



Research into microfinance and ICTs: A bibliometric analysis

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ABSTRACT

Information and communication technologies (ICTs) play an ever-increasing role in improving the efficiency, profitability, and sustainability of microfinance institutions. This paper aims to assess the role of ICTs in the microfinance industry by systematically reviewing the literature with bibliometric methods. In this research, a total of 347 samples (from 1998 to 2021) were selected from the Web of Science database according to the guideline of the systematic review. By performing descriptive statistical analysis, the contributing institutions, countries, journals, authors, as well as influential publications were identified. In the co-citation and co-word analysis section, three primary types of visualization—cluster views, timezone views and timeline views were all presented through CiteSpace. It turns out that crowdfunding, P2P lending and mobile banking have been the favorite topics. A central issue is the role of these platforms in entrepreneurship. We also proposed that applying fintech, especially blockchain and other emerging technologies, to promote financial inclusion is one of the future research trends. The findings of this study will be of interest to researchers, managers, policymakers, and evaluators and facilitate them to make well-informed decisions in their respective domains.

1. Introduction

Remarkable development has been seen in the microfinance industry over the past decade. Microfinance providers (MFPs) (both microfinance institutions (MFIs) and traditional banks) play a crucial role in poverty reduction and economic development (Kauffman & Riggins, 2010). However, they have to balance outreach and sustainability due to the increasingly competitive environment (Kauffman & Riggins, 2012). By extending financial services to distant customers cost-effectively (Singh & Padhi, 2015), information and communication technologies (ICTs) provide an opportunity to deal with this situation. With the advent of emerging technologies, the great potential of microfinance will also be realized (Attali, 2000). ICTs can not only help achieve environmental sustainability (Wu et al., 2018; Wu et al., 2016) but also change the way businesses operate (Iyengar et al., 2010) and facilitate business sustainability (Yanti et al., 2021). The financial sector is no exception. A series of recent advancements, such as online platforms and mobile apps, are updating the way financial services are delivered (Bruton et al.,

2015). Therefore, it is worthwhile to explore the relationship between microfinance and ICTs. Furthermore, the outstanding contribution of ICTs in the fight against the Covid-19 pandemic also results in an urgent need to understand their role in the microfinance industry better.

ICTs represent a wide range of communication devices, application software, and various related services. Specifically, ICT tools used in the microfinance sector consist of mobile phones, mobile banking applications, fax, electronic mails, electronic point-of-sale (E-POS), management software (e.g., form-filling software), bank websites, and other internet-based services (Adebayo et al., 2017; Ali, Gueyié, et al., 2021; Rozzani et al., 2013). Additionally, they are also classified by their purpose. For example, Ashta (2010) classified technologies used in microfinance into two types: tools to provide information to customers and microfinance, tools for management and support. However, the European Microfinance Network proposed that they are should be divided into three types: client-facing technologies, process automation technologies and technologies for running the business (Rozzani et al., 2013). Moreover, Njihia (2019) claimed that ICTs are mostly used in

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financial management, marketing management and human resource departments.

Until quite recently, an increasing number of studies have attempted to explore the relationship between ICTs and microfinance. Singh and Padhi (2015), for example, assessed the impact of ICTs on risk management, work efficiency and client management of MFIs through a case study. Simultaneously, Seoudi (2015) examined the relationship between ICTs and the performance of microfinance with an empirical method. Besides, Riggins and Weber (2016) explored the impact of ICT on the intermediation market structure of the microfinance sector with experimental research methods. Adebayo et al. (2017) identified the ICT devices used in the Nigerian microfinance sector through 126 structured questionnaires. The latest study was carried out by Homaïd (2019), which examined the factors influencing the acceptance and usage of ICTs among microfinance employees in Yemen based on the technology acceptance model (TAM). However, to date, no study has systematically reviewed the relationship between microfinance and ICTs. Although there have been some reviews in the microfinance field (Braun & Woller, 2004; Gutiérrez-Nieto & Serrano-Cinca, 2019; Hermes & Hudon, 2018; Rooyen et al., 2012), few of them addressed issues from the ICTs perspective. This study is a pioneer to examine the role of ICTs in the microfinance sector with bibliometric analysis. Unlike previous bibliometric analyses, the present study is not limited to providing bibliometric statistics but also presents the whole knowledge structure and evolution based on science mapping. Existing literature has provided comprehensive overviews of microfinance in general, but research on a specific aspect of microfinance is relatively scarce. In particular, overviews of the relationship between microfinance and ICTs are often overlooked. Additionally, given that many previous studies often focused on topics like their sustainability, efficiency, performance and outreach without taking ICTs into consideration, this study is also an important complement to the rare microfinance and ICTs research.

Consequently, there is a need to provide a comprehensive overview of the relationship between ICTs and microfinance. To achieve this goal, the current study seeks to systematically review the research of this field by employing the bibliometric technique. A bibliometric review enables us to figure out the most influential works and the tendency of the research field. By introducing quantitative analysis into a literature review and mapping the research, it also allows analysts to express opinions without subject bias. Despite these benefits of this method, it is rarely applied to the microfinance field (Akter et al., 2021; Gutiérrez-Nieto & Serrano-Cinca, 2019; Zaby, 2019). Hence, this paper aims to address the following research questions:

RQ1: What are the growth trends in publications and citations for microfinance and ICTs research?

RQ2: Which institutions, countries, journals and authors have made outstanding contributions in microfinance and ICTs research, and what are the influential studies?

RQ3: What are the hot topics and trends in the research domain of microfinance and ICTs?

To address these research questions, a total of 347 samples (from 1998 to 2021) were selected from the Web of Science database with reference to the guideline of the systematic review. Besides, to perform co-citation analysis and co-word analysis, three main types of visualization—cluster views, timezone views and timeline views—were all presented through the CiteSpace software. Based on the bibliometric analysis, this paper identified the contributing institutions, countries, journals, authors as well as influential studies. For example, ranked by the number of institutions, the most active countries studying microfinance and ICT tools are the United States, China and France. Europe as a whole has contributed a lot in this field. Furthermore, it is found that crowdfunding, P2P lending and mobile banking are the major topics. Of particular interest is the relationship between these platforms and entrepreneurship. We also proposed that applying fintech, especially

blockchain and other emerging technologies, to promote financial inclusion is one of the future research trends.

This study makes significant contributions by bringing together scattered literature in the field and identifying critical sources, authors, literature and topics evolution of the discipline. These findings assist researchers, policymakers and evaluators related to microfinance and ICTs in understanding the application and development trend of ICTs in the microfinance sector. It allows researchers to understand the existing knowledge and focus of research in this domain. In particular, the analyses of hot topics and research prospects provide direction for future scholars. Evaluators for research can apply the findings to evaluate the outstanding researchers, the promising funding streams and themes, and to assess the outcomes of prior investments. Additionally, this study motivates practitioners to recognize the important role of ICTs play in the microfinance industry and make full use of ICTs to achieve sustainability and financial inclusion. They will benefit from the findings of relevant studies identified by this research by discussing and assessing ICT issues analyzed by these documents. On the other hand, practitioners like managers, policymakers, financial planners and evaluators, and fintech designers will be particularly interested in the results from the co-citation analysis and co-word analysis. That's because the emerging trends and topics from these analyses will facilitate them to design technology programs, choose ICT products, make ICT investment plans, and evaluate the outcomes of investment.

The organization of the paper is as follows: after this introduction, Section 2 introduces the material and methods used in this study, including literature resources, analysis methods and visualization tools. Section 3 presents and analyzes the results on the basis of descriptive statistical analysis, co-citation analysis and co-word analysis. Section 4 summarizes and discusses the findings to conclude the research.

2. Material and methods

2.1. Literature resources and samples

The database we used to collect samples is the Web of Science Core Collection, which compiles world-class academic journals, books, proceeding materials, etc. It is well known that the Web of Science database is one of the most worldwide and authoritative databases (Analytics, 2020; Norris & Oppenheim, 2007). Compared with Google Scholar, it is more suitable for complex searches for co-citation analysis. In addition, Scopus was also not considered because some references in publications were not normalized enough (Leydesdorff et al., 2010). The Web of Science database encompasses over 15,000 high-quality journals and 50,000,000 publications classified into 251 subject categories and 151 research fields (Merigó & Yang, 2017). The main part of the Web of Science database is Core Collection which contains more than 20,000 journals plus books and conference proceedings across 254 subject disciplines with nearly 75 million records (Birkle et al., 2020; Singh et al., 2021). As a consequence, to ensure the quality of the research samples, the Web of Science database was selected as our data source.

