Fintechs: A literature review and research agenda

Eduardo Z. Milian*, Mauro de M. Spinola, Marly M. de Carvalho

Department of Production Engineering, University of Sao Paulo, Av. Prof. Luciano Gualberto, 1380 – 05508-010 Sao Paulo, Brazil

A B S T R A C T

Although the fintech subject has been widely discussed in the press and communications media, there is a lack of consensus on the definition of the term in the scientific literature and the key research topics and trends. Aiming to narrow this gap, the objective of this study is to investigate the concept of fintech, to map the literature and point out new routes and opportunities in the field. For this purpose, a Systematic Literature Review (SLR) is performed, attempting to describe the areas of fintech activities, propose a categorization for this literature, highlight the main issues dealt with to date in the sample publications, as well as to point out new questions for continuing research in this field. The results show a set of definitions for the term fintech and suggest as a comprehensive understanding of fintech, as innovative companies active in the financial industry making use of the availability of communication, the ubiquity of the internet, and the automated processing of information. Moreover, the literature focuses on financial services and innovations, dealing with issues of financial industry regulation and local legislation or the financial system globally. The innovation of research subcategories (technology adoption/network externalities), blockchain and security appear with great emphasis in this work and represent the current most sensitive aspects also linked to the more global theme of digital transformation. Finally, subjects related to financial services operation particularly deal with risks of financial loss related to different factors involved in the business environment of these organizations.

1. Introduction

The financial industry is, without a doubt, of great importance to society and in the daily lives of people worldwide. Although this sector has undergone major transformations over the centuries due to changes in political and geographic regimes and legislation, several authors (Berger, 2003; Mareev, 2016; Shim and Shin, 2016) state that a new era is being born for banks with the rise of fintechs. This is an under-explored phenomenon and represents an important challenge for academia as well as for managers in the financial industry (DeYoung, 2005; Dapp, 2014; Gábossy, 2016; Schueffel, 2016; Iwata, 2017).

Fintech appears as a "buzz word" or hype, especially in the press, as if it were an important phenomenon that should be observed by practitioners linked to the financial industry, information technology (IT) and innovation (incubators, venture capital, angels, among others). Derived from contracting the words finances and technology, the term "fintech" arose in the scientific literature in 1972. In an academic article, the vice president of Manufacturers Hanover Trust, Abraham Leon Bettinger, detailed models about how daily problems encountered in that organization were analyzed and resolved, and formulated the following definition for fintech: "*an acronym which stands for financial technology, combining bank expertise with modern management science techniques and the computer*" (Bettinger, 1972, p. 62). Also found spelled as FinTech, Fin-Tech or fin-tech, in the present context fintech is a neologism that describes the connection of the modern, such as internet-related, technologies (for example, cloud computing, mobile internet) with business activities typical of the financial services industry (for example, loans, payments, transfers of monetary values and diverse banking operations) (Gomber et al., 2017)Despite the increasing interest in fintech, there is still a lack of consensus on its definition among scholars and practitioners and on the theoretical foundations of this field. Furthermore, there is a notable lack of works in the academic literature that deal with this subject systematically or that seek to map it in such a way as to abbreviate surveys of the existing literature to point to new research activities as well as to structure scientific knowledge in this area, and thus to be able better to subsidize its researchers and practitioners.

Looking to address this research gap, this article aims to investigate the concept of fintech, to map the literature and point out new routes and opportunities in the field. To achieve that objective, the following research questions (RQ) were formulated:

RQ1. How has the literature on fintechs evolved over time? RQ2.

* Corresponding author.
E-mail addresses: eduardo.zied@usp.br (E.Z. Milian), mauro.spinola@usp.br (M.d.M. Spinola), marlymc@usp.br (M.M.d. Carvalho).

Table 1
Fintech Activity Sectors.

Fintech Activity	CB Insights (2017). Global Fintech Report Q1/2017	Khandwe (2016) – Societal Implications of Fintechs
Loan Technology	Credit companies include mainly peer-to-peer loan platforms, as well as platforms for loan underwriters. They use "machine learning" technologies and algorithms to assess the reliability of the borrowers. Among all the Fintechs, the loan modality is the most recurrent.	In 2014, around 27% of total global capital was destined to consumer loans and 16% to PMEs. Companies such as Zopa, Lending Club, and SoFi worked with personal loans, while OnDeck and MarketInvoice lent to PMEs.
Payments/Billing technology	Payment and collection companies include solutions to facilitate processing payments for the developers of payments by card (or bank slips) for software tools for billing by subscription.	One of the challenges most frequently facing traditional operators is the disintegration of the payments business. Companies such as M − Pesa, ApplePay, Google Wallet or Paytm permit customers to use and enjoy ease of payment from their cell phones or tablets.
Personal Finance/Asset Management	These are technology companies that help individuals manage their accounts and/or personal credit, and their assists and personal investments.	These are applications that connect people's current accounts, classifying their expenses and helping in their financial management.
Money Transfer/Remittance	Companies that transfer money include mainly peer-to-peer platforms to transfer funds between individuals in different countries.	
Blockchain/Cryptocurrency	These companies include "key softwares" or technology companies in the domain of distributed ledger registers. Ranging from Bitcoin portfolios to suppliers of sidechain insurance.	
Institutional Technology/Capital Markets	Tools for financial institutions, such as banks, hedge funds, mutual funds or other institutional investors. These range from alternative commercial systems to software modelling and financial analysis.	These applications suggest where and how users should invest based on information such as age, objectives, and market knowledge.
Equity crowdfunding	Platforms that allow a group of individuals to make financial contributions to projects or companies provisioned in an equity form.	In addition to financing debts, crowdfunding companies such as Seeders, Crowdcube or OurCrown approach companies and investors interested in investing in small businesses and start-ups.
Security Technology	Companies that create new platforms for subscriptions, public offers, distribution and brokerage, offers to improve customer experience and Software as Service (SaaS) to help insurers deal with problems with legacy information systems.	These platforms allow getting quotes, comparisons and contracting insurance online in the most varied modalities.

What are the main subjects and issues associated with fintechs found in the scientific literature?

In pursuit of this goal, the work describes the areas of fintech activity, maps the literature on the subject, and proposes a categorization for it, highlighting the main questions which have been dealt with to date in the research contained in the indexed databases, recognized as important to the scientific community. Moreover, based on a critical review of the subjects found, new research questions capable of increasing the quality and the relevance of future studies on the subject are proposed. The research approach selected was a Systematic Literature Review (SLR), applying bibliometric and content analysis, through a coding schema and network analysis. This Systematic Literature Review (SLR) provides researchers and practitioners with a structured, categorized view of what has been produced in the literature on fintechs from 1980 to the present (February 2018).

This article is structured as follows: following this introduction, there are presented the main definitions, concepts and categorizations of fintechs found in the academic literature, journals and consulting company reports, such as KPMG (Fortnum et al., 2017) and CB Insights (2017). Then the method used to carry out the SLR is described, followed by the results and a discussion of them, and finally, the conclusions of the work.

