“Low-cost innovation in emerging markets”</i>	2015	6	39	Defines four types of low-cost innovations in EMs : jugaad, frugal, value, and reverse. Their features, their similarities, and their differences are described.
[66]	<i>“Can frugal go global? Diffusion patterns of frugal innovations”</i>	2016	6	30	Identifies four main diffusion patterns of frugal innovation labeled: local diffusion, proximity diffusion, distance diffusion, and global diffusion.
[33]	<i>“Disruptive Innovation ... in Reverse: Adding a Geographical Dimension to Disruptive Innovation Theory”</i>	2014	5	9	Provides an overview of how the RI theory relates to and within the disruptive innovation theory
[68]	<i>“Frugal approach to innovation: State of the art and future perspectives”</i>	2018	5	23	Systematic literature review of 113 contributions published on frugal innovation to identify different typologies of innovations and evolution of the frugal innovation concept
[61]	<i>“Frugal Innovation and Development: Aides or Adversaries?”</i>	2016	4	27	Publication explores the sustainability dimension of frugal innovation and argues that an empirical approach is needed to asses where and when frugal innovation fosters inclusive development.
[19]	<i>“Business models for sustainable innovation- an empirical analysis of frugal products and services”</i>	2017	4	53	Analyses the relationship between frugal and RI and their sustainability performance and describes business models for sustainable development
[21]	<i>“That’s not how the learning works – the paradox of Reverse Innovation: a qualitative study”</i>	2016	3	15	Discusses that the term RI is used differently among industries and reviews the way in which RI is used within healthcare
[58]	<i>“Business Models for Frugal Innovation in Emerging Markets: The Case of the Medical Device and Laboratory Equipment Industry”</i>	2017	3	17	Investigates various business models that foster frugal innovation within the healthcare domain

Table IV presents the top ten locally cited articles, i.e., articles that are most referred to by researchers in the field. These papers may further indicate the researchers’ topics of interests and how they relate or have built upon each other’s works.

Some scholars find that direct citation is better at clustering and connecting references than either bibliographic coupling or

cocitation [71]. Therefore, in Fig. 9, we present a global citation map. It consists of two global citation networks. The left part of Fig. 9 indicates the network of clusters found by VOSviewer. The right part represents the same network with yearly overlay visualization, which is a useful way to explore patterns in influential literature produced across different disciplines over time.

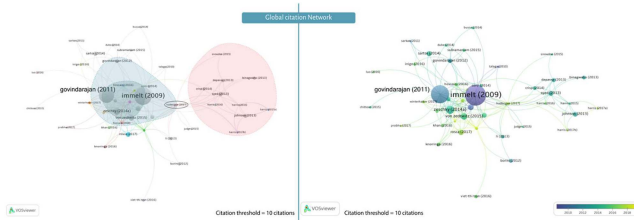


Fig. 9. Global citation network.

Fig. 9 indicates that most of the research activity has been generally well spread across the timeframe. The citation networks show a focus on the foundation papers produced from 2011 to 2014 [1], [10]. A number of structural holes are evident between the main area in the middle and the clusters surrounding it [7], [38]. The first structural hole is between the domain related to healthcare (red area) and the conceptual development of RI (green area) and was discussed in previous sections. The systematic literature review by Hadengue [8] forms a broker between these research domains. Syed et al. [72] had the same function within the intellectual structure. Govindarajan and Trimble [7] are brokers of the conceptual development of RI with the business perspective. Identifying the brokers is useful for understanding power, influence, and dependence in the network. They can be considered as researchers that connect different domains and aid in knowledge transfer from one area to another [73].

V. DISCUSSION: FROM RETROSPECT TO PROSPECT

This section discusses the findings of the bibliometric analyses in Section IV in order to address the two objectives of the study: 1) examine the conceptual development and evolving structural state of the RI research landscape; and 2) identify future research directions that scholars need to focus on for further advancement of the field.

A. Research Landscape of RI: Existing Intellectual Structure of RI Research (2009–2019)

The bibliometric results demonstrate that the emphasis of existing RI research differs predominantly with respect to their research goals and the industry application. For instance, while scholars and practitioners in healthcare are mainly concerned with the application of RI and its effects on the healthcare industry in high-income countries, innovation scholars are mostly interested in generalizable knowledge and theory. As a result, we find that the topics of interest of innovation scholars are directly connected to the specific phases of the RI process: from product characteristics to diffusion patterns and market conditions to ensure the reversal of innovation occurs. Meanwhile, healthcare practitioners focus more on organizational procedures. The bibliometric visualizations indicate that research interest is assorted to topics and structured in a scattered way. This allows for ample opportunities toward engaging in research on RI.

The results of the bibliometric analyses in the period 2009–2019 reveal that *Globalisation and Health*, *Research Technology Management*, and *Journal of Cleaner Production* are the

top three leading journals for RI research (see Table I). The researchers in the top three most contributing countries so far were located in Germany, the U.K., and the U.S. (see Fig. 4). Regarding the most impactful authors within RI literature, the top three scholars are Harris, Govindarajan, and Bhatti (see Table II). These authors belong to the research interests of the conceptual development of RI (Govindarajan), RI for health-care (Harris), and the relations between frugal and RI (Bhatti). The three most influential papers based on global citations (see Table III) are, respectively, by Immelt et al. [1], Govindarajan et al. [6], and Zeschky et al. [12].