In order to obtain comprehensive and representative samples, keyword selection is crucial. Given that our research objectives include ICTs and microfinance, the keywords were first divided into two keyword groups—keywords representing microfinance and keywords representing ICTs. Among the keywords related to ICTs, there are both ICT tools (e.g., “computer”, “mobile phone”) and ICT-based platforms (e.g., “crowdfunding”, “P2P lending”). After confirming the keywords, we performed the search by the “topic”, which covers “title”, “abstract” and “keywords” at the same time. Table 1 presents the search terms for “microfinance” and “ICTs” in detail.

Initially, 4652 and 1499,576 records were found, respectively, by searching the two groups of keywords. Then, a total of 1901 records were collected by combining these two sets of data using the search string “and” in the Web of Science. However, considering they are not all related to the research topic, it is necessary to screen and exclude

Table 1
Search Terms.

Search Terms for "Microfinance"	"microfinance" (including "micro finance", "micro-finance"), "microcredit" (including "micro-credit", "micro credit"), "microbanking" (including "micro-banking", "micro bank ing"), "microlending" (including "micro lending", "micro-lending"), "microsaving" (including "micro-saving", "micro saving"), "microinsurance" (including "micro insurance" "micro-insurance").
Search Terms for "ICTs"	"IT", "ICT", "ICTs", "technology", "innovation", "fintech", "artificial intelligence", "robot", "machine", "electronic", "software", "computer", "telephone", "mobile phone", "smartphone", "telecommunication", "internet", "online", "website", "digital", "mobile banking", "mobile payment", "mobile money", "peer-to-peer", "P2P", "crowdfunding", "blockchain", "cashless payment", "E-banking", "paypal", "Alipay", "point of sale".

Source: own elaboration

irrelevant documents. After screening all the papers based on their titles, abstracts, keywords and even full text (if necessary), we excluded: papers without full text, duplicate papers, and irrelevant papers. For instance, many papers appearing in the initial results, with titles like "The mobile street food service practice in the urban economy of Kumba, Cameroon" (Acho-Chi, 2002) and "Towards better supply chain management through micro-finance: A case study for banana production" (Irianto & Poernomo, 2008), were utterly irrelevant to our subject. Besides, while it covers the topic of both technology and microfinance, some papers have different meanings. For example, the paper with the title "The impact of microcredit on agricultural technology adoption and productivity: Evidence from randomized control trial in Tanzania" (Nakano & Magezi, 2019) explained the relationship between agricultural technology use and microfinance instead of the adoption of technology in microfinance.

At last, a total of 347 documents, which were closely associated with the topic, were added to our samples. These samples include articles, book chapters, reviews, proceeding papers, and the like during the period from 1998 to 2021 (until March 9, 2021). Here 1998 is considered to be the starting year since the first paper regarding our topic is from that year in the Web of Science database.

2.2. Data analysis and visualization

The bibliometric analysis technique was employed for this paper. It is characterized as a complement for meta-analysis and qualitative structured literature reviews by introducing a quantitative approach to evaluate and review publications (Zupic & Čater, 2015). Compared with narrative literature reviews, bibliometric analysis allows researchers to express opinions without subject bias. More importantly, it is particularly useful in studying the current state and the development trend of a knowledge domain. This method has been increasingly used in a wide variety of disciplines and introduced into the microfinance field. For example, both Gutiérrez-Nieto and Serrano-Cinca (2019) and Zaby (2019) have applied bibliometric analysis to track the evolution of microfinance research.

To carry out the bibliometric analysis, the methods used in this paper include descriptive statistical analysis, co-citation analysis and co-word analysis. The descriptive statistical analysis enables us to identify contributing journals, authors, and institutions (Liu et al., 2020), as well as influential publications by citations. Co-citation analysis and co-word analysis, on the other hand, reveal the intellectual structure and dynamics of research topics and predict the direction of future research (Leung et al., 2017; Tan Luc et al., 2020; Walter & Ribière, 2013).

Co-citation analysis is a science mapping approach that implies documents that are frequently co-cited are thematically similar (Donthu et al., 2021; Hjørland, 2013). Co-citation is defined as an occurrence in which two publications are cited together by another publication (Wang et al., 2016). In other words, if both articles A and B are cited by article C, then articles A and B have a co-citation relationship. Similarly, based on the sharing of keywords between publications, the co-word analysis assumes that keywords that frequently occur together are connected thematically (Arroyo Esteban et al., 2022).

Moreover, the co-authorship analysis was also utilized to explore the cooperative relationship between authors and institutions. Once two authors publish an article together, their relationship is established. In the light of the authors' institutional affiliations, co-author analysis can also provide evidence of cooperation on the level of institutions and countries (Zupic & Čater, 2015).

Among a variety of software tools for visualization, such as Bibexcel, CiteSpace, BiblioMaps, CitNetExplorer, SciMAT, Sci2 Tool, VOSviewer (Cobo et al., 2011; Moral-Muñoz et al., 2020), CiteSpace was chosen to visualize the results of this study considering its powerful functions, especially in cluster analysis. By performing cluster analysis on references and keywords, emerging trends and hot topics can be detected (Chen, 2006). In this paper, three primary visualization modes—cluster views, timezone views and timeline viewswere all presented.

3. Results

3.1. Descriptive statistical analysis

3.1.1. Analysis of the evolution of scientific output

The growth trend of publications reflects the dynamic development of scientific knowledge directly. Hence, it is necessary to analyze this trend and explore the causes. Fig. 1 reveals that, despite a few fluctuations, there has been a gradual increase in the number of annual publications and citations from 1998 to 2020 in general. The first study in the Web of Science database that considered the use of ICTs in microfinance was published in 1998 and has only been cited 18 times so far. By examining the relationship between household conditions and MFIs lending technologies, this research suggested that MFIs lending technologies should be redesigned to be sensitive to initial household conditions (Sinha & Matin, 1998).

It can be seen that there is a surge in the number of both publications and citations after 2006. There are two possible reasons for this phenomenon. On the one hand, in 2006, the Nobel Peace Prize was awarded to the founder of Grameen Bank—Muhammad Yunus, who contributes substantially to poverty alleviation through microfinance (Hermes & Hudon, 2018). Another possible explanation for this might be that the rapid development of technologies contributed to the development of financial innovation (Liu et al., 2020) and E-finance (Shahrokhi, 2008) after 2006. Accordingly, there has been a growing concern about microfinance and the application of ICTs over the past ten years. Subsequently, in 2017, the number of papers reached a peak level of 39. Compared with the only two publications in 1998, it indicates that this field attracts more and more academic attention.

Interestingly, publications leveled off but citations dropped sharply after 2015. This result may potentially suggest a relative decline in interest among academics. However, it is also likely to be related to the evolution of the topic and semantic change in the literature. For example, since microfinance is a tool to achieve financial inclusion, many researchers have recently turned to focus on financial inclusion instead of just microfinance (Ozili, 2018; Schuetz & Venkatesh, 2020; Senyo & Osabutey, 2020). In this paper, however, considering financial inclusion is a broader scope and not limited to microfinance (Zaby, 2019), it was excluded from our search string.

What stands out in this figure is that the number of citations attained two apparent peaks in 2012 and 2015, respectively. The reason for this condition is that some significant literature occurred in these years

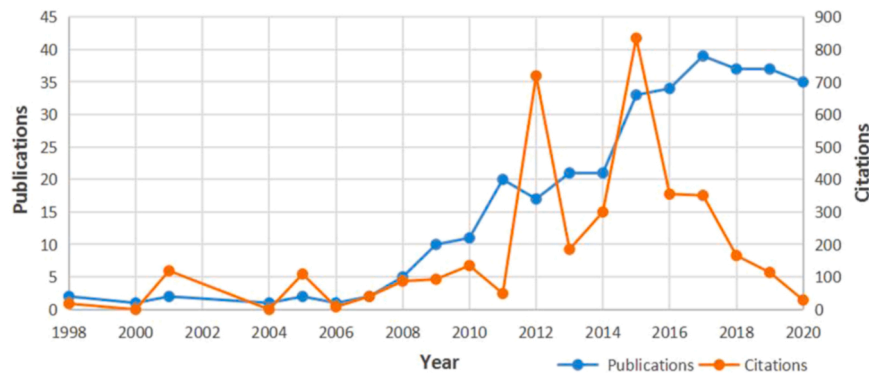


Fig. 1. : Trends of Publications and Citations.

which were cited frequently. For example, the articles published by Lee in 2012 and Bruton in 2015 were cited as many as 134 and 235 times, respectively. Both of the two research studies the application of ICT-based platforms, including crowdfunding and peer-to-peer lending (Bruton et al., 2015; Lee & Lee, 2012).