2. Background

Formed by a contraction of the words finance and technology, the term fintech refers to companies that are using technology to operate outside traditional business models for financial services, seeking to change the way these services are offered (Fortnum et al., 2017), using communication, the internet and the automated processing of information (Arner et al., 2016; Chen, 2016; Gabor and Brooks, 2017; Szpringer, 2016).

According to Christensen's (2003) theory of disruptive innovation, fintechs can be classified in two categories: "Sustainable Fintechs", for established financial service providers that work to protect their market positions by using IT through incremental innovations and "Disruptive Fintechs" that are new companies and start-ups that challenge established providers by offering new products and services. (Jesse

McWaters, 2015; Chiu, 2016; Lacasse et al., 2016). These undertakings have new business models that promise greater flexibility, security, efficiency and opportunities than traditional financial services (Gomber et al., 2017).

Even though the financial industry has been traditionally an early adopter and an intensive user of new IT solutions, the rise of innovative business models and new competitors have had a tremendous influence on the present dynamic of the industry. In a rapidly changing economic environment and in light of demanding and expensive regulation requirements, the traditional players in banking and financial services are facing a substantial transformation with the rise of digital finances (Gomber et al., 2017). Thus, fintech start-ups and even large IT companies enter into the domain of the financial industry, gain ground and conquer customers who had been traditionally served by well-established providers. According to Gomber et al. (2017), there are three main reasons why this occurs. First, fintech companies offer new products and solutions that meet the needs of customers which were formerly not met or had not been made sufficiently available by traditional providers of financial services. An example is the introduction of a magnetic card reader unit for smart phones and tablets, which made it possible for street vendors and mobile vendors to accept debit and credit cards (Gomber et al., 2017). Second, fintech companies created new opportunities for product and services sales through applications of new technologies and new concepts. MarketInvoice (www.marketinvoice.com) for example, offers small and medium businesses the opportunity to speed up their invoicing to obtain working capital more rapidly in exchange for payment of a certain commission, and they no longer have to depend on receipt of the original invoice data (an operation known as factoring, marketing or commercial development) (Buckley and Webster, 2016). Third, IT companies often have a culture that is essentially different from the traditional financial services providers. They are sufficiently agile and innovative to put the established competitors under pressure. Fintech companies concentrate on internet-based business models, accessible and profitable, to compete with traditional financial service providers. According to Hemmadi (2015), some specialists in the financial area believe that at some point banks will be used only for deposits, while the rest will be done using fintech services (Hemmadi, 2015, cited in Gomber et al., 2017).

In his study of the implications of fintechs for society and business, Khandwe (2016), citing Jesse McWaters (2015), identified the main subsectors of fintech activity. Table 1 is an adaptation of a classification of the Activity Sectors of Fintechs based on Khandwe (2016), with the vertical columns used by CB Insights in the Global Fintech Report Q1/2017 (CB Insights, 2017).

Pollari (2016) questions whether traditional banks are sufficiently agile, flexible and competitive in terms of cost. Banks do not always stay abreast with technological change as well as technology companies do and therefore they can win over some of their customers. Nevertheless, banks enjoy greater confidence as secure institutions that are subject to state regulation and oversight. The activities of fintech companies prompt questions about equality of conditions, evaluating the competition and about cooperation, as well as the convenience of subjecting these new competitors to the regulations of banks, insurance companies, investment companies, payments institutions and/or electronic currency (Pollari, 2016).

3. Research method

The basic objective of a Systematic Literature Review (SLR) is to gather and assess the available research related to the subject of interest (the research question), thus achieving impartial results that can be audited and repeated. An SLR is a rigorous methodological review of research results, whose objective is not just to group existing works on this subject; it is also meant to help develop evidence-based guidance for professionals involved in the area of study (Kitchenham, 2004). Moreover, to demonstrate that the work is new to the existing body of knowledge, the results of an SLR should identify the state of the art with respect to the research question (Levy and Ellis, 2006)

3.1. Research questions

For the study to achieve its objectives, i.e. to provide researchers and practitioners with a structured categorized view of what has been produced in the fintech literature, here are the two proposed research questions. The first is concerned with presenting an overall quantitative and longitudinal view of the works on the subject, phrased as follows:

RQ1. How has the literature on fintechs evolved over time?

Seeking answers of a more quantitative nature, this question has been broken down into the following:

RQ1.1. Which have been the most influential studies (considering the number of citations)?
RQ1.2. Which basic references influenced the identified studies (considering not just the primary studies in the selected sample, but also their citations)?
RQ1.3. What are the main periodicals for this subject and how has the number of publications evolved over time?

In this work of identifying the existing literature to create and develop new studies, a grouping of the major subjects and research questions was taken from the fintech activities found in the publications from the sample in categories. Thus, the second question of this work has the following formulation:

RQ2. What are the main subjects and issues in the scientific literature on fintechs?

This section describes the process followed to accomplish this systematic literature review, which is based on a known and validated methodology (Kitchenham et al., 2008). The *StArt – State of the Art through Systematic Review* was used. This was developed in the research *Lab on Software Engineering* [LaPES of the Federal University of São Carlos (UFSCar)] which lends support for planning, executing, and summarizing an SLR, as proposed by Kitchenham (2004). Thus, the

evaluation method presented by Kitchenham and Charters (2007) together with the work of Carvalho et al. (2013), were adapted to carry out this research project on Fintechs. Moreover, to identify the scenario for scientific literature on fintech, bibliometric analysis techniques (Ikpaahindi, 1985) and content analysis (Duriau et al., 2007) were used.

3.2. The sampling process

The initial sample was taken from the indexed databases Web of Science Core™ Collection through the ISI Web of Knowledge™ portal (*Thomson Reuters*) and Scopus® by Elsevier B.V. These databases were selected since they provide interfaces that make it possible to perform simultaneous searches on different sources using the common set of search strings. In a broad way, i.e., without restriction on periodicals, periods or areas of knowledge, studies from 1980 until the end of February 2018 were identified, from sources such as Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, and from the Emerging Sources Citation Index, which contains studies of ACM, EBSCOhost, Elsevier, Emerald, IEEE, INFORMS, ProQuest, SAGE, Springer, Taylor & Francis, Wiley, among others.

These databases are also a source for calculating the indicator Journal Citation Report (JCR) which is one of the most often used mechanisms to assess publications with a database of citations, and the SCImago, Journal Rank (SJR) indicator developed by SCImago from the widely known algorithm Google PageRank™. This SJR indicator shows the visibility of the journals contained in the 1996 Scopus® database from 1996.

Only publications of the "Article" or "Review" type were selected because they have undergone a rigorous peer review process prior to publication. Moreover, these works also contain all the information necessary (metadata) to undertake bibliometric analysis, with authors, references, number of citations and date of publication (Carvalho et al., 2013). Works that did not meet the above requirements were rejected under the quality criterion (Kitchenham and Charters, 2007; Kitchenham et al., 2008).