Furthermore, the concept cooccurrence analysis and bibliographic network reveal specific textual patterns and topics that further result in the formation of five-color clusters within the research on RI (see Fig. 8). As previously given in Table IV, the five-color clusters can be associated with the three structural clusters (see Fig. 7).

The first structural cluster focuses on the conceptual development of RI as both a strategy and a phenomenon by looking at multiperspective of market, business/organization, and product. The investigation relates to why RI occurs (phenomenon) and how RI is adopted and managed in companies (strategy). In this research stream, scholars have also studied the relation of RI to EM business models of frugal innovation [58], [59], disruptive innovation theory [30], [33], and open innovation [57]. The first structural cluster is further subdivided into four subclusters (see Fig. 7): organizing for RI, market perspective, product perspective, and business perspective.

The second structural cluster, sustainable dimension of RI, scholars aim to show the shared characteristics of frugal innovation and RI (i.e., resource-constrained innovation) but they also make a clear distinction between when frugal innovation becomes RI and when it remains frugal innovation [12]. Here, the frugal characteristics are explored as a sustainable approach to innovation [19].

In the third structural cluster, RI for healthcare, scholars have studied how resource-constrained ideas in EMs for the healthcare sector can be valuable for healthcare practices in DMs, such as policies and management practices [72]. Here, RI is about the reverse of healthcare product innovations but also refers to the reverse flow of ideas/knowledge transfers.

B. RI in Prospect: Future Research Directions

In order to provide an overview of future research directions, we combine the bibliometric findings with structural hole theory and social network analysis. In particular, we investigate the structural holes, weak ties, and the direction of recent research interests to come to these avenues. Structural holes connect nodes that might otherwise remain disconnected, hence facilitating access to information and resources from various fields [73]. Therefore, structural holes show an opportunity to fill a knowledge gap for research that bridges these nodes or create more links.

Table V presents future research directions that are derived based on structural clusters (see Fig. 7) by outlining key potential research questions. To illustrate how we use structural clusters

TABLE V
STRUCTURAL CLUSTER, RESEARCH GAP, AND POTENTIAL RESEARCH QUESTIONS FOR FUTURE RESEARCH

Structural cluster	Research gap	Potential research questions for future research
Conceptual development of RI	<ul style="list-style-type: none"> No holistic investigation of organizing for RI The role of governments in RI has been left quite underresearched Lead market potential for RI is overlooked RI has focused on the reversal of an innovation within an organizational boundary (i.e. captive outsourcing) 	<p>A. <u>Organizing for RI</u>:</p> <ul style="list-style-type: none"> What kind of management style and organizational structure are conducive for RI? How should headquarter-subsidiaries relationship be managed in the RI context? How should firms organize to benefit from knowledge spillovers between a subsidiary and parent company? How do firms manage and allocate their R&D system for RI? How should firms manage knowledge transfer and collaboration between EMs and DMs for RI? (cf., open innovation, disruptive innovation) How disruptive is RI and how do firms manage such disruptions that RI may create? What governmental drivers and antecedents could foster RI? How can governments of EMs attract global business to innovate for EMs and DMs? <p>B. <u>Market perspective</u>:</p> <ul style="list-style-type: none"> What is the role of lead market in fostering RI? How should marketing strategy be designed for RI? <p>C. <u>Product perspective</u>:</p> <ul style="list-style-type: none"> Besides the frugal characteristics, what are important characteristics of RI products to increase their likelihood of adoption in developed countries or globally? How do firms manage their RI and existing product/service portfolios? <p>D. <u>Business perspective</u>:</p> <ul style="list-style-type: none"> How do MNCs (EMNEs and/or DMNEs) define or rethink business models for RI to increase their accessibility in (global) markets? What are the key performance indicators to measure the effectiveness (payoff) of RI? Could offshore outsourcing mitigate the risks and issues of RI?
Sustainable dimension of RI	A need to better understand how open innovation and RI can be combined or how they can enhance each other's outcomes in terms of sustainability	<ul style="list-style-type: none"> What are the relations between open innovation and RI and are they interdependent to achieve sustainability? What is the value creation of RI (e.g. regarding finance, sustainability, social)? What are sustainability conditions or requirements that RI should entail? How can the sustainability dimension of RI be measured in outcome-based metrics?
RI for healthcare	A need to examine the role of healthcare institutions in EMs and DMs in stimulating RI	<ul style="list-style-type: none"> What is the role of (healthcare or other) institutions in EMs and DMs in stimulating RI? How can policy makers in EMs and DMs stimulate firms to further engage in RI for healthcare? Besides healthcare, with what are other sectors that healthcare may generate synergies? How do users in EMs, as lead users for healthcare innovations, help stimulate more frugal innovations globally? Why are RIs or frugal healthcare innovations overlooked or frowned upon by developed markets? How can RIs be adjusted to mitigate the risk of being unaccepted by developed markets?

to identify potential research questions, in the following we discuss how the structural clusters lead to some research gaps and research questions.

Regarding the first structural cluster (conceptual development of RI), Fig. 9 shows weak ties and linkages between the study of Borini et al. [51] and the main RI research field. Borini et al. [51] studied the factors that allow subsidiaries to develop innovations used by the parent company. The same holds for Li et al. [52], who analyzed knowledge spillovers between the subsidiary and parent company as a dynamic and reciprocal process with knowledge flowing between and among foreign and domestic firms. However, there is no overall investigation of organizing for RI. This weak tie indicates that analyzing RI from an organizational context is an interesting area. For instance, there is a need to explore to what extent the involvement of MNCs in RI increases the organizational and managerial complexity due to their complex headquarter–subsidiaries structure. Important questions in the “Organizing for RI” subcluster are: 1) What kind of management style and organizational structure are conducive for RI?; 2) how should headquarter–subsidiaries relationship be managed in the RI context?; 3) How should firms organize to benefit from knowledge spillovers between a subsidiary and parent company?