3.1.2. Analysis of the distribution of publications by institutions and countries

Table 2 provides the fruitful institutions that published more than two articles. Apart from some comprehensive universities (e.g., National University of Singapore, Tsinghua University and Washington State University), many of them are specialized institutions focusing on business and economics, such as Centre for European Research in Microfinance, Fundacao Getulio Vargas, HEC Montreal, Copenhagen Business School, Stockholm School of Economics, Burgundy School of Business, Group ESC Dijon Bourgogne. It is noteworthy that the National University of Singapore is the most prolific research institution with seven publications, then come Singapore Management University (6 publications) and North Dakota State University (5 publications). However, the institution receiving the most citations is Washington State University with a high level of 331 times; next are the University of Zaragoza (175 citations) and Texas A&M University (147 citations). This result can be explained by a few influential articles published by these two institutions. For instance, one article published by Washington State University in 2015 studied online crowding platforms (Allison et al., 2015) and singly attained as many as 200 citations. Moreover, two articles by Serrano-Cinca & Gutiérrez-Nieto (2016); Serrano-Cinca et al. (2015) from the University of Zaragoza received 75 and 72 citations, respectively. Both of them focused on the topic of P2P lending. It can be referred that ICT-based platforms are a major concern.

On the other hand, it can be observed that the most active country studying microfinance and ICTs use is the United States (6 institutions). Furthermore, China, France and Singapore each have two institutions. The result also shows us the geographical distribution of research. Among the top 20 institutions, Europe and North America each account for 35% (7 of 20). Besides, 25% (5 of 20) institutions are located in Asia and 5% (1 of 20) are in South America.

The last row lists the primary cooperative relationships between institutions based on co-authorship analysis. In view of the results, Tsinghua University cooperating with the National University of Singapore and the University of Michigan to study crowdfunding (Ai et al., 2016) has the most extensive partnership. Apart from that, the University Regensburg and Centre for European Research in Microfinance (CERMI), as well as Copenhagen Business School and Stockholm School of Economics, also conducted collaborative research on crowdfunding projects (Dorfleitner et al., 2020; Nielsen, 2018). Additionally, some institutions such as North Dakota State University and Northern Arizona University worked together to study P2P lending (Dorfleitner & Oswald, 2016; Riggins & Weber, 2015). Nevertheless, most institutions

conducted independent research, such as the University of Technology Mara and the University of Zaragoza.

3.1.3. Analysis of journals

The statistics of the prolific journals publishing more than three articles are presented in Table 3. Notably, Electronic Commerce Research and Applications published the most articles (6), followed by Sustainability (5) and Journal of Business Ethics (5). What is interesting is that, from the perspective of citations received, Entrepreneurship Theory and Practice is the most influential journal with 563 citations and 140.75 citations per document; Development and Change is next with 112 citations and 56 citations per document.

Furthermore, the journal impact factor (JIF) provided by the Web of Science database is introduced in this table to evaluate the influence of journals. As a widespread measure, the result of JIF is obtained by dividing the number of citations received by a journal in a designated year for the contents in the previous years by the total number of articles and reviews published in the previous two years (Ali, 2021). It is somewhat surprising that few authoritative management information systems (MIS) journals were noted in Table 3 (only Electronic Commerce Research and Applications). Instead, publications are scattered in other journals related to economics, management or development, such as Journal of Business Ethics, Journal of Product Innovation Management, Journal of Small Business Management, and World Development. This result suggests that research on ICTs in microfinance is insufficient and fragmented. Another possible explanation for this unexpected finding might be attributed to a lack of interest in microfinance in current MIS journals.

Apart from these journals, some influential books are needed to be reviewed, such as Ashta (2010), Vong and Song (2015). The former covering 18 documents in our samples demonstrates a series of advanced technologies for microfinance in detail, such as point of sale technology (Musa & Khan, 2011), mobile banking (Morawczynski, 2011; Shrivastava, 2011), Web 2.0 technologies (Ashta & Assadi, 2011), P2P microlending websites (Assadi & Hudson, 2011) and other online financing platforms, while the latter with four papers in our samples analyzes the application and effect of emerging technologies, especially mobile technologies in microfinance.

3.1.4. Analysis of core authors

Table 4 provides the contributing authors from 1998 to 2020. There are 13 authors who have published more than two articles. Among these scholars, Riggins from North Dakota State University published the most papers (7), while Weber, Guan, Ashta, Gutierrez-Nieto, Assadi and Serrano-Cinca published four articles each. Besides, six authors, including Kauffman, Amin, Dorfleitner, Jayo, Li and Pozzebon, published three papers each. With respect to research direction, Riggins, Weber, Kauffman and Jayo focused on the impact and role of ICTs in microfinance (Diniz et al., 2014; Kauffman & Riggins, 2012; Riggins &

Table 2
The most prolific institutions (3 papers or above).

Num.	Institution	Country	Documents	Citations	Main Cooperative Institutions
1	National University of Singapore	Singapore	7	30	Tsinghua university
2	Singapore Management University	Singapore	6	49	University of Michigan
3	North Dakota State University	USA	5	36	North Dakota State University
4	University of Michigan	USA	4	17	Singapore Management University
5	University Regensburg	Germany	4	10	Northern Arizona University
6	University of Technology Mara	Malaysia	4	4	Tsinghua university
7	University of Zaragoza	Spain	4	175	National University of Singapore
8	Tsinghua University	China	3	16	Centre for European Research in Microfinance
9	Centre for European Research in Microfinance	Belgium	3	2	\
10	Fundacao Getulio Vargas	Brazil	3	53	\
11	HEC Montreal	Canada	3	56	National University of Singapore
12	Northern Arizona University	USA	3	12	University of Michigan
13	Copenhagen Business School	Denmark	3	10	University of Colorado Boulder
14	Stockholm School of Economics	Sweden	3	10	University Regensburg
15	Texas A&M University	USA	3	147	HEC Montreal
16	University of Colorado Boulder	USA	3	92	Fundacao Getulio Vargas
17	Washington State University	USA	3	331	North Dakota State University
18	Burgundy School of Business	France	3	9	University of Michigan
19	Group ESC Dijon Bourgogne	France	3	1	University of Colorado Boulder
20	Harbin Institute of Technology	China	3	7	University Regensburg

Source: own elaboration.

Weber, 2016), while Serrano-Cinca, Ashta, Assadi, Amin, Li and Dorfleitner researched crowdfunding and P2P lending platforms (Amin & Li, 2014; Assadi et al., 2018; Serrano-Cinca & Gutiérrez-Nieto, 2016; Serrano-Cinca et al., 2015). Moreover, Guan and Ashta also followed an interest in mobile technologies and mobile banking (Ashta, 2017; Guan, 2015), whereas Pozzebon studied the use of ICTs to promote financial inclusion (Diniz et al., 2012).

As mentioned in the previous section, the extensive collaborations between these core authors can also be observed based on co-authorship analysis. For example, Riggins cooperated with Kauffman to study the role of ICTs in microfinance (Kauffman & Riggins, 2012). He also researched the information asymmetry of P2P lending platforms with Weber (Riggins & Weber, 2017). Furthermore, Amin and Li, as well as Gutierrez-Nieto and Serrano-Cinca, have also cooperated to study P2P lending platforms (Amin & Li, 2014; Serrano-Cinca & Gutiérrez-Nieto, 2016).