Fig. 1 is a schematic presentation of the process for identifying and selecting the sample for the study. In the publication identification phase, with the use of preliminary definitions for the search strings, the searches were carried out on the databases indexed in Web of Science and Scopus. Based on the results obtained, the strings were refined eliminating publications in which the expressions contained in the search string were not connected with financial technology or fintech (such as "finetech" OR "findings*tech*", for example), i.e. publications that did not meet the search objective were eliminated. Then the results of the search done using the refined search strings were inserted into the database of the StArt tool, in the Web of Science and Scopus databases. The StArt tool automatically excluded articles from the *Scopus* database that had already been inserted from the Web of Science database, taking care to verify whether the publications were classified as articles or reviews in the two indexed databases. At the end of this selection process a manual sweep was done on the set of articles which had previously been ordered alphabetically by title order to weed out other duplications.

Table 2 shows the strings used to search the indexed Web of Science Core™ Collection through the ISI Web of Knowledge™ portal (Thomson Reuters) that resulted in 118 publications (112 articles and six reviews) and also those used in the search done on Scopus®"by Elsevier B.V. database that resulted in 218 publications (204 articles and 13 reviews). It is noteworthy that these totals include publications which, despite fulfilling the search criteria of each of the databases, have nothing to do with the goal of this study. This identification phase (see Fig. 1) resulted in a sample with 211 publications (see Table 2). Bowden's (2006) work is classified as a review in the Scopus® database and as an article in the Web of Science Core™ database.
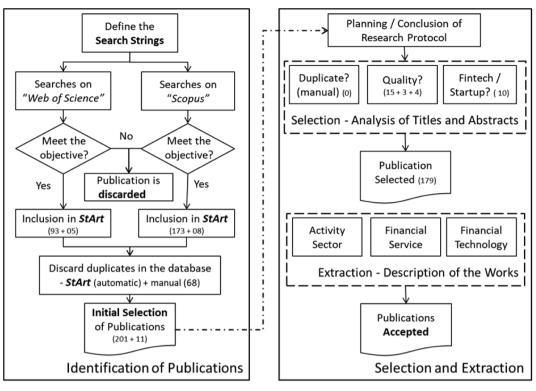
Fig. 1. Process to Identify and Select the Sample.

Of these 211 publications, 32 were determined to be outside the focus of the study and were thus excluded from the bibliometric analysis and content (extraction) phases. Thus 179 publications were accepted.

As shown in Fig. 1, the first activity in the selection and extraction phase closed out the planning phase. Once the research protocol was concluded, the practice of separating the sample was established by excluding the publications that did not meet the quality criteria because they were magazine articles, were from corporations, or their English version could not be found, and separating the remaining publications related to financial services or financial technology. Moreover, the publications included that make explicit reference to the term fintech (or its variations) or start-ups were marked.

As Carvalho et al. (2013) suggested, during the triage process the authors of the present study read the titles and abstracts of 211 publications separately. Then they kept in the sample only those publications that everyone agreed met the inclusion criteria, that is, they fit the scope of the fintech study and had the necessary metadata for the following stages of analysis. When consensus was not reached among the authors, the complete article was analyzed and discussed with renewed scrutiny resulting in its inclusion or exclusion.

In this phase of the selection process, 172 publications were identified through Title and Abstract Analysis. Then, the sampling technique of snowballing (Frey et al., 2000; Fink, 2003) was used to identify the most important references that had not been recovered in the initial sample, considering the most-cited articles that fit the scope of the study and maintaining the same restrictions as in the initial triage. This technique consists of trusting the members of the group of publications that meet the criteria of the initial search, identifying new publications that met the initial search criteria, identifying new publications that share the same characteristics of the original group, so that they could be included in the sample (Henry, 1990). Seven publications were included in the initial sample as a result of this process, totalling 179 publications for the sample selected.

In the extraction phase, with the description of the works, the research sample was analyzed using two techniques: bibliometric analysis

and content analysis. Fig. 1 shows the work flow for the activities undertaken, adapted from Carvalho et al. (2013), which is detailed in the next subsections.

3.3. Data analysis

Bibliometric analysis (Ikpaahindi, 1985) and content analysis (Duriau et al., 2007) techniques were applied to identify the range of scientific literature on fintechs, describing the trends and main topics addressed. These analyses are complementary, since the first attempts to identify patterns of literature based on publication dates, and the second captures information on the main topics, approaches and methods as well as the most important definitions of the subject in question (Carvalho et al., 2013). The applications of these processes of analysis are described in the following.

3.4. Bibliometric analysis

Bibliometric analysis is intended to answer questions related to the evolution of the literature on fintechs over time. More specifically, these are questions RQ1.1, RQ1.2 and RQ1.3. This analysis can be defined as a set of techniques to qualify the process of written communication (Ikpaahindi, 1985), making it possible to identify the most productive authors, the periodicals and periods in which the publications were produced, the evolution of publications over time, the most influential articles in a particular set of studies and the subjects most closely related to the research question (Prasad and Tata, 2005).

Version 1.3 of the Science of Science (Sci2) tool is to create networks of citations and co-occurrences of keywords (Sci2 Team, 2009). The Sci2 tool is a modular set of tools to study scientific communications, supporting a temporal, geospatial, topical and network analysis. The data sets from the selected sample were exported as "pure text" from the Web of Science Core™ Collection and Scopus® databases and imported to the tool Sci2.

The citations were analyzed to identify the most influential studies. This analysis is based on the premise that authors cite publications they

Table 2
Origin of the Sample Publications (02/20/2018).

	"Web of Science Core™"	"Scopus®"	Common to the databases	Total
Search string	(ts=("fin*tech*" OR "financial* technolog*" OR "financial* technology*" OR "bank* start up*" OR "bank* start-up*" OR "bank* startup*" OR "banking* start up*" OR "banking start-up*" OR "banking startup*") OR TITLE-ABS-KEY (("financial* start*up*" OR "financial* start-up*" OR "financial* start up*" OR "financial* startup*" OR "start up* financial" OR "start up* bank*" OR "start-up* bank*" OR "startup* bank*" OR "startup* banking*") NOT (ts =("*finetech*" OR "findings*tech*" OR "financial, technological" OR "financially, technologically")))	(TITLE-ABS-KEY (("fin*tech*" OR "financial* technolog*" OR "bank* start up*" OR "bank* start-up*" OR "banking* start up*" OR "banking start-up*" OR "banking startup*")) OR TITLE-ABS-KEY (("financial* start*up*" OR "financial* start-up*" OR "financial* start up*" OR "start up* financial")) OR TITLE-ABS-KEY (("start up* bank*" OR "start up* banking*" OR "startup* banking*")) AND NOT TITLE-ABS-KEY (("SUR FIN TECH*" OR "(FIN) technique*" OR "*finetech*" OR "findings*tech*" OR "financial, technological" OR "financially, technologically")))		
Filters	Article OR Review	Article OR Review		
Articles	92	173	64	**201**
Reviews	06	08	03	**11**
TOTAL	98	181	121	**212***

N.B. * A Bowden (2006) publication appears as an article in the Web of Science Core™ database and as a review in Scopus®.

consider important to the development of their studies; therefore, the documents cited with greatest frequency probably exercise a greater influence that the least often cited (Ramos-Rodríguez and Ruíz-Navarro, 2004).