As shown in Fig. 9, Prabhu [60] is quite distinct from the RI research field. The study [60] argues for a systematic shift to a frugal economy and also considers the role of governments in bringing about change when market processes alone are insufficient. However, the role of governments in RI has been left quite underresearched. Of major interest is more research on drivers and antecedents within and beyond an organizational boundary (e.g., at the government level) allow for the maximization of knowledge spillovers between a subsidiary and a parent company aiding the development of RI [51]. A need exists for future research on: 1) what governmental drivers foster RI, and 2) how can developing countries’ governments attract businesses to innovate and contribute to economic growth and welfare of the local economy.

Regarding “Market perspective” subcluster, Fig. 9 also shows a weak tie based on the distinct study of Luo [74]. Studied reverse adaptation occurs when an MNC’s local employees understand, assimilate, and adjust their individual conduct (e.g., values, norms) and competency (e.g., standards, objectives, language, expertise, abilities) to match the MNC’s global outlook and global competencies. This signifies that having a clear understanding of both markets (EMs and DMs) is crucial for the success of RI. Relatedly, an interesting potential research direction is to look at the construct of lead market which is defined as “the country where a globally successful innovation first took off” [75]. Scholars may use the theory of lead market to further investigate the structural model (cost advantage, demand advantage, export advantage, market structure advantage, and transfer advantage) of lead market to identify lead market potential for RI [75]. Tiwari and Herstatt [76] have applied it to “cost-effective” innovations in India. Judge et al. [77] describe the power of recognizing developing country users as lead users for healthcare innovations to reveal latent needs and wants for the development of globally disruptive innovations. Tran and

Ravaud [78] argue that in order to deliver adequate healthcare to patients in constrained environments, healthcare providers frequently devise novel and frugal solutions. These innovations are often overlooked but they provide vast opportunities for developed healthcare systems that are increasingly struggling with reduced innovation efficiency. A few links have been found to these publications that open up a research possibility especially in healthcare. An avenue could thus be to apply this idea using developing country users as lead users for healthcare products and services to see if certain commonalities in market or product characteristics can be determined as precursors for RI. Also researchers could analyze why these frugal innovations are overlooked and how practitioners and scholars could avoid these issues hampering the adoption of these frugal and RIs.

Sartor and Beamish [79] investigate two approaches in offshoring innovation practices: *captive offshoring* where an MNC conducts innovation activities through its own subsidiary in an offshore market, and *offshore outsourcing* where the MNC fully outsources innovation operations to an independent foreign contractor. However, their study lacks some linkages to the main field as can be observed in Fig. 9. Currently, research on RI has focused on the reversal of an innovation within an organizational boundary, i.e., captive outsourcing. An avenue for future research in the “Business perspective” subcluster could be to study RI through offshore outsourcing and analyze if any of the present risks and issues with RI are decreased. Also, the drivers and antecedents of RI could be different with this approach.

Further research can bridge present RI business perspective literature and RI healthcare literature in a variety of ways. In particular, Talaga [57] discusses how open innovation may aid in the present “productivity paradox” of the pharmaceutical industry through the sharing of risk, cost, and intellectual property through strategic alliances with all types of innovators. Furthermore, Talaga [57] discusses that RI may provide a solution to address current R&D costs in the healthcare sector in developed countries. Thus, further research toward the relation between open innovation and RI and their interdependence is interesting. Open innovation creates cocreation opportunities that can be used to design, develop, and produce frugal innovations that are successful for the producer’s revenues but also for customer satisfaction. It is interesting to investigate how open innovation conduces these frugal innovations successfully to the design, development, and production of RI. There is a need to better understand how open innovation and RI can be combined or how they can enhance each other’s outcomes in terms of sustainability. This understanding would be especially important for exploring sustainable dimension of RI. It is also important to deepen insights into the value creation of RI as a whole (e.g., regarding finance, sustainability, social) and how can we measure and monitor sustainable dimension of RI.

Busse et al. [44] conclude that with the help of enhanced monitoring and evaluation frameworks, the simple action of trying to measure RI could represent a change in the way global health partnerships are viewed. By focusing on two-way learning advantages that occur, perception can be changed such that these lead to increased performance of global health partnership

spending. In the existing literature, RI is not measured in terms of its performance, specifically how it impacts the MNCs and people involved. As healthcare is one dominant application of RI, there is a need to examine the role of healthcare institutions in EMs and DMs in stimulating RI. This is an interesting avenue for future research. Furthermore, the importance of both financial and social benefits through investing has increased in recent years. There is a growing need to move away from output-based performance metrics to outcome-based metrics that consider both the financial and social implications of business activities [55]. Determining outcome-based metrics for RI is a new area of research for global strategy and RI and can result in more interest toward RI from the business sector as it constitutes a business practice that is financially viable, socially responsible, and environmental friendly.

VI. CONCLUDING REMARKS

This study provides key insights into the progression and development of RI research and avenues for future research. In retrospect, we have identified and revealed main research streams, influential scholars and works, important scholarly associations, and collaborative networks. A dominant part of RI research centers around the health care domain. This is the influence from the paper by Immelt et al. [1] with its focus on GE's healthcare products. This finding is corroborated by the analysis which shows that healthcare is dealt with by most scholars.