3.1.5. Analysis of influential documents

The influence of a publication can be reflected by the citations it received. Table 5 lists the top 20 most influential publications based on citations. The publication receiving the most citations (235) is Bruton et al. (2015), which analyzed the use of microfinance, crowdfunding and P2P lending in promoting entrepreneurship. The following article exploring the impact of social media on the sales of the microlending market (Stephen & Galak, 2012) received 211 citations. Another influential paper receiving 195 citations assessed the impact of the extrinsic and intrinsic cues in microloan entrepreneurial narratives on funding outcomes (Allison et al., 2015). It is worth noting that 4 of the top 5 documents focused on ICT-based platforms—crowdfunding and P2P lending (Allison et al., 2015; Bruton et al., 2015; Burtch et al., 2014; Lee & Lee, 2012). Interestingly, among these 20 documents, more than half (12) researched these issues. Besides, there are three papers on the application of mobile technologies (e.g., mobile phone, mobile banking, mobile payment and mobile money) (Bayes, 2001; Diniz et al., 2012; Duncombe & Boateng, 2009; Suri & Jack, 2016). This result further confirms that crowdfunding, P2P lending and mobile banking have been favorite topics for analysis in the field of microfinance. In addition to the above articles, the remaining four papers study women's empowerment (Holvoet, 2005), credit scoring (Yum et al., 2012), financial inclusion (Gabor & Brooks, 2017), as well as the debate regarding technologies for financial services (Bhatt & Tang, 2001).

Additionally, the number of empirical studies (14) is more than twice that of conceptual studies (6). It indicates that scholars tend to use empirical methods to study this issue. Next, 90% (18 / 20) of the total number of documents are in the form of articles. More importantly, according to the classification of research directions offered by the Web of Science database, “business and economics” is the leading research field, followed by “computer science” and “Government and Law”. It seems to be associated with the aim of microfinance—economic growth and poverty reduction (Newman et al., 2017). As a result, the subject receives more attention from the economic and business research field.

3.2. Co-citation analysis and co-word analysis

In this section, co-citation analysis and co-word analysis were performed to identify the research hotspots and emergent trends. Co-citation analysis varies according to the research object (e.g., articles, journals, authors), whereas co-word analysis is derived from “author keywords”. We performed these two analyses on cluster views, timezone views and timeline views provided by CiteSpace. In the process, the pivotal points and the dynamics of the research front were detected. Generally, the size of clusters depends on the number of co-cited references or keywords, while the size of the nodes indicates the frequency of an article or keyword co-cited. In addition, links connecting two nodes explain the relationship between the two co-cited articles or keywords. The thicker the link, the more frequently they are co-cited.

Table 3
The Prolific Journals (2 or above).

Num.	Journal	D	TC	TC/D	JIF	Country	Subject
1	Electronic Commerce Research and Applications	6	304	50.67	3.824	USA	Economics
2	Sustainability	5	20	4.00	2.576	Switzerland	Environment / Ecology
3	Journal of Business Ethics	5	5	1.00	4.141	Netherlands	Economics
4	Entrepreneurship Theory and Practice	4	563	140.75	10.750	USA	Economics
5	Venture Capital	4	39	9.75	1.844	England	Economics
6	Third World Quarterly	3	87	29.00	1.754	England	Environmental Studies
7	Information Technology for Development	3	28	9.33	2.733	England	Geography and Development
8	Development and Change	2	112	56.00	2.246	England	Library and Information Sciences
9	Economic Modelling	2	46	23.00	1.93	Netherlands	Environmental Studies
10	World Development	2	41	20.50	3.869	England	Geography and Development
11	Journal of Product Innovation Management	2	37	18.50	5.000	USA	Management
12	Developing Economies	2	36	18.00	0.840	Japan	Environmental Studies
13	Telecommunications Policy	2	30	15.00	2.224	England	Geography and Development
14	Journal of Small Business Management	2	20	10.00	3.461	USA	Library and Information Sciences
15	Ids Bulletin-Institute of Development Studies	2	18	9.00	0.606	England	Management
16	Post-Communist Economies	2	16	8.00	0.875	England	Environmental Studies
							Geography and Development
							Economics

D: the number of documents; TC: the number of citations; TC/D: the number of citations by documents; JIF: journal impact factor
Source: own elaboration

Table 4
Contributing Authors (3 or above).

Num.	Author	Institution	Publications	Year Begin
1	Frederick J Riggins	North Dakota State University	7	2010
2	David M Weber	Northern Arizona University	4	2013
3	Lim Siong Guan	National University of Singapore	4	2015
4	Arvind Ashta	Burgundy School of Business	4	2011
5	Begona Gutierrez-Nieto	University of Zaragoza	4	2008
6	Djamchid Assadi	Burgundy School of Business	4	2011
7	Carlos Serrano-Cinca	University of Zaragoza	4	2008
8	Robert J Kauffman	Singapore Management University	3	2010
9	Md Khaled Amin	American International University-Bangladesh	3	2014
10	Gregor Dorfleitner	University of Regensburg	3	2016
11	Martin Jayo	University of Sao Paulo	3	2008
12	Jinghua Li	Zhejiang Gongshang University	3	2014
13	Marlei Pozzebon	HEC Montreal	3	2008

Source: own elaboration.

3.2.1. Co-citation analysis

CiteSpace provides us with an opportunity to perform cluster analysis of the co-citation network. Based on similarity or dissimilarity, clustering algorithms classify all of the cited references into several clusters (Frades & Matthiesen, 2010). In other words, articles within a cluster are more similar or consistent in content. Moreover, a series of statistics and views make it easier for us to detect the connections between clusters.

Fig. 2 presents the four prominent clusters achieved based on co-cited references—Cluster #0 (“microfinance industry”), Cluster #1 (“emerging technologies”), Cluster #2 (“microfinance industry”), and Cluster #5 (“sustainable growth”). These cluster labels are extracted from the titles of references through the Log-likelihood ratio (LLR)

method. Although both Clusters #0 and Cluster #2 are labeled as “microfinance industry”, their properties are not the same. Compared with Cluster #2, Cluster #0 mainly focuses on the study of online microfinance platforms, which will be analyzed in the following part.

It is worth noting that these clusters are closely connected due to the links of some key nodes. In essence, the publications corresponding to these nodes represent the close relationship between clusters. For example, [Hermes et al. \(2011\)](#) combining Cluster #1 and Cluster #2 argued that emerging banking technologies have helped MFIs to improve their sustainability and efficiency by reducing costs and improving the delivery of services. Similarly, [Kauffman and Riggins \(2012\)](#), which also combines Cluster #1 and Cluster #2, assessed the extent to which ICTs support the sustainability of microfinance.

Table 6 shows the basic information of these clusters, including the cluster ID, labels, size, silhouette, mean (year), and top terms (log-likelihood ratio, p-level). It is found that Cluster #0 labeled as “microfinance industry” has the most documents (84); Cluster #1 (“emerging technologies”) is next with 45, while cluster #2 (“microfinance industry”) and Cluster #5 (“sustainable growth”) have 38 and 24, respectively. Furthermore, CiteSpace also offers the value of silhouette. Generally, it should be between 0 and 1. The closer the value is to 1, the more consistent or similar the content of the articles within the cluster. As can be seen from Table 6, the value of silhouette for all four clusters is greater than 0.92, which indicates the high quality of this cluster analysis. From the mean year, most papers in these clusters were published around 2011 except for those in Cluster #0 (2014).

To be specific, the studies of Cluster #0 pay attention to online microfinance platforms—crowdfunding ([Ahlers et al., 2015](#); [Allison et al., 2015](#); [Belleflamme et al., 2015](#); [Colombo et al., 2015](#); [Mollick, 2014](#)), while these studies in Cluster #2 focus on the impact of microfinance ([Duvendack et al., 2011](#)), the nature of microfinance ([Cull et al., 2009](#)), performance or efficiency of MFIs ([Ahlin et al., 2011](#); [Hudon & Traca, 2011](#)), outreach ([Cull et al., 2011](#); [Hermes et al., 2011](#)). In addition, these papers in Cluster #1 research the adoption of ICT-based P2P lending and crowdfunding platforms, including their characteristics ([Berkovich, 2011](#); [Lee & Lee, 2012](#)), profitability ([Burtch et al., 2015](#); [Emekter et al., 2015](#)) and default probability ([Dorfleitner et al., 2016](#)) because of information asymmetries ([Lin et al., 2013](#); [Yum et al., 2012](#)) and credit risk ([Byanjankar et al., 2015](#)). At last, Cluster #5 studies the rise and revolution of crowdfunding ([Howe, 2006](#); [Lawton & Marom, 2010](#)).

Table 5

The Top 20 Most Cited Documents (TR: types of the research; TD: types of documents; RD: research direction; Con: conceptual; Emp: empirical) .