In the Social Network Analysis (SNA), a network consists of nodes and links in which each node is a point on the network and a link is a line that connects two nodes (Wasserman and Faust, 1994). In a co-authored network, nodes represent authors and links (non-directional) the pairs of authors who write a certain article together. One common technique of network analysis is to measure the centrality of the author, concerned with the kinds and number of connections that authors have with other members of their network component.

There are three main principles of centrality: degree, betweenness and closeness (Freeman, 1979). The degree of centrality measures how many coauthors a given author has with other authors. Betweenness measures the number of times that one node intercepts the shortest route between two other nodes and thus gives an indication of the extent to which authors play a connecting role among other authors. Farness is calculated as the sum of the shortest distance of a node from all the other nodes; closeness is the reciprocal of farness and the greater the degree, the less total distance from one node to all the other nodes in the component. Authors with high closeness receive new information more quickly and can disseminate their ideas more quickly. UCINET (Borgatti et al., 2002) is a proprietary tool for calculating centralities.

3.5. Content analysis

The use of content analysis techniques is intended to respond to question RQ2. This technique was adopted because it offers flexibility in defining a coding scheme for the activity sectors of the fintechs and for the research question in the area contained in the sample. This is then used in the frequency statistics for these codes and their relationships, as well as in the qualitative analysis of the interpretation (Duriau et al., 2007).

A word cloud with the keywords contained in the initial selection of publications was created using the StArt tool while still in the planning/conclusion of the research protocol phase (see Fig. 1) to aid in structuring the content analysis and was one of the elements used in meetings among this work's authors with the other members of the research group. These meetings were held to identify the major subjects related to the work in focus and to propose a categorization scheme able to map these research questions while systematically organizing them.

The content analysis was accomplished using as its basis the coding scheme elaborated to analyze the works, as shown in Table 3. To create

Table 3
Stratification of the Codes.

Activity Sector (Khandwe, 2016; CB Insights, 2017)	Service Operations (SO)
S1 – Not focused on a specific sector	OS1 – Risk/Delinquency
S2 – Payments/Billing	OS2 - Risk/Security
S3 - Loans	OS3 – Compliance
S4 – Investments	OS4 – Others
S5 – Transfers/Remittances	*Financial Technology (FT)*
S6 – Crowdfunding	FT1 – Adoption/Externality
S7 – Blockchain /Cryptocurrencies	FT2 – Mobile
S8 – Institutional/B2B	FT3 – Blockchain
S9 – Insurance	FT4 – Big data
Financial Service (FS)	FT5 – Biometrics
FS1 – Innovation	FT6 – Security
FS2 – Regulation	FT7 – Risk
FS3 – Financial Inclusion	*Mobile (M)*
FS4 – Financial Education	M1 – Internet Banking
FS5 – Services Operation	M2 – Mobile Banking
Innovation (I)	M3 – Self Service
I1 – Product or Service	
I2 – Financial Arrangements	

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the coding scheme, a mixed deductive approach was used based on the theoretical references and insights of bibliometrics such as keywords and hot topics, as suggested by Carvalho et al. (2013). The codes related to the fintech activity sector are supported in Khandwe (2016) and CB Insights (2017), see Table 1, using an adaptation of the categories originally proposed in those works. The StArt software was also used to help in the process of coding the sample contributing to the creation of the other codes in Table 3.

The coding system was then analyzed using descriptive statistics and relationships (cross-tabulation and correlation), using the IBM SPSS software, and later the relationship networks and the core-periphery analysis (Borgatti et al., 2002) among codes that were created with the help of the UCINET software (Borgatti et al., 2002) and Netdraw (Borgatti et al., 2002).

4. Results

4.1. Bibliometric analysis

This subsection contains the results of the process of surveying quantitative data related to the periods, publications, authors, citations and other information involving the periodicals that are part of the sample.

4.1.1. Publications/year/period

The sample covers the period from 1980 to February 2018 and contains 179 publications; 11 of them (6.1%) were found up to 1999, three (1.7%) are from 1986 and three (1.7%) from 1999. The period between 2000 and 2015 concentrates 29% of the sample with 52 publications. It is emphasized that 60% of the publications are from the last two years, i.e., they occurred between 2016 and 2017, with 36 (20.1%) and 72 (40.2%) works, respectively, clearly showing the intensity, currency and increased interest by researchers in the subject. 8 publications (4.5%) were found in the period from the beginning of 2018 until the end of February 2018, totalling the 179 publications selected.

4.1.2. Publications /periodicals/periods

The 179 works in the sample were published in 142 different periodicals. Table 4 shows the number of publications per periodical, as well as the indicators Journal Impact Factor (JCR) and SCIMAGO – Scientific Journal Rankings (SJR), when available. Only the periodicals that showed at least three publications between 1980 and February of 2018 are highlighted.

4.1.3. Frequency of the citations in the periods

Table 5 presents the frequency of citations in the period beginning in 2009, showing the significant increase in publications and citations over the last ten years. The precursor work of Chandavarkar (1980) fulfills the criteria of the sample and deals with money remittances by

Table 4
Publications by Periodicals.

Periodical	JCR (2016)	SJR (2016)	Publications
Computer	1.755	0.427	6
Financial Innovation (FIN)	na	na	6
NEC Technical Journal	na	0.141	4
Electronic Commerce Research and Applications	1.954	1.045	4
International Journal of Security and Its Applications	na	0.179	4
Capital Markets Law Journal	na	na	3
Savings And Development	na	na	0.102	3

Sources: ISI Web of Knowledge™ (Thomson Reuters) and "Scopus®" (Elsevier B.V.) http://www.scimagojr.com/journalrank.php.

immigrant workers to their countries of origin. This article was most frequently cited until 2008, when it experienced a plateau and then a reduction in the number of citations in the last ten years.

Fig. 2 shows the frequency of citations of the works in the sample. The size of the node represents the number of citations of that publication. It can be seen that the works of Davila et al. (2003), Berger (2003), Au and Kauffman (2008), Bamford et al. (2000), Neu et al. (2006), DeYoung (2005) and Mulligan and Sala-i-Martin (2000) were the most frequently cited for the period included in the study.

4.1.3.1. Network of publication citations. In creating the citation network for the publications, using Sci2 Tool (Sci2 Team, 2009), the procedure proposed by Börner and Polley (2014) was used in the following manner: during the data preparation phase a paper-citation network was extracted (extracts an unweighted directed network from papers to their citations) and in the analysis stage a network with Unweighted & Undirected → Node Degree (the degree of a node is the number of edges that are adjacent to the node. The algorithm determines the degree of all nodes (degree sequence), which will be listed in the output file, resulting in the Network (with degree attribute added to node list). The GESS (Interactive data analysis and visualization tool) was used for analysis, visualization and presentation of the final results of the citation network.