The analysis of the scholarly associations reveals that RI has been examined from: 1) the conceptual development of RI by means of the foundational aspects that include organizing for RI, market, product, and business perspectives; 2) sustainable dimensions of RI; and 3) RI for healthcare. The collaborative networks were analyzed with the help of (co-)citation analysis and show that high impact is generated by studies that investigate RI from the lenses of healthcare as well as frugal innovation. Further it reveal that the main foundational publications are located in the center of the network including the product life cycle theory, product innovation in emerging economies, and theory building from case study research.

Future research directions are derived by combining bibliometric findings with structural hole theory and social network analysis. An interesting area to explore is the organizational complexity of RI within MNCs. First, a clear avenue could be how MNCs have to act and organize at local and global levels in order to attract local talent that has potential to be translated in global talent. A study by Weyrauch et al. [80] that suggests the objective-conflict-resolution approach is a relevant consideration for MNCs. Second, what government policy drivers can foster RI? A third research direction is how lead markets theory can be used more extensively in exploring RI. Low-income and severely resource-constrained customers in developing countries can be lead customers, for e.g., healthcare innovation that can also be used in DMs. The question how MNCs can use both open innovation and RI to make RI successful is a fourth research line. Open innovation creates opportunities to use information from low-income customers in

resource-constrained environments that can be used in design of RI. Finally, a research line that has hardly been explored is investigating how RI affects the broad performance of MNCs, i.e., financial and social implications of the business activities focused on RI design, development, and production.

REFERENCES

- [1] J. Immelt, V. Govindarajan, and C. Trimble, "How GE is disrupting itself—Harvard business review," *Harvard Bus. Rev.*, vol. 87, no. 10, pp. 3–11, 2009. [Online]. Available: www.hbr.org
- [2] N. Agarwal, M. Grottke, S. Mishra, and A. Brem, "A systematic literature review of constraint-based innovations: State of the art and future perspectives," *IEEE Trans. Eng. Manage.*, vol. 64, no. 1, pp. 3–15, Feb. 2017, doi: [10.1109/TEM.2016.2620562](https://doi.org/10.1109/TEM.2016.2620562).
- [3] M. Harris, Y. Bhatti, J. Buckley, and D. Sharma, "Fast and frugal innovations in response to the COVID-19 pandemic," *Nature Med.*, vol. 26, no. 6, pp. 814–817, Jun. 2020, doi: [10.1038/s41591-020-0889-1](https://doi.org/10.1038/s41591-020-0889-1).
- [4] M. Vesci, R. Feola, R. Parente, and N. Radjou, "How to save the world during a pandemic event. A case study of frugal innovation," vol. 51, pp. 352–363, 2021. [Online]. Available: <https://www.isinn>
- [5] N. Agarwal, J. Oehler, and A. Brem, "Constraint-based thinking: A structured approach for developing frugal innovations," *IEEE Trans. Eng. Manage.*, vol. 68, no. 3, pp. 739–751, Jun. 2021, doi: [10.1109/TEM.2020.3042929](https://doi.org/10.1109/TEM.2020.3042929).
- [6] V. Govindarajan and R. Ramamurti, "Reverse innovation, emerging markets, and global strategy," *Glob. Strategy J.*, vol. 1, no. 3/4, pp. 191–205, Nov. 2011, doi: [10.1002/gsj.23](https://doi.org/10.1002/gsj.23).
- [7] V. Govindarajan and C. Trimble, "Reverse innovation: A global growth strategy that could pre-empt disruption at home," *Strategy Leadership*, vol. 40, no. 5, pp. 5–11, 2012, doi: [10.1108/10878571211257122](https://doi.org/10.1108/10878571211257122).
- [8] H. Marine, "Reverse innovation: A systematic literature review," *Int. J. Emerg. Markets*, vol. 12, no. 2, pp. 142–182, Jan. 2017, doi: [10.1108/IJoEM-12-2015-0272](https://doi.org/10.1108/IJoEM-12-2015-0272).
- [9] S. Malodia, S. Gupta, and A. K. Jaiswal, "Reverse innovation: A conceptual framework," *J. Acad. Marketing Sci.*, vol. 48, pp. 1009–1029, 2020, doi: [10.1007/s11747-019-00703-4](https://doi.org/10.1007/s11747-019-00703-4).
- [10] V. Govindarajan, P. K. Kopalle, and E. Danneels, "The effects of mainstream and emerging customer orientations on radical and disruptive innovations," *J. Product Innov. Manage.*, vol. 28, no. SUPPL. 1, pp. 121–132, 2011, doi: [10.1111/j.1540-5885.2011.00865.x](https://doi.org/10.1111/j.1540-5885.2011.00865.x).
- [11] M. Von Zedtwitz, S. Corsi, P. V. Søberg, and R. Frega, "A typology of reverse innovation," *J. Product Innov. Manage.*, vol. 32, no. 1, pp. 12–28, Jan. 2015, doi: [10.1111/jpim.12181](https://doi.org/10.1111/jpim.12181).
- [12] M. Zeschky, B. Widenmayer, and O. Gassmann, "Organising for reverse innovation in Western MNCs: The role of frugal product innovation capabilities," *Int. J. Technol. Manage.*, vol. 64, no. 2/4, pp. 255–275, 2014, doi: [10.1504/IJTM.2014.059948](https://doi.org/10.1504/IJTM.2014.059948).
- [13] N. Furue and Y. Washida, "Conception of the inductive reverse innovation by developed-country multinational enterprises," in *Proc. Portland Int. Center Manage. Eng. Technol., Proc., Infrastructure Service Integr.*, 2014, pp. 900–906.
- [14] Y. Ding, R. Rousseau, and D. Wolfram, *Measuring Scholarly Impact*. Berlin, Germany: Springer, 2014, doi: [10.1007/978-3-319-10377-8](https://doi.org/10.1007/978-3-319-10377-8).
- [15] N. J. van Eck and L. Waltman, "Citation-based clustering of publications using CitNetExplorer and VOSviewer," *Scientometrics*, vol. 111, no. 2, pp. 1053–1070, May 2017, doi: [10.1007/s11192-017-2300-7](https://doi.org/10.1007/s11192-017-2300-7).
- [16] N. J. van Eck and L. Waltman, "Software survey: VOSviewer, a computer program for bibliometric mapping," *Scientometrics*, vol. 84, no. 2, pp. 523–538, 2010, doi: [10.1007/s11192-009-0146-3](https://doi.org/10.1007/s11192-009-0146-3).
- [17] L. Waltman, N. J. van Eck, and E. C. M. Noyons, "A unified approach to mapping and clustering of bibliometric networks," *J. Informetrics*, vol. 4, no. 4, pp. 629–635, Oct. 2010, doi: [10.1016/j.joi.2010.07.002](https://doi.org/10.1016/j.joi.2010.07.002).
- [18] Z. Lin, Y. Zhang, Q. Gong, Y. Chen, A. Oksanen, and A. Y. Ding, "Structural hole theory in social network analysis: A review," *IEEE Trans. Comput. Social Syst.*, vol. 9, no. 3, pp. 724–739, Jun. 2022, doi: [10.1109/TCSS.2021.3070321](https://doi.org/10.1109/TCSS.2021.3070321).
- [19] E. Rosca, M. Arnold, and J. C. Bendul, "Business models for sustainable innovation—An empirical analysis of frugal products and services," *J. Cleaner Prod.*, vol. 162, pp. S133–S145, Sep. 2017, doi: [10.1016/j.jclepro.2016.02.050](https://doi.org/10.1016/j.jclepro.2016.02.050).