Num.	Documents	TR	TD	RD	Journals	Citations
1	Bruton et al. (2015) . New financial alternatives in seeding entrepreneurship: Microfinance, crowdfunding, and peer-to-peer innovations	Con	Article	Business and Economics	Entrepreneurship Theory and Practice	235
2	Stephen and Galak (2012) . The effects of traditional and social earned media on sales: A study of a microlending marketplace	Emp	Article	Business and Economics	Journal of Marketing Research	211
3	Allison et al. (2015) . Crowdfunding in a prosocial microlending environment: Examining the role of intrinsic versus extrinsic cues	Emp	Article	Business and Economics	Entrepreneurship Theory and Practice	195
4	Lee and Lee (2012) . Herding behavior in online P2P lending: An empirical investigation	Emp	Article	Business and Economics; Computer Science	Electronic Commerce Research and Applications	134
5	Burtch et al. (2014) . Cultural differences and geography as determinants of online prosocial lending	Emp	Article	Computer Science; Information Science and Library Science; Business and Economics	MIS Quarterly	113
6	Suri and Jack (2016) . The long-run poverty and gender impacts of mobile money	Emp	Article	Science and Technology	Science	110
7	Holvoet (2005) . The impact of microfinance on decision-making agency: Evidence from South India	Emp	Article	Development Studies	Development and Change	108
8	Michels (2012) . Do unverifiable disclosures matter? Evidence from peer-to-peer lending	Emp	Article	Business and Economics	Accounting Review	89
9	Short et al. (2017) . Research on crowdfunding: reviewing the (very recent) past and celebrating the present	Con	Editorial Material	Business and Economics	Entrepreneurship Theory and Practice	85
10	Cordova et al. (2015) . The determinants of crowdfunding success: Evidence from technology projects	Emp	Proceedings Paper	Business and Economics; Social Sciences	\	81
11	Yum et al. (2012) . Mixture cure models in credit scoring: If and when borrowers default	Con	Article	European Journal of Operational Research	Business and Economics; Operations Research and Management Science	81
12	Serrano-Cinca and Gutiérrez-Nieto (2016) . The use of profit scoring as an alternative to credit scoring systems in peer-to-peer (P2P) lending	Emp	Article	Science and Technology	Plos One	74
13	Gabor and Brooks (2017) . The digital revolution in financial inclusion: International development in the fintech era	Emp	Article	Business and Economics; International Relations; Government and Law	New Political Economy	72
14	Serrano-Cinca et al. (2015) . Determinants of default in P2P lending	Emp	Article	Computer Science; Operations Research and Management Science	Decision Support Systems	70
15	Bhatt and Tang (2001) . Delivering microfinance in developing countries: Controversies and policy perspectives	Con	Article	Government and Law; Public Administration	Policy Studies Journal	64
16	Duncombe and Boateng (2009) . Mobile phones and financial services in developing countries: A review of concepts, methods, issues, evidence and future research directions	Con	Article	Development studies	Third World Quarterly	63
17	Barasinska and Schafer (2014) . Is crowdfunding different? Evidence on the relation between gender and funding success from a german peer-to-peer lending platform	Emp	Article	Business and Economics	German Economic Review	61
18	Bayes (2001) . Infrastructure and rural development: insights from a Grameen bank village phone initiative in Bangladesh	Emp	Article, Proceedings Paper	Agriculture; Business and Economics	Agricultural Economics	55
19	Beaulieu et al. (2015) . A conceptual framework for understanding crowdfunding	Con	Editorial Material	Computer Science; Information Science and Library Science; Business and Economics	European Journal of Information Systems	51
20	Josefy et al. (2017) . The Role of community in crowdfunding success: Evidence on cultural attributes in funding campaigns to “save the local theater”	Emp	Article	Business and Economics	Entrepreneurship Theory and Practice	48

Source: own elaboration

Through analyzing the top 20 most co-cited references shown in [Table 7](#), we can also identify the hot topics are online crowdfunding and P2P lending platforms. In fact, 80% (16 / 20) belong to this subject. This result is consistent with the previous citation analysis. Additionally, 11 papers are from cluster #0, 7 from Cluster #1, and 2 from Cluster #2. The most co-cited reference is [Mollick \(2014\)](#), which offered insights into how crowdfunding works; next is [Belleflamme et al. \(2015\)](#), which developed a model combining crowdfunding with pre-ordering and price discrimination.

Furthermore, the relationship between online microfinance platforms and entrepreneurship aroused widespread attention from researchers. For instance, [Bruton et al. \(2015\)](#) investigated the influence of

microfinance, crowdfunding, and P2P lending in seeding entrepreneurship, while [Ahlers et al. \(2015\)](#) analyzed the signals used by entrepreneurs to encourage small investors to invest financial resources in an equity crowdfunding environment. Another example is [Allison et al. \(2015\)](#), which argued that crowdfunding platforms are a beneficial tool to promote entrepreneurial activity through microcredit and assessed how the extrinsic and intrinsic motivating cues in microloan entrepreneurial activities affect funding outcomes.

3.2.2. Co-word analysis

Understanding and detecting the dynamics of a research field is essential for researchers. In this section, the timezone view and timeline

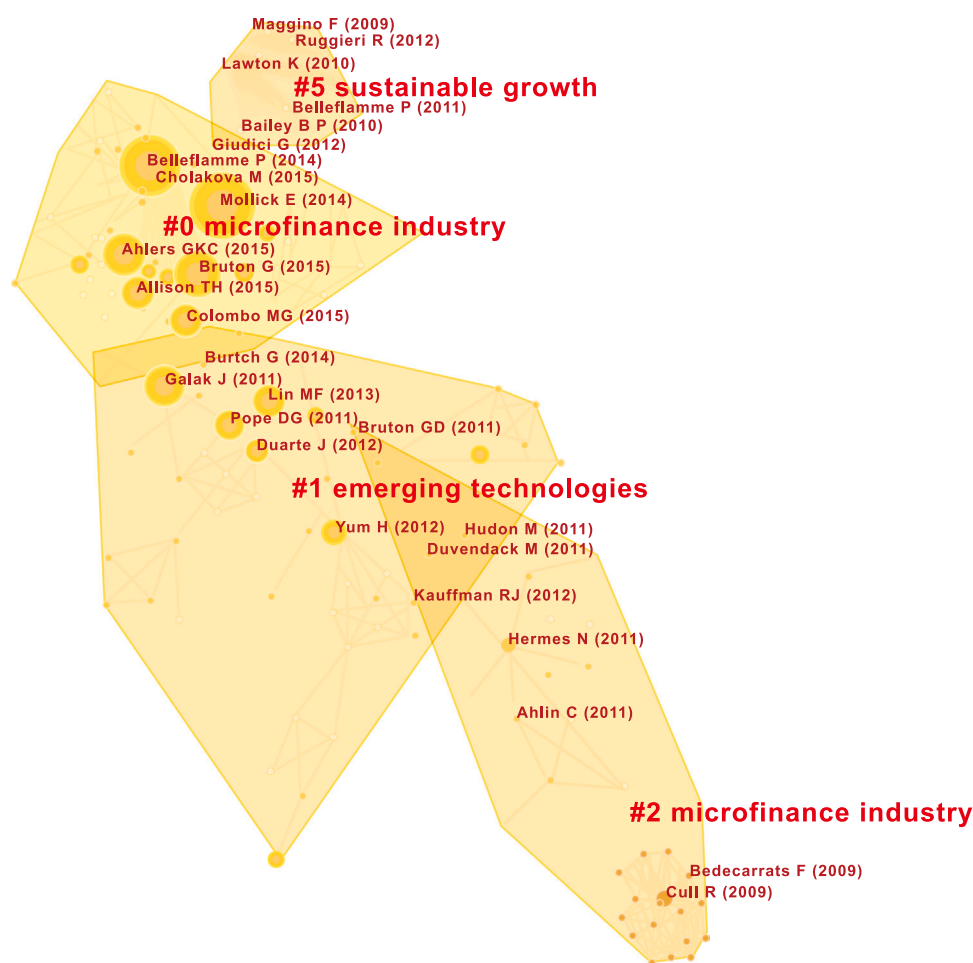


Fig. 2. Clusters of Co-Cited References.

view were presented through CiteSpace to perform the co-word analysis. Both of these diagrams incorporate the time factor into the visual analysis, which can help us to identify the hot topics and the evolution of the research effectively. Before running the software, we merged synonyms by creating a file named “CiteSpace.alias” in the original data folder. It is necessary to merge them since some different keywords have the same meaning. For example, “micro finance”, “micro-finance”, and “microcredit” were merged into “microfinance”. In addition, we integrated “ICT”, “information and communication technology”, “communication technology”, and “telecommunications technology” into “technology” for ease of analysis.