4.1.4. Centrality of the publications

Bibliometric analysis was used in the attempt to interrelate the articles in the study. A network was created through direct extraction of the citations of the works in the sample, with the attribution of a high node degree among its nodes. The size of the nodes represents the total degree of centrality of that node, the arrows point in the direction of the information flow of the direct citations among the nodes, from the oldest to the newest publications. The node labels, in addition to identifying the publications, contain the global count of citations (ISI times cited) and the total degree of centrality. For purposes of analysis, the resulting network was reduced to the nodes that show a degree of centrality higher than ten (Fig. 3).

Fig. 3 highlights the works of Zhou et al. (2015), with a degree of centrality of 106, pointing to China as one of the main service centres for digital finance and financial technology, and argues that the country needs to provide an adequate regulatory basis for the future development of these new financial services and fintechs, balancing growth and innovation with financial stability and, in showing signs of advancing in this direction, it can contribute to regulatory developments in other countries. The works of Arner et al. (2016), Chen (2016) and Stern et al. (2017), with 12 and 15 degrees of centrality respectively supported in the work of Zhou et al. (2015), advance in the importance of regulating the industry. For Arner et al. (2016), the regulatory challenge resides in resolving the tension between a framework devoted to the future that promotes innovation and also sufficiently rigorous to maintain trust in the market. Therefore, more experimentation and innovation in regulatory approaches is needed, but it is still early to seek to harmonize international regulation in this area. For Chen (2016), the fintech organizations have grown much more rapidly in China than in the United States. In China, this success did not come from an initial technological advantage, but from integrations among financial needs and real life. That experience has important implications for understanding financial innovation and for developing inclusive finances. The study by Stern et al. (2017) aims to provide an overall view of fintechs in China, considering that it is the country with the highest number (approximately 2000) of loan platforms (P2P) operating in the world.

The work of Li et al. (2017) also highlighted in Fig. 3, in investigating the entry of fintech companies in the American retail bank market found results that indicate a positive relationship between growth of financing and in the business of the fintechs and an increase in return on investments in stock of traditional retail bank stock. The work of Li, 2007, with a centrality degree of 44 is also supported by the

Table 5

Frequency of Citations in the Time Periods.

Publication	To 2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Citations
Davila et al. (2003)	18%	5%	8%	9%	9%	8%	8%	6%	13%	11%	5%	224[1]
Berger (2003)	24%	7%	7%	9%	9%	13%	7%	9%	5%	8%	1%	165[1]
	31%	6%	7%	10%	6%	11%	7%	5%	7%	9%	1%	121[2]
Au and Kauffman (2008)		7%	11%	4%	12%	8%	13%	15%	17%	11%	4%	142[1]
		3%	10%	7%	9%	7%	13%	21%	17%	7%	6%	89[2]
Bamford et al. (2000)	29%	14%	7%	4%	6%	12%	5%	6%	7%	6%	3%	103[1]
	21%	11%	8%	4%	7%	18%	5%	8%	8%	8%	1%	73[2]
Preda (2006)	9%	14%	5%	13%	6%	8%	8%	13%	10%	12%	2%	86[1]
	17%	14%	3%	12%	8%	5%	12%	13%	9%	8%	1%	78[2]
Neu et al. (2006)	9%	16%	9%	10%	10%	5%	8%	12%	10%	8%	3%	77[1]
	8%	8%	8%	9%	9%	9%	6%	13%	17%	8%	6%	53[2]
Mulligan and Sala-i-Martin (2000)	**41%**	7%	7%	11%	9%	4%	4%	9%	4%	4%		46[1]
	42%	3%	8%	11%	11%	8%	5%	8%	3%	3%		38[2]
DeYoung (2005)	21%	7%	7%	12%	7%	16%	7%	7%	12%	5%		43[2]
Arnoldi (2004)	18%	10%	5%	26%	8%	8%	3%	8%	13%	3%		39[1]
	15%	9%	6%	21%	6%	12%	9%	6%	9%	9%		34[2]
Kirilenko and Lo (2013)						3%	13%	16%	35%	29%	3%	31[2]
Chandavarkar (1980)	**74%**	3%	6%	6%	3%		3%	3%				31[1]
Barnett and Pasupathy (2003)	**53%**	13%	13%	7%	3%			7%	3%			30[1]
Patel and Broughton (2002)	37%	17%	7%	3%	7%		13%	3%	10%		3%	29[1]
	24%	18%	12%		6%		18%		18%		6%	17[2]
Grote et al. (2002)	**46%**	21%		4%	4%	8%	8%		4%	4%		24[1]
	55%	9%		5%		9%	5%	5%	5%	9%		22[2]
Cetina (2006)	14%	9%	14%	23%	14%	9%		5%	5%	9%		22[1]
		9%	27%	18%	9%			18%	9%	9%		11[2]
Kane (2000)	**52%**	10%	10%	5%	10%	5%	5%		5%			21[1]
Kim et al. (2015)									81%	19%		16[1]
Cincotti et al. (2012)					67%		8%		25%			12[1]
					57%		14%	7%	21%			14[2]
Gail Perry (2008)					7%	29%	14%		7%	43%		14[1]

Sources: (**1**) "Scopus®" (Elsevier B.V.) and (**2**) ISI Web of Knowledge™ (Thomson Reuters).
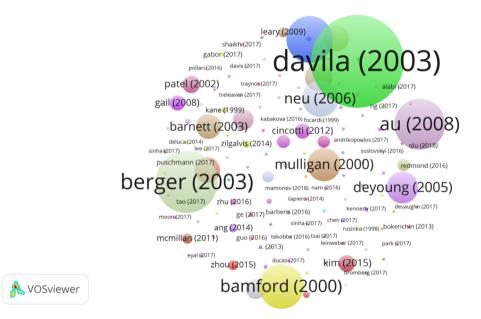

Fig. 2. VOSviewer – Frequency of Citations (179 publications) (Fractionalization).

works of Davila et al. (2003) and Jun and Yeo (2016), with centrality degrees of 35 and 28 respectively.

A network of co-occurrences was created that has the references in its origin nodes and citations as the destination nodes. Having found no isolated nodes, the betweenness centrality was calculated and the results are shown in Fig. 4. The betweenness centrality measures the number of times that a node intercepts the shortest route between two other nodes and, thus is an indication of the importance that an author has in the role of connection among the other authors (communication potential). Only the nodes for which betweenness centrality is greater

than 100,000 degrees are shown. The publications Minto et al. (2017), Wonglimpiyarat (2017), Langley and Leyshon (2017) and Au and Kauffman (2008) have betweenness centrality higher than 300,000 degrees, with this last the highest degree (537.842)