- [20] L. Pereira et al., "Smart innovation, systems and technologies 198." Accessed: Jul. 12, 2023. [Online]. Available: <http://www.springer.com/series/8767>
- [21] M. Harris, E. Weisberger, D. Silver, V. Dadwal, and J. Macinko, "That's not how the learning works—The paradox of Reverse innovation: A qualitative study," *Glob. Health*, vol. 12, no. 1, Jul. 2016, Art. no. 36, doi: [10.1186/s12992-016-0175-7](https://doi.org/10.1186/s12992-016-0175-7).
- [22] S. Knizkov and J. C. Arlinghaus, "Frugal processes: An empirical investigation into the operations of resource-constrained firms," *IEEE Trans. Eng. Manage.*, vol. 68, no. 3, pp. 667–684, Jun. 2021, doi: [10.1109/TEM.2020.3016776](https://doi.org/10.1109/TEM.2020.3016776).
- [23] J. W. Scannell, A. Blanckley, H. Boldon, and B. Warrington, "Diagnosing the decline in pharmaceutical R&D efficiency," *Nature Rev. Drug Discov.*, vol. 11, no. 3, pp. 191–200, Mar. 2012, doi: [10.1038/nrd3681](https://doi.org/10.1038/nrd3681).
- [24] N. Bloom, C. I. Jones, J. van Reenen, and M. Webb, "Are ideas getting harder to find?," *Amer. Econ. Rev.*, vol. 110, no. 4, pp. 1104–1144, Apr. 2020, doi: [10.1257/aer.20180338](https://doi.org/10.1257/aer.20180338).
- [25] A. M. F. Danilevich and G. D. Cunha, "Market oriented new product development," in *Proc. 10th ISPE Int. Conf. Concurrent Eng.*, 2003, pp. 1255–1262, doi: [10.1108/14601060510578583](https://doi.org/10.1108/14601060510578583).
- [26] F. Osareh, "Bibliometrics, citation analysis and co-citation analysis: A review of literature I," *Libri*, vol. 46, no. 3, pp. 149–158, 1996, doi: [10.1515/libr.1996.46.3.149](https://doi.org/10.1515/libr.1996.46.3.149).
- [27] J. A. Moral-Muñoz, E. Herrera-Viedma, A. Santisteban-Espejo, and M. J. Cobo, "Software tools for conducting bibliometric analysis in science: An up-to-date review," *Prof. Informacion*, vol. 29, no. 1, pp. 1–20, 2020, doi: [10.3145/epi.2020.ene.03](https://doi.org/10.3145/epi.2020.ene.03).
- [28] M. Aria and C. Cuccurullo, "Bibliometrix: An R-tool for comprehensive science mapping analysis," *J. Informetrics*, vol. 11, no. 4, pp. 959–975, 2017, doi: [10.1016/j.joi.2017.08.007](https://doi.org/10.1016/j.joi.2017.08.007).
- [29] C. Chen, "CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature," *J. Amer. Soc. Inf. Sci. Technol.*, vol. 57, no. 3, pp. 359–377, Feb. 2006, doi: [10.1002/asi.20317](https://doi.org/10.1002/asi.20317).
- [30] C.-C. Hang, J. Chen, and A. M. Subramian, "Developing disruptive products for emerging economies: Lessons from Asian cases," *Res. Technol. Manage.*, vol. 53, no. 4, pp. 21–26, Jul. 2010, doi: [10.1080/08956308.2010.11657637](https://doi.org/10.1080/08956308.2010.11657637).
- [31] N. Agarwal and A. Brem, "Frugal and reverse innovation-literature overview and case study insights from a German MNC in India and China," in *Proc. 18th Int. ICE Conf. Eng., Technol. Innov.*, 2012, pp. 1–11, doi: [10.1109/ICE.2012.6297683](https://doi.org/10.1109/ICE.2012.6297683).
- [32] G. Mani, K. Annadurai, and R. Danasekaran, "Frugal innovations: The future of affordable health care," *Asian J. Pharmaceut. Res. Health Care*, vol. 6, no. 2, pp. 1–2, 2014.
- [33] S. Corsi and A. Di Minin, "Disruptive Innovation ... in reverse: Adding a geographical dimension to disruptive innovation theory," *Creativity Innov. Manage.*, vol. 23, no. 1, pp. 76–90, Mar. 2014, doi: [10.1111/caim.12043](https://doi.org/10.1111/caim.12043).
- [34] H. W. Chesbrough, H. B. S. Press, and J. S. Brown, "Open innovation: The new imperative for creating and profiting from technology," in *G - Reference, Information and Interdisciplinary Subjects Series*. Watertown, MA, USA: Harvard Bus. School Press, 2003.
- [35] M. Prime, Y. Bhatti, and M. Harris, "Frugal and reverse innovations in surgery," in *Global Surgery: The Essentials* (Division of Surgery and Cancer, Inst. Global Health Innovation, Imperial College London). Berlin, Germany: Springer, 2017, pp. 193–206, doi: [10.1007/978-3-319-49482-1_11](https://doi.org/10.1007/978-3-319-49482-1_11).