Fig. 3 provides the timezone view based on the keywords co-occurring over three times. The revolution of the keywords and their connection with each other can be recognized from it. Each node in the figure represents a keyword, and its location depends on the year in which it first appeared. The size of the node represents the co-occurrence frequency of this keyword from the year of appearance to the present. For instance, the largest node “microfinance” co-occurred 152 times with other keywords from 2009 to 2021. While the smallest node “blockchain” co-occurred only three times since it appears late (from 2020 to 2021).

In Fig. 3, microfinance, crowdfunding, technology, performance, model, impact, innovation, information, financial inclusion, and entrepreneurship are the top 10 most frequently co-cited keywords to study this issue. Moreover, market, outreach, investment, banking, determinant, fintech, poverty, P2P lending, microfinance institution, Islamic microfinance, and efficiency are also widely used by researchers. Analysis from the perspective of time, fintech, network, blockchain,

finance, access, entrepreneur, determinant, sustainability, and so on attracted attention by the latest research. These keywords mentioned above also represent hot topics and emerging trends. The details of these keywords are given in Table 8.

Unlike timezone views, timeline views are presented in the form of clusters. As shown in Fig. 4, the timeline view generated in this paper consists of 5 clusters, including Cluster #0 (“knowledge sharing”), Cluster #1 (“social crowdfunding platform”), Cluster #2 (“financial inclusion”), Cluster #3 (“P2P lending”), Cluster #4 (“fintech research”), Cluster #5 (“human capital”). The timespan of each cluster is marked as yellow lines. Table 9 provides the basic information of these clusters.

Among these clusters, Cluster #0 (“knowledge sharing”) has the most keywords—microfinance, technology, credit, developing country, innovation, determinant, Kiva, framework, risk, as well as the most extended timespan (from 2009 to 2020). While Cluster #3, with the keywords credit risk, trust, organization, model, culture, and management, has the shortest timespan (from 2016 to 2018). Other clusters with a relatively long timespan are Cluster #2 (from 2010 to 2020), including banking, poverty, finance, fintech, impact, financial inclusion, and mobile banking, and Cluster #1 (from 2013 to 2019) with investment, growth, crowdfunding, information, crowdsourcing, entrepreneurship, market, and crowd. In addition, we can also recognize the two latest clusters—Cluster #4 (from 2017 to 2020) and Cluster #5 (from 2016 to 2020). Cluster #4 contains keywords like microfinance institutions, performance, outreach, bank, efficiency, and blockchain, and Cluster #5 involves orientation, network, sustainability, and Islamic microfinance.

To further illustrate the impact of ICTs on the microfinance industry

Table 6
Details of Main Clusters.

ID	Label	Size	Silhouette	Mean (Year)	Top Terms (log-likelihood ratio, p-level)
0	microfinance industry	84	0.926	2014	microfinance industry (17.81, 1.0E-4); emerging technologies (15.53, 1.0E-4); financial service (15.53, 1.0E-4); crowdfunding research (15.53, 1.0E-4); information sharing (13.26, 0.001)
1	emerging technologies	45	0.961	2011	emerging technologies (20.2, 1.0E-4); financial service (20.2, 1.0E-4); crowdfunding research (20.2, 1.0E-4); information sharing (17.25, 1.0E-4); empirical study (17.25, 1.0E-4)
2	microfinance industry	38	0.968	2011	microfinance industry (49.36, 1.0E-4); decomposition analysis (17.5, 1.0E-4); microfinance institution (17.5, 1.0E-4); communication technology (11.55, 0.001); intermediation market structure (11.55, 0.001)
5	sustainable growth	24	0.992	2011	sustainable growth (10.67, 0.005); useful way (10.67, 0.005); document model building (0.16, 1.0); qualitative system dynamics model (0.16, 1.0); underlying dynamics (0.15, 1.0)

Source: own elaboration from data provided by CiteSpace (2021)

in detail, we present Fig. 5. It can be seen from this figure, that “technology” in Cluster #0 is associated with almost all clusters except Cluster #1 and Cluster #3. Specifically, the keyword “technology” is linked with “microfinance”, “Islamic microfinance”, “microfinance institutions”, “developing country”, “blockchain”, “fintech”, “Kiva”, “framework”, “determinant”, “innovation” and the like keywords. Research corresponding to these connections, on the one hand, evaluated the impact of ICTs on various aspects of microfinance. For example, Diniz et al. (2014) found that ICT-based platforms can help expand the microfinance business through the cooperation between commercial banks and local MFIs. According to Singh and Padhi (2015), ICTs use can promote efficiency in terms of cost and client management. Furthermore, Riggins and Weber (2016) found that ICTs can affect intermediation and market structure among different participants in the microfinance industry by referring to industry risk reports from 2011 to 2014. Besides, Akhter (2018) found that ICTs have an insignificant relationship with the performance of microfinance institutions in Bangladesh. In contrast, the latest study carried out by Ali, Gueyié, et al. (2021) revealed that investments in ICTs were positively related to MFIs’ financial performance.

Apart from that, numerous studies analyzed the impact of mobile technologies (or mobile phones, mobile banking, mobile money, mobile payment) on microfinance. For example, Amran et al. (2014), Assadi et al. (2018) and Gomera (2020) reported that the application of mobile technologies can improve financial services. Both Vong and Song (2015) and Uwamariya et al. (2020) focused on the impact of mobile technologies on the performance of MFIs. In comparison, Elliot et al. (2018) found that mobile technologies play a role in mitigating microfinance market inefficiencies.

Table 7
Top 20 Most Co-Cited Documents.

Num.	Author and Year	Titles of Documents	CC	Cluster ID
1	Mollick (2014)	The dynamics of crowdfunding: an exploratory study	44	0
2	Belleflamme et al. (2015)	Crowdfunding: Tapping the right crowd	36	0
3	Bruton et al. (2015)	New financial alternatives in seeding entrepreneurship: Microfinance, crowdfunding, and peer-to-peer innovations	32	0
4	Ahlers et al. (2015)	Signaling in equity crowdfunding	21	0
5	Allison et al. (2015)	Crowdfunding a prosocial microlending environment: Examining the role of intrinsic versus extrinsic cues	21	0
6	Lin et al. (2013)	Judging borrowers by the company they keep: Social networks and adverse selection in online peer-to-peer lending	21	1
7	Colombo et al. (2015)	Internal social capital and the attraction of early contributions in crowdfunding	19	0
8	Cholakova and Clarysse (2015)	Does the possibility to make equity investments in crowdfunding projects crowd out reward-based investments?	18	0
9	Galak et al. (2011)	Microfinance decision making: A field study of prosocial lending	18	1
10	Agrawal et al. (2011)	The geography of crowdfunding	17	0
11	Pope and Sydnor (2011)	What’s in a picture? Evidence of discrimination from prosper.com	17	1
12	Yum et al. (2012)	From the wisdom of crowds to my own judgment in microfinance through online peer-to-peer lending platforms	15	1
13	Moss et al. (2015)	The effect of virtuous and entrepreneurial orientations on microfinance lending and repayment: A signaling theory perspective	14	0
14	Duarte et al. (2012)	Trust and credit: The role of appearance in peer-to-peer lending	13	1
15	Ordanini et al. (2011)	Crowd-funding: Transforming customers into investors through innovative service platforms	13	0
16	Kauffman and Riggins (2012)	Information and communication technology and the sustainability of microfinance	12	1
17	Burtch et al. (2014)	Cultural differences and geography as determinants of online prosocial lending	11	1
18	Donner and Tellez (2008)	Mobile banking and economic development: Linking adoption, impact, and use	11	2
19	Cull et al. (2009)	Microfinance meets the market	10	2
20	Zhang and Liu (2012)	Rational herding in microloan markets	10	0

CC: the number of co-citations

Source: own elaboration

On the other hand, previous studies also examined the factors influencing the adoption of ICTs in the microfinance industry. For instance, based on the technology acceptance model (TAM), Wibowo et al. (2020) found that maqashid sharia (an individual’s perceptions based on his/her religious understanding) and market structure directly influenced the intention to use technologies in Islamic microfinance. Another investigation conducted by Tadele et al. (2018) claimed that the size of MFIs, financial structure, and social-oriented funding are positively related to MFI website accessibility. Besides, Rozzani et al. (2016) found that the lack of easiness in methods of conducting transactions affected the interest of clients in using mobile