4.1.5. Network of keyword occurrences

In the keyword network shown in Fig. 5, the intensity of the lines that connect the nodes represents the intensity of the relationships of the most frequent keywords in the articles in the sample. When 6 repetitions are considered, the network results in 4 clusters: finance,
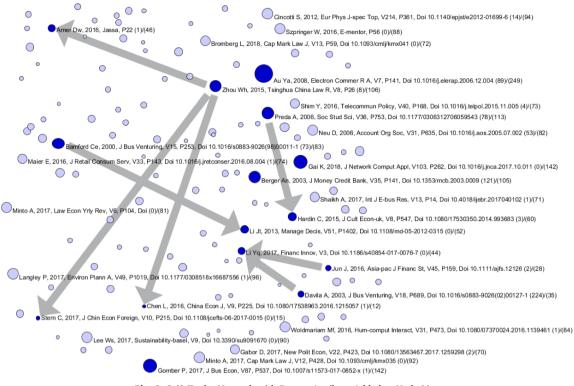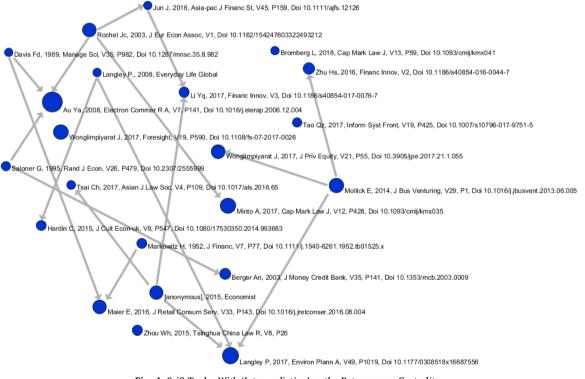
Fig. 3. Sci2 Tool – Network with Degree Attribute Added to Node List.

blockchain, banking/financial inclusion and big data. In this network, the words bitcoin, cryptocurrency, electronic money appear grouped around the word blockchain and on the right of Fig. 5, showing the frequency and the up-to-dateness of these terms, the interest of researchers, and the currentness of the subject.

4.1.6. Centrality of keywords

A third keyword co-occurrence network (Extract Co-occurrence Network) was created using the Sci2 tool to analyze the sample publications. For this analysis the following parameters were selected: *Unweighted & Directed → Nodes Betweenness Centrality → Weight > Weight; Centrality Attribute Name > betweenness_centrality.* The size of the nodes represents the betweenness centrality of that

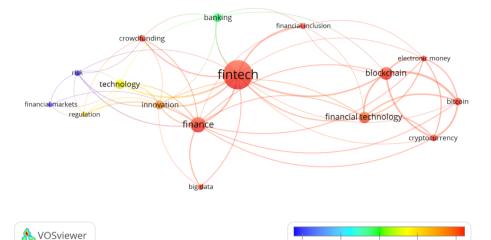**Fig. 4.** Sci2 Tool – With 'Intermediation' as the Betweenness Centrality.

Fig. 5. VOSviewer – Network Visualization of the Occurrences of Keywords.
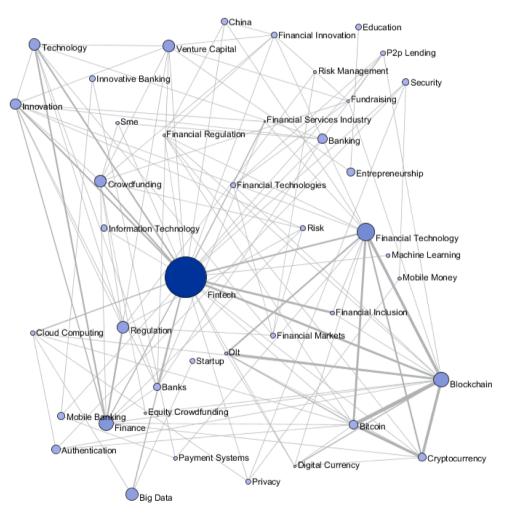

Fig. 6. Sci2 Tool – Keyword Co-occurrence Network.

node, having eliminated those with a betweenness centrality of less than 2000 degrees. The thickness of the connection represents its weight in this case, the co-occurrence frequency (proximity) weighted by the highest number of occurrences of a given combination of nodes (Fig. 6).

With the participation of the research groups to which the authors belong, with the application of the Affinity Diagram technique, which is a method developed to organize data by affinity, and is also known as

the KJ method of grouping (Mizuno, 1993), the keyword co-occurrence network in Fig. 6, and the Freeman Degree Centrality diagram in Fig. 7, created based on Table 6, were used to identify emerging themes, which are used to respond to RQ2.

As a result of the analysis and discussion to identify emerging themes, the choice was to group studies using the main keywords such as Innovation (technology adoption/network externalities), Mobility, Biometrics, Blockchain, Risk and Security around Financial Technology
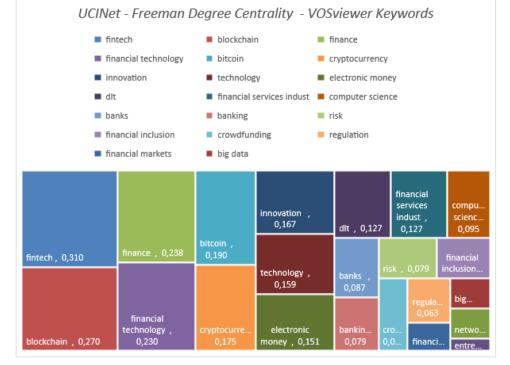
Fig. 7. UCINet – Freeman Degree Centrality of the VOSviewer Sample (04/08/18).

Table 6
UCINet - Freeman Degree Centrality of the VOSviewer Sample (04/08/18).

Keyword	Degree 1	Degree 2	Keyword	Degree 1	Degree 2
Fintech	39,000	0.310	Computer science	12,000	0.095
Blockchain	34,000	0.270	Banks	11,000	0.087
Finance	30,000	0.238	Banking	10,000	0.079
Financial technology	29,000	0.230	Risk	10,000	0.079
Bitcoin	24,000	0.190	Financial inclusion	9000	0.071
Cryptocurrency	22,000	0.175	Crowdfunding	9000	0.071
Innovation	21,000	0.167	Regulation	8000	0.063
Technology	20,000	0.159	Financial markets	5000	0.040
Electronic money	19,000	0.151	Big data	5000	0.040
dlt	16,000	0.127	Networks	5000	0.040
Financial services industry	16,000	0.127	Entrepreneurship	2000	0.016
Centralization	0.1992				

(FT). Innovation, Regulation, Financial Inclusion, Financial Education and Services Operation were grouped around Financial Services (FS). See the result of this categorization process in Table 3.

4.2. Content analysis

Table 7 shows a statistical summary of the coding results for the 179 studies, selected according to the criteria described in Section 3.5 and using the coding scheme shown on Table 3. The complete results are available in the appendices attached to this study. The relative value ("% Relative" column) was calculated based on the number of articles attributed to each category ("Occurrence" column) and the total occurrences of that particular code (total number between parentheses in the "Code Classification" column), identifying the code frequency. Each publication was categorized in just one of the categories for the activity sector. In the other categories a given publication can be computed in one or more categories.

5. Discussion

5.1. **RQ1**. How has the literature on fintechs evolved over time?

This question is answered in the discussion based in the bibliometric analysis through its development in RQ1.1, RQ1.2 and RQ1.3.