- [36] M. S. Prime, "Frugal innovation for healthcare: Strategies and tools for the identification and evaluation of frugal and reverse innovations in healthcare," Imperial College London (Dissertation/Thesis), 2017.
- [37] M. Skopec, H. Issa, and M. Harris, "Delivering cost effective healthcare through reverse innovation," *BMJ*, vol. 367, 2019, Art. no. 16205, doi: [10.1136/bmj.16205](https://doi.org/10.1136/bmj.16205).
- [38] S. B. Syed, V. Dadwal, and G. Martin, "Reverse innovation in global health systems: Towards global innovation flow," *Glob. Health*, vol. 9, no. 1, Aug. 2013, Art. no. 36, doi: [10.1186/1744-8603-9-36](https://doi.org/10.1186/1744-8603-9-36).
- [39] V. Rowthorn, A. J. Plum, and J. Zervos, "Legal and regulatory barriers to reverse innovation," *Ann. Glob. Health*, vol. 82, no. 6, pp. 991–1000, 2016, doi: [10.1016/j.aogh.2016.10.013](https://doi.org/10.1016/j.aogh.2016.10.013).
- [40] A. Klarin, "Mapping product and service innovation: A bibliometric analysis and a typology," *Technol. Forecasting Social Change*, vol. 149, 2019, Art. no. 119776, doi: [10.1016/j.techfore.2019.119776](https://doi.org/10.1016/j.techfore.2019.119776).
- [41] A. Agnihotri, "Low-cost innovation in emerging markets," *J. Strategic Marketing*, vol. 23, no. 5, pp. 399–411, Jul. 2015, doi: [10.1080/0965254X.2014.970215](https://doi.org/10.1080/0965254X.2014.970215).
- [42] F. Ahmed et al., "Can reverse innovation catalyse better value health care?," *Lancet Glob. Health*, vol. 5, no. 10, pp. e967–e968, Oct. 2017, doi: [10.1016/S2214-109X\(17\)30324-8](https://doi.org/10.1016/S2214-109X(17)30324-8).
- [43] C. D. Johnson et al., "Learning from the Brazilian community health worker model in North Wales," *Glob. Health*, vol. 9, Jun. 2013, Art. no. 25, doi: [10.1186/1744-8603-9-25](https://doi.org/10.1186/1744-8603-9-25).
- [44] H. Busse, E. A. Aboneh, and G. Tefera, "Learning from developing countries in strengthening health systems: An evaluation of personal and professional impact among global health volunteers at Addis Ababa University's Tikur Anbessa specialized hospital (Ethiopia)," *Glob. Health*, vol. 10, no. 1, Sep. 2014, Art. no. 64, doi: [10.1186/s12992-014-0064-x](https://doi.org/10.1186/s12992-014-0064-x).
- [45] N. Crisp, "Mutual learning and reverse innovation—where next?," *Glob. Health*, vol. 10, no. 1, 2014, Art. no. 14, doi: [10.1186/1744-8603-10-14](https://doi.org/10.1186/1744-8603-10-14).
- [46] A. Binagwaho et al., "Shared learning in an interconnected world: Innovations to advance global health equity," *Glob. Health*, vol. 9, Aug. 2013, Art. no. 37, doi: [10.1186/1744-8603-9-37](https://doi.org/10.1186/1744-8603-9-37).
- [47] M. Harris, J. Macinko, G. Jimenez, and P. Mullachery, "Measuring the bias against low-income country research: An implicit association test," *Glob. Health*, vol. 13, no. 1, Nov. 2017, Art. no. 80, doi: [10.1186/s12992-017-0304-y](https://doi.org/10.1186/s12992-017-0304-y).
- [48] M. Harris, J. Marti, H. Watt, Y. Bhatti, J. Macinko, and A. W. Darzi, "Explicit bias toward high-income-country research: A randomized, blinded, crossover experiment of English clinicians," *Health Affairs*, vol. 36, no. 11, pp. 1997–2004, Nov. 2017, doi: [10.1377/hlthaff.2017.0773](https://doi.org/10.1377/hlthaff.2017.0773).
- [49] M. Harris, E. Weisberger, D. Silver, and J. Macinko, "They hear 'Africa' and they think that there can't be any good services—Perceived context in cross-national learning: A qualitative study of the barriers to reverse innovation," *Glob. Health*, vol. 11, no. 1, 2015, Art. no. 45, doi: [10.1186/s12992-015-0130-z](https://doi.org/10.1186/s12992-015-0130-z).