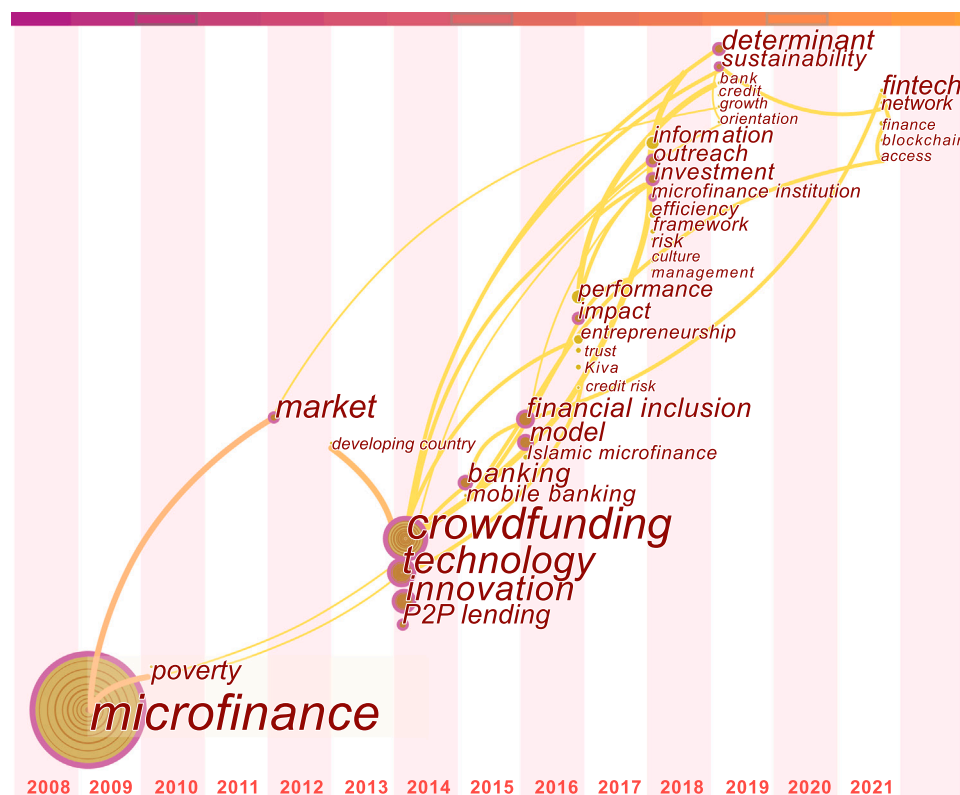


Fig. 3. Timezone View Based on Keywords.

Table 8
Main Keywords by Co-citations.

Num.	Keywords	Co-citations	Year	Num.	Keywords	Co-citations	Year
1	microfinance	153	2009	21	efficiency	6	2018
2	crowdfunding	44	2014	22	framework	6	2018
3	technology	27	2013	23	mobile banking	6	2015
4	performance	25	2017	24	sustainability	6	2019
5	model	22	2016	25	network	5	2020
6	impact	21	2017	26	risk	4	2018
7	innovation	19	2014	27	credit risk	3	2017
8	information	16	2018	28	credit	3	2019
9	financial inclusion	16	2016	29	finance	3	2020
10	entrepreneurship	15	2017	30	developing country	3	2013
11	market	13	2012	31	Kiva	3	2017
12	outreach	12	2018	32	trust	3	2017
13	investment	11	2018	33	bank	3	2019
14	banking	10	2015	34	culture	3	2018
15	determinant	10	2019	35	blockchain	3	2020
16	fintech	8	2020	36	access	3	2020
17	poverty	8	2010	37	management	3	2018
18	P2P lending	8	2014	38	growth	3	2019
19	microfinance institution	8	2018	39	orientation	3	2019
20	Islamic microfinance	7	2016				

banking.

What is more, the co-occurrence of technology with Kiva, fintech, and blockchain explains the evolution of technology research. As an online crowdfunding platform, Kiva has received a great deal of recent academic attention. In fact, many studies obtained data from Kiva (Burtch et al., 2014; Ly & Mason, 2012; Meer & Rigbi, 2013) or introduced Kiva into their case studies (Chen et al., 2017; Ge et al., 2016; Uddin et al., 2018) to research crowdfunding and P2P lending. As for fintech, which is defined as technological innovations in financial services (Vučinić, 2020), many investigations have combined it with financial inclusion. For example, Demir et al. (2020), Bhagat and Roderick (2020), and Mushtaq and Bruneau (2019) all argued that

fintech plays a vital role in financial inclusion. Nevertheless, according to Vučinić (2020), fintech also brings micro-financial and macro-financial risks to the financial system. Blockchain research primarily concentrates on adopting blockchain technology (Hu et al., 2018; Mukkamala et al., 2018) and its impact (Ozili, 2020; Seyedsayamdost & Vanderwal, 2020). For instance, Lane et al. (2017) discussed the importance of blockchain in lowering financial inclusion barriers. To sum up, applying fintech, especially blockchain and other emerging technologies, to promote financial inclusion is one of the research trends in terms of ICTs use in microfinance.

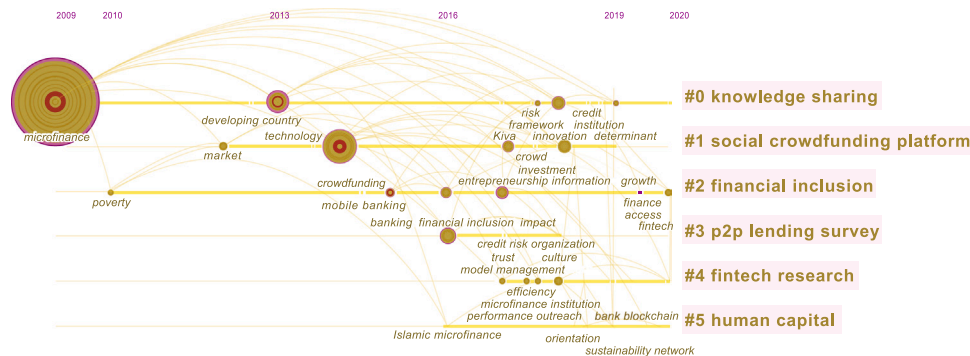


Fig. 4. Timeline View Based on Keywords.

Table 9
Details of Keywords Clusters.

Cluster ID	Cluster Label	Size	Keywords	Timespan
0	knowledge sharing	10	microfinance, technology, credit, developing country, innovation, determinant, Kiva, framework, risk, investment, growth, crowdfunding, information, crowdsourcing, entrepreneurship, market, crowd.	2009–2020
1	social crowdfunding platform	8	crowdfunding, information, crowdsourcing, entrepreneurship, market, crowd.	2013–2019
2	financial inclusion	8	banking, poverty, finance, fintech, impact, financial inclusion, mobile banking	2010–2020
3	P2P lending survey	6	credit risk, trust, organization, model, culture, management	2016–2018
4	fintech research	6	microfinance institutions, performance, outreach, bank, efficiency, blockchain	2017–2020
5	human capital	4	orientation, network, sustainability, Islamic microfinance	2016–2020

Source: own elaboration from data provided by CiteSpace (2021).

4. Discussion and conclusions

4.1. Discussions

Despite the significance of ICTs in the development of the microfinance industry, few studies have provided a whole picture of the relationship between microfinance and ICTs. This paper aims to examine the role of ICTs in microfinance by systematically reviewing the literature with bibliometric methods. Although this method has been introduced to the microfinance field recently, this paper is the first to address

issues from the perspective of ICTs.

In this study, a total of 347 samples were collected from the Web of Science database with reference to the guideline of the systematic review. To carry out the bibliometric analysis, the methods used in this paper include descriptive statistical analysis, co-citation analysis, and co-word analysis. In the co-citation analysis section, we performed these two analyses on cluster views, timezone views, and timeline views provided by CiteSpace. In this process, the pivotal points and the dynamics of the research front were detected.