5.1.1. RQ1.1. What are the most influential studies (counting the number of citations)?

As shown in Table 5, the precursor work of Chandavarkar (1980) with 74% of the total citations, Kane (2000) with 52%, Grote et al. (2002) with 46% and Mulligan and Sala-i-Martin (2000) with 41%, had the largest volume of citations of their works in the initial years of the sample period of this study, i.e., until 2008, when these citations hit a plateau and there was even a reduction over the last ten years. One can observe then, a loss of relative relevance of these studies over the years with respect to more recent publications. On the other hand, Cincotti et al. (2012), with 67% of citations in 2012, 9% in 2017 and 2018 and Kim et al. (2015) with 81% in 2016 and 19% in 2017 of the citations show the currentness and the increased interest of researchers in their works.

Table 7
Categorization of the Publication by Research Subject.

Coding Classification		Occurrences	% Relative
Activity Sector (Khandwe, 2016; CB Insights, 2017) (179 publications)	S1 – Not focused on specific sector	97	54.2%
	S2 – Payments/Billing	9	5.0%
	S3 – Loans	21	11.7%
	S4 – Investments	22	12.3%
	S5 – Transfers/ Remittances	4	2.3%
	S6 – Crowdfunding	9	5.0%
	S7 – Blockchain /Cryptocurrencies	14	7.8%
	S8 – Institutional/B2B	3	1.7%
	S9 – Insurance	–	–
Financial Service (FS) (1 1 5)	FS1 – Innovation	38	26.6%
	FS2 – Regulation	31	21.7%
	FS3 – Financial Inclusion	10	7.0%
	FS4 – Financial Education	3	2.1%
	FS5 – Services Operation	43	30.1%
Innovation (I) (38)	I1 – Product or Service	18	40.0%
	I2 – Financial Arrangements	27	60.0%
Operations Services (OS) (43)	OS1 – Risk/ Delinquency	18	31.0%
	OS2 – Risk/Security	8	13.8%
	OS3 – Compliance	3	5.2%
	OS4 – Others	29	50.0%
Financial Technology (FT) (61)	FT1 – Adoption/ Externality	18	26.5%
	FT2 – Mobile	8	11.8%
	FT3 – Blockchain	14	20.6%
	FT4 – Big Data	4	5.9%
	FT5 – Biometrics	5	7.4%
	FT6 – Security	16	23.5%
	FT7 – Risk	3	4.4%
Mobile (M) (8)	M1 – Internet Banking	3	25.0%
	M2 – Mobile Banking	8	66.7%
	M3 – Self Service	1	8.3%

One can see in Fig. 2 that the publications of Davila et al., (2003), Berger (2003), Au and Kauffman (2008), Bamford et al. (2000), Neu et al. (2006), DeYoung (2005) and Mulligan and Sala-i-Martin (2000) are those which were most cited for the period of this review. Also exhibited in Table 5 the most influential publications in the sample (with over 100 citations in the Web of Science Core™ Collection or Scopus® databases) are Davila et al. (2003), Berger (2003), Au and Kauffman (2008) and Bamford et al. (2000) have a number of citations kept at a relatively constant level over the entire period of the study. In his article, Berger (2003) examines technological progress and its effects on the banking industry. For this author, the banks are intensive users of IT and financial technologies and have a large quantity of data available that can be useful for the overall comprehension of the effects of technological change. His research suggests improvements in the costs and capacity of loans due to improvement in the technologies used in the back-office, as well as new benefits to consumers with the refinement of front-office technologies. He suggests significant increases in productivity in terms of better quality and variety in banking services. Moreover, he states that technological progress probably helped to facilitate the consolidation of this services sector.

For Au and Kauffman (2008), economic theory provides a unique point of view based on which it is possible to examine issues in relation to emerging technologies, where the standards and the adoption, the changes in the business processes and the results of implementation, information security, investments and commercial value and impact of the industry require care and consideration by senior managers,

leadership and strategists in the financial industry. In this article, the authors highlight mobile payments with a new technology application associated with the wireless connectivity revolution which has spread throughout the world.

In their study, Bamford et al. (2000) examine a sample of banks at the time they were initiating their operations, in order to investigate the hypothesis that the conditions and initial decisions at the bank's founding had a lasting impact on its performance; to obtain a vision of the temporal duration of these initial conditions and decisions and to utilize various performance measures, permitting a comparison of this important issue, since it affects various aspects of performance measurement of a new undertaking. The research found that the initial conditions and decision at the time of the company's founding are significantly related to the growth potential of this new enterprise, even seven years after founding. The study strongly suggests that considerable effort should be concentrated on the initial decisions of a new enterprise, as well as the market conditions present at the start of its operations.

5.1.2. RQ1.2. What are the fundamental references that influenced the studies identified (considering not just the primary studies contained in the selected sample, but also their citations)?

Fig. 3 shows the fundamental works which most influenced the studies in the sample. In addition to the already-mentioned primary studies they contain, such as Au and Kauffman (2008), Wonglimpiyarat (2017), Langley and Leyshon (2017) and Berger (2003), among the most influential works are Mollick (2014) with his exploratory study on the dynamics of crowdfunding. Also Rochet and Tirole (2003) who argued that in most cases there are two sides in the markets with network externalities so that platforms can be successful in industries such as software, portals and media, payment systems and that the internet should be "to get the two sides of the market on board". Seminal are the articles of Davis (1989) that compare two theoretical models on user acceptance of computing technology and those of Saloner and Shepard (1995) who empirically examine the effect of network externalities on adopting automatic teller machines (ATMs).

5.1.3. RQ1.3. What are the major periodicals on this subject and how has the number of publications evolved over time?

The 179 works in the sample were published in 142 different periodicals, demonstrating interest in the subject by a significant range of journals. The periodicals with the highest number of publications are *Computer* (ISSN 0018-9162) and *Financial Innovation (FIN)* (*ISSN 2199-4730*), with six publications each. The publication of greatest impact among those with a higher number of publications (4 publications) is *Electronic Commerce Research and Applications* (*ISSN* 1567-4223). Table 4 shows the number of publications by periodical as well as the indicators *Journal Impact Factor (JCR)* and SCIMAGO – *Scientific Journal Rankings (SJR)*, when available. Only the periodicals that have at least three publications from 1980 to 2018 are highlighted.

In the sample, 14 periodicals appear with two publications and 121 periodicals with only one. There are a large number of periodicals in the sample as well as several areas of knowledge related to fintech, as evidenced in the discussions responding to question RQ2, as follows.

*5.2. **RQ2**. What are the main subjects and issues in the scientific literature on fintechs?*

Fig. 8 which was developed based on Table 7, shows the results of the content analysis of the publications when distributing the sample publications by the sectors of fintech activity. It can be observed that over half (54.2%) of the publications deal with subjects that are not directly related to a given sector of activity, i.e., they are research questions that span different aspects related to fintech companies. The most frequent sectors are investments and loans, representing, when totalled, almost one quarter of the works. Blockchain/ Cryptocurrencies
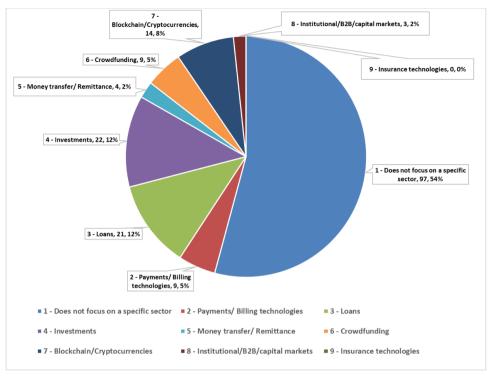
Fig. 8. Distribution of Publications by Fintech Activity Sectors Source: Sample with 179 selected publications (2018).

with 7.8% of the works, Payments/Billing and Crowdfunding, each with 5%, are the most frequently encountered sectors. It is noteworthy that no works were found in the insurance sector.