- [50] V. Rodriguez and C. Montalvo, "Innovation policies from the European union: Methods for classification," *Bull. Sci. Technol. Soc.*, vol. 27, no. 6, pp. 467–481, 2007, doi: [10.1177/0270467607308287](https://doi.org/10.1177/0270467607308287).
- [51] F. M. Borini et al., "The reverse transfer of innovation of foreign subsidiaries of Brazilian multinationals," *Eur. Manage. J.*, vol. 30, no. 3, pp. 219–231, Jun. 2012, doi: [10.1016/j.emj.2012.03.012](https://doi.org/10.1016/j.emj.2012.03.012).
- [52] H. Li, Y. (Anthea) Zhang, and M. Lyles, "Knowledge spillovers, search, and creation in China's emerging market," *Manage. Org. Rev.*, vol. 9, no. 3, pp. 395–412, Nov. 2013, doi: [10.1111/more.12036](https://doi.org/10.1111/more.12036).
- [53] M. Subramaniam, H. Ernst, and A. Dubiel, "From the special issue editors: Innovations for and from emerging markets," *J. Product Innov. Manage.*, vol. 32, no. 1, pp. 5–11, Jan. 2015, doi: [10.1111/jpim.12167](https://doi.org/10.1111/jpim.12167).
- [54] R. Chittoor and P. S. Aulakh, "Organizational landscape in India: Historical development, multiplicity of forms and implications for practice and research," *Long Range Plan.*, vol. 48, no. 5, pp. 291–300, 2015, doi: [10.1016/j.lrp.2015.07.005](https://doi.org/10.1016/j.lrp.2015.07.005).
- [55] M. Sarkar, "Moving forward by going in reverse: Emerging trends in global innovation and knowledge strategies," *Glob. Strategy J.*, vol. 1, no. 3/4, pp. 237–242, Nov. 2011, doi: [10.1002/gsj.29](https://doi.org/10.1002/gsj.29).
- [56] M. B. Zeschky, S. Winterhalter, O. Gassmann, S. WinterhalterProf, and O. Gassmann, "From cost to frugal and reverse innovation: Mapping the field and implications for global competitiveness," *Res. Technol. Manage.*, vol. 57, no. 4, pp. 20–27, Jul. 2014, doi: [10.5437/08956308X5704235](https://doi.org/10.5437/08956308X5704235).
- [57] P. Talaga, "The future of pharmaceutical R and D: Somewhere between open and reverse innovation?," *Future Med. Chem.*, vol. 2, no. 9, pp. 1399–1403, 2010, doi: [10.4155/fmc.10.213](https://doi.org/10.4155/fmc.10.213).
- [58] S. Winterhalter, M. B. Zeschky, L. Neumann, and O. Gassmann, "Business models for frugal innovation in emerging markets: The case of the medical device and laboratory equipment industry," *Technovation*, vol. 66/67, pp. 3–13, Aug. 2017, doi: [10.1016/j.technovation.2017.07.002](https://doi.org/10.1016/j.technovation.2017.07.002).
- [59] S. Winterhalter, M. B. Zeschky, and O. Gassmann, "Managing dual business models in emerging markets: An ambidexterity perspective," *R&D Manage.*, vol. 46, no. 3, pp. 464–479, Jun. 2016, doi: [10.1111/radm.12151](https://doi.org/10.1111/radm.12151).
- [60] J. Prabhu, "Frugal innovation: Doing more with less for more," *Philos. Trans. Roy. Soc. A, Math., Phys. Eng. Sci.*, vol. 375, 2017, Art. no. 2095, doi: [10.1098/rsta.2016.0372](https://doi.org/10.1098/rsta.2016.0372).
- [61] P. Knorringa, I. Peša, A. Leliveld, and C. Van Beers, "Frugal innovation and development: Aides or adversaries?," *Eur. J. Develop. Res.*, vol. 28, no. 2, pp. 143–153, Apr. 2016, doi: [10.1057/ejdr.2016.3](https://doi.org/10.1057/ejdr.2016.3).
- [62] E. A. Inigo and L. Albareda, "Understanding sustainable innovation as a complex adaptive system: A systemic approach to the firm," *J. Cleaner Prod.*, vol. 126, pp. 1–20, Jul. 2016, doi: [10.1016/j.jclepro.2016.03.036](https://doi.org/10.1016/j.jclepro.2016.03.036).
- [63] L. Dubé et al., "Convergent innovation for sustainable economic growth and affordable universal health care: Innovating the way we innovate," *Ann. New York, NY, USA Acad. Sci.*, vol. 1331, no. 1, pp. 119–141, 2014, doi: [10.1111/nyas.12548](https://doi.org/10.1111/nyas.12548).
- [64] M. Hossain, "Frugal innovation: A review and research agenda," *J. Cleaner Prod.*, vol. 182, pp. 926–936, May 2018, doi: [10.1016/j.jclepro.2018.02.091](https://doi.org/10.1016/j.jclepro.2018.02.091).