Based on descriptive statistical analysis, the evolution of scientific output, the active institutions and countries, the influential journals, authors and publications were identified. First, it is found that there has been an overall increase in the number of annual publications and citations from 1998 to 2020. After 2006, a surge occurred in the number of both publications and citations. One possible reason for this is that the Nobel Peace Prize was awarded to the founder of Grameen Bank—Muhammad Yunus in 2006. This result may be also associated with the rapid development of technologies after 2006. Second, we found that the National University of Singapore, Singapore Management University and North Dakota State University are the top 3 prolific research institutions, while Tsinghua University has the most extensive partnership. From the distribution of these institutions, the most active countries are the United States, followed by China, France, and Singapore. Third, Electronic Commerce Research and Applications, Sustainability, and Journal of Business Ethics are recognized as the top 3 productive journals. We also identified “business and economics” as the leading research field, followed by “computer science” and “government and law”. Additionally, the most influential publications, such as Bruton et al. (2015), Stephen and Galak (2012) and Allison et al. (2015), are pointed out by citations. Finally, it turns out that there are 13 authors who have published more than two articles. Riggins, Weber, Guan, Ashta, Gutierrez-Nieto, etc. contribute substantially to this research field.

A key finding is that ICT-based crowdfunding and P2P lending platforms have been the major topics of this research field. In addition,

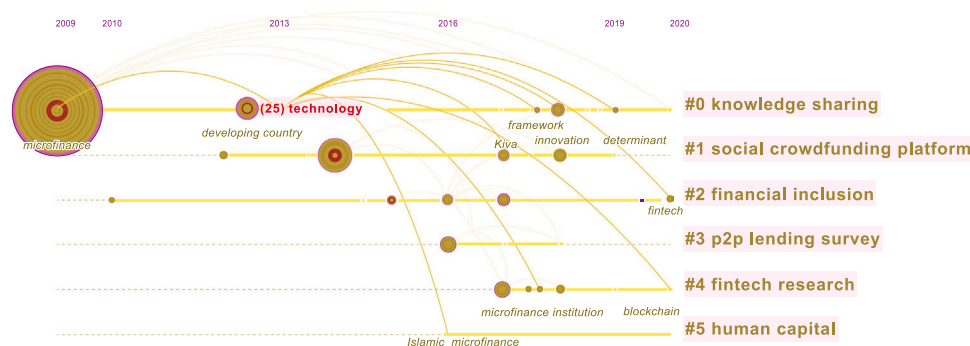


Fig. 5. Links to “technology”.

there has been a spate of research interest in the role of these online microfinance platforms in entrepreneurship. The following fact can explain this result. At first, according to the number of citations, 12 of the top 20 documents focused on these issues. Besides, institutions with extensive partnerships, such as Tsinghua University, the National University of Singapore and the University of Michigan, also mainly researched online microfinance platforms. Apart from that, the results of the co-citation analysis further confirm this conclusion. In the co-citation analysis section, we found that, among the top 20 most cited references, 80% of them studied online crowdfunding and P2P lending platforms. Also, based on cluster analysis, both Cluster #0 and Cluster #1 pay attention to this subject. In the section of the co-word analysis, the keyword “crowdfunding” ranks second after “microfinance” with as many as 44 co-citations. Another research hotspot is mobile banking or mobile payments according to the result of citations analysis and co-citation analysis.

To further illustrate the impact of ICTs on the microfinance industry, we have analyzed the links between “technology” and “microfinance” shown in the timeline view. Research corresponding to these connections, on the one hand, examined the impact of ICTs on various aspects of microfinance, including impacts on operations, efficiency, performance, sustainability, outreach, etc. In particular, numerous studies evaluated the impact of mobile technologies (or mobile banking, mobile payment, mobile money) on microfinance. On the other hand, some of these works explored the factors influencing the adoption of ICTs in microfinance.

Based on the above findings, it can be inferred that studies on microfinance and ICTs use can be divided into two categories. First, from the macro-level, many studies explored the relationship between ICTs and the microfinance industry directly. A classic example is [Kauffman and Riggins \(2012\)](#), which discussed the role and impact of technology on the sustainability of the microfinance industry. Another category is analyzing the specific application of ICTs in the microfinance industry—ICT-based crowdfunding and P2P lending platforms, including how they work, their revolution and risks, their relationship with entrepreneurship, etc. It is expected that ICTs and ICT-based platforms will continue to play a role in the future development of microfinance and even the entire finance industry. Subsequently, more and more academic attention will be put on this subject.

At last, we proposed that research on applying fintech, especially blockchain technology and other emerging technologies, to promote financial inclusion is one of the future research trends. Although there is a growing body of literature on the application of emerging fintech, limited empirical evidence could be found to measure its impact. Future work could be done to examine whether, how and to what extent the operation of MFPs might be affected by these technology innovations with empirical methods ([Cai, 2018](#)). Accessing how managers or investors respond to these changes will also be interesting. Otherwise, considering the potential risks appearing with the advent of emerging technologies, future research regarding risk management will also be worthwhile. More broadly, other interesting questions such as the opportunities and challenges faced by COVID-19, the role of fintech in Islamic countries, the factors influencing the customer experience of using fintech and digital solutions from the microfinance sector, and if these digital solutions can have positive or disruptive influence on financial inclusion are raised by the study.

In addition, it can be anticipated that the evolution of these studies in keywords has similarities with research on entrepreneurship. During the past decade, literature on entrepreneurship has also focused on topics like microfinance ([Karlan & Valdivia, 2011](#); [Nega & Schneider, 2014](#)), poverty ([Bruton et al., 2013](#); [Ogundele et al., 2012](#)), developing countries ([Munemo, 2012](#); [Ratten, 2014](#)), innovation ([Huggins & Thompson, 2015](#); [Ndubisi & Iftikhar, 2012](#)), performance ([Arogyaswamy, 2017](#); [Randøy et al., 2015](#)), credit risk ([Shahriar & Garg, 2017](#)), determinants ([Khattab et al., 2017](#)), microfinance institutions ([Kittilaksanawong & Zhao, 2018](#)), and fintech ([Kouame & Kadir, 2020](#)). Furthermore, much

of the recent literature pays particular attention to financial inclusion and entrepreneurship domains ([Nogueira et al., 2020](#)). According to [Goel and Madan \(2019\)](#) and [Ajide \(2020\)](#), financial inclusion has a significant effect on entrepreneurship. Given that the role of financial inclusion in poverty alleviation and economic development has been worldwide recognized, more empirical research is needed to determine whether and how financial inclusion influences entrepreneurship. Besides, exploring more channels to realize the positive impact of financial inclusion on entrepreneurship will be interesting.

4.2. Limitations

Given that our samples come from a single database, future research can expand it to multiple databases for comparison and completeness. Another limitation of this study is that our sample size is restricted to search keywords. Some critical articles may have been missed because of ignoring certain keywords (e.g., financial inclusion). Accordingly, future research can increase the sample size by adding additional keywords to generalize the findings. Notwithstanding these limitations, we hope the current study can provide a basis for future research.

4.3. Lessons learned

Information and communication technologies (ICTs) play a significant role in achieving the great potential of microfinance, especially in the context of the Covid-19 pandemic. Although considerable research effort has been put into microfinance and ICTs, no study has provided a whole picture of the relationship between microfinance and ICTs. This research aims to assess the role of ICTs in the microfinance industry by systematically reviewing the literature with bibliometric methods. It provides a comprehensive review of ICT-related research in the field of microfinance, which will be of interest to scholars, practitioners, policymakers, and evaluators, and has far-reaching theoretical and practical implications.

The study provides policymakers and evaluators with important insights into the role of ICTs in microfinance and even the entire financial industries. First, the role of technological advancements in the profitability, efficiency and sustainability of MFIs cannot be underestimated. Evaluators must conduct targeted investigations and determine whether and to what extent such technological improvements contribute to organizations. Second, policymakers and evaluators must evaluate the issues presented in this research, such as what has occurred and what might be done in the future to avoid technological maladies and boost sustainable development. In addition to analyzing each cluster, the connection of distinct themes should also be taken into consideration by policymakers and evaluators. For example, the adoption of fintech to promote financial inclusion has become one of the future trends. Correspondingly, the implications of this trend for management processes and operations also require further evaluation. Third, our findings suggest that practical assessments of the cultural, organizational, and environmental elements that influence ICTs adoption are required. It is also necessary to evaluate the application of ICTs to management processes from a legal and ethical perspective.

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CRedit authorship contribution statement

Aiping Liu: Conceptualization, Methodology, Formal analysis, Writing – original draft. **Elena Urquía Grande:** Validation, Investigation structure, Writing – review & editing, Supervision. **Pilar López Sánchez:** Validation, Investigation structure, Writing – review & editing, Supervision. **Ángel Rodríguez López:** Validation, Investigation

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Declarations of Competing Interest

None

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