- [65] M. Hossain, "Mapping the frugal innovation phenomenon," *Technol. Soc.*, vol. 51, pp. 199–208, 2017, doi: [10.1016/j.techsoc.2017.09.006](https://doi.org/10.1016/j.techsoc.2017.09.006).
- [66] M. Hossain, H. Simula, and M. Halme, "Can frugal go global? Diffusion patterns of frugal innovations," *Technol. Soc.*, vol. 46, pp. 132–139, Aug. 2016, doi: [10.1016/j.techsoc.2016.04.005](https://doi.org/10.1016/j.techsoc.2016.04.005).
- [67] R. Khan, "How frugal innovation promotes social sustainability," *Sustainability*, vol. 8, no. 10, Oct. 2016, Art. no. 1034, doi: [10.3390/su8101034](https://doi.org/10.3390/su8101034).
- [68] A. Pisoni, L. Michelini, and G. Martignoni, "Frugal approach to innovation: State of the art and future perspectives," *J. Cleaner Prod.*, vol. 171, pp. 107–126, Jan. 2018, doi: [10.1016/j.jclepro.2017.09.248](https://doi.org/10.1016/j.jclepro.2017.09.248).
- [69] F. Oserah, "Bibliometrics, citation analysis and co-citation analysis: A review of literature II," *Libri*, vol. 46, pp. 217–225, 1996, doi: [10.1080/0300443840170106](https://doi.org/10.1080/0300443840170106).
- [70] J. E. Hirsch, "An index to quantify an individual's scientific research output," *Proc. Nat. Acad. Sci.*, vol. 102, no. 46, pp. 16569–16572, Nov. 2005, doi: [10.1073/pnas.0507655102](https://doi.org/10.1073/pnas.0507655102).
- [71] R. Klavans and K. W. Boyack, "Which type of citation analysis generates the most accurate taxonomy of scientific and technical knowledge?," *J. Assoc. Inf. Sci. Technol.*, vol. 68, no. 4, pp. 984–998, 2017, doi: [10.1002/asi.23734](https://doi.org/10.1002/asi.23734).
- [72] M. Harris, V. Dadwal, and S. B. Syed, "Review of the reverse innovation series in globalization and health—where are we and what else is needed?," *Globalization Health*, vol. 16, no. 1, Mar. 2020, Art. no. 26, doi: [10.1186/s12992-020-00555-6](https://doi.org/10.1186/s12992-020-00555-6).
- [73] R. S. Burt, *Brokerage and Closure: An Introduction to Social Capital*. London, U.K.: Oxford Univ. Press, 2005.
- [74] Y. Luo, "Toward a reverse adaptation view in cross-cultural management," *Cross Cultural Strategic Manage.*, vol. 23, no. 1, pp. 29–41, Feb. 2016, doi: [10.1108/CCSM-08-2015-0102](https://doi.org/10.1108/CCSM-08-2015-0102).
- [75] M. Beise and T. Cleff, "Assessing the lead market potential of countries for innovation projects," *J. Int. Manage.*, vol. 10, no. 4, pp. 453–477, 2004, doi: [10.1016/j.intman.2004.08.003](https://doi.org/10.1016/j.intman.2004.08.003).
- [76] C. Herstatt and R. Tiwari, "India's emergence as a lead market for frugal innovations: An introduction to the theme and to the contributed volume," in *Lead Market India*. Cham, Switzerland: Springer, 2017, pp. 1–10, doi: [10.1007/978-3-319-46392-6_1](https://doi.org/10.1007/978-3-319-46392-6_1).
- [77] B. M. Judge, K. Hölttä-Otto, and V. Amos Winter, "Developing world users as lead users: A case study in engineering reverse innovation," *J. Mech. Des.*, *Trans. ASME*, vol. 137, no. 7, Jul. 2015, Art. no. 071406, doi: [10.1115/1.4030057](https://doi.org/10.1115/1.4030057).
- [78] V.-T. Tran and P. Ravaud, "Frugal innovation in medicine for low resource settings," *BMC Med.*, vol. 14, Jul. 2016, Art. no. 102, doi: [10.1186/s12916-016-0651-1](https://doi.org/10.1186/s12916-016-0651-1).
- [79] M. A. Sartor and P. W. Beamish, "Offshoring innovation to emerging markets: Organizational control and informal institutional distance," *J. Int. Bus. Stud.*, vol. 45, no. 9, pp. 1072–1095, Dec. 2014, doi: [10.1057/jibs.2014.36](https://doi.org/10.1057/jibs.2014.36).
- [80] T. Weyrauch, C. Herstatt, and F. Tietze, "The objective-conflict-resolution approach: A novel approach for developing radical and frugal innovation," *IEEE Trans. Eng. Manage.*, vol. 68, no. 3, pp. 699–712, Jun. 2021, doi: [10.1109/TEM.2020.3000924](https://doi.org/10.1109/TEM.2020.3000924).



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