In the content analysis process (3.5) 115 publications focusing on Financial Services (FS) were categorized, i.e. their main objective is the discussion of research subjects directly linked to the core business of the financial organizations, such as the operation and regulation of financial services, financial inclusion and innovations for products and services as well as business models. The works on services operation were grouped with financial risk management and operational risk management, in addition to other research problems related to operational aspects of company business in the financial industry.

Similarly, 62 articles were identified whose main focus is on technologies that can be applied in the financial industry. Within these technologies, the works were distributed in the subcategories: adoption of technologies/network externalities, mobility, blockchain, big data, biometrics, information security and risk management.

Table 7 shows a panel with the sample publications distributed according to different subjects grouped in Financial Services (115 works) and Financial Technology (FT) (61 publications).

By cross analyzing the coding of the 172 articles, core-periphery analysis observed that the central subjects (core members) of the literature are Financial Services (FS), without a focus on a specific sector (S1) dealing with the subject of Innovation (FS1) and a greater concern with possible new Financial Arrangements (12), as Table 8 highlights, with a Core/Periphery fit of 0.7731.

From the analysis of the relationships among groups from the coding scheme there emerged a framework for literature summary whose main axis is the fintech activity sectors, as shown in Fig. 9.

The framework of the literature, show that S3 (loans), S4 (investments) and S6 (crowdfunding) are more related with Fintech Services (FS) while S7 (Blockchain /Cryptocurrencies) is more linked with Financial Technology (FT). This mapping served as the guiding thread for the analyses to obtain an answer for RQ2, organized in the two following topics.

5.2.1. Main subjects and issues in the scientific literature on fintechs related to financial services (FS)

In the Financial Services (FS) category, 38 publications (26.6%) are about innovations and 31 (21.7%) deal with issues of financial industry regulation and local legislation or the financial system globally. However, the largest number, 43 articles (30.1%) discuss subjects related to financial services operation. Among the subcategories of Financial Services (FS) there are works distributed among Risk/Delinquency (18); that is, subjects related to risks of financial loss related to different factors involved in the business environment of these organizations. Risk/Security (8 works) related to fraud or other threats to services operations; Compliance (3 works) and, lastly, Others with 29 publications, the most varied aspects related to processes and operations typically found in the everyday activities of the economic sector. In lesser numbers appear FS3, Financial Inclusion with 10 (7.9%) that discusses the inclusion of the populations with no access to the most basic financial services, and FS4, Financial Education with 3 (2.1%) publications that discuss the institutional role of institutions in preparing clients to use financial products to their benefit. The occurrences in the 5 categories total 125 publications since some of the 115 works were classified in more than one of them. The most recurring subjects in the studies related to Financial Services (FS) are discussed in the following:

5.2.1.1. Financial Service (FS): FS1 – innovation.
Publications on *FS1 – Innovation* are classified in *I1 – Product or Service* or *I2 – Financial Arrangements* with 60% of the works classified in this latter category, which can be explained by the increase in the number of mobile internet users which causes an increase in the variety of on-demand services, such as Uber and Airbnb known worldwide. The opportunities provided by digital finance, understood as the availability of financial services through mobile devices, especially in developing countries, make issues such as business models, venture capital, sustainable business and co-creation of value an important aspect of innovation in the financial industry and, as a result, they have been frequently discussed by the academy (DeYoung, 2005; Japparova and Rupeika-Apoga, 2017; Gomber et al., 2017; Lee and Shin, 2018).

Table 8
Core-Periphery Analysis.

	FS	FS1	S1	I2	FT	S4	S5	S6	S7	S8	S9	S2	S3	FS3	FS4	FS5	OS1	OS2	OS3	OS4	FT1	FT2	FT3	FT4	FT5	FT6	FT7	I1	FS2	M1	M2	M3
FS	115	37	53	26		20	3	8	3	4		4	20	10	3	42	18	8	3	21	1					1		16	30			
FS1	37	38	21	27	1	5	1	5	1			2	3		1	2	1	1		1			1					16	3			
S1	53	21	103	14	34								2	2		17	5	5	3	16	10	5	2	3	4	9	1	12	17	3	5	1
I2	26	27	14	27	1	3	1	5	1				3			2	1	1		1			1					5	3			
FT		1	34	1	61	5	1	2	11	1		4	3							8	17	8	14	4	5	15	3	1	1	3	8	1
S4	20	5		3	5	25							3			12	7	1			6	1				2		2	1			
S5	3	1		1	1		4						2					1														
S6	8	5		5	2			10								3	1			2			1			1		1	1			
S7	3	1		1	11				14								1	1		1	3		10			2						
S8	4				1					5						2	1	1		1	1					1			1			
S9																																
S2	4	2			4							9				1		1			2		1		1	2		3	3		2	
S3	20	3		3	3								23	2	1	7	4			3	1	1		1		1			8		1	
FS3	10		2			3	2		1				2	10		1	1												1			
FS4	3		2										1		3													1				
FS5	42	2	17	2	12		3	1	2			1	7	1		43	17	3	3	21								1	6			
OS1	18	1	5	1	7		1		1				4	1		17	18	1											3			
OS2	8	1	5	1	1				1	1						3	1	8		1									1			
OS3	3		3													3													3			
OS4	21	1	16	1	8	6		2	1	1			3			21		1		29								1				
FT1	1		10		17	1	1		3	1		1	1								18		2			3			1			
FT2			5		8							2	1									8		1	2	2				3	8	1
FT3		1	2	1	14			1	10			1										2	14			2			1			
FT4			3		4								1								1			4						1	1	
FT5			4		5							1										2			5	1				1	2	1
FT6	1		9		15				1	2	1	2	1							3	2	2			1	16	1		1		2	
FT7			1		3	2																				1	3					
I1	16	16	12	5	1	2		1				3			1	1				1								18	1			
FS2	30	3	17	3	1	1		1		1		3	8	1		6	3	1	3		1		1			1		1	31			
M1			3		3																	3		1	1					3	3	
M2			5		8							2	1									8		1	2	2				3	8	1
M3			1		1																	1								1	1	

N.B. Done with data from the content analysis with UCINET software.
Core/Periphery fit (correlation) = 0,7731.
Core/Periphery Class Memberships:
Core: FS S1 FS1 I2
Periphery: FT S2 S3 S4 S5 S6 S7 S8 S9 FS2 FS3 FS4 FS5 OS1 OS2 OS3 OS4 FT1 FT2 FT3 FT4 FT5 FT6 FT7 I1 M1 M2 M3.

Among the main subjects found in both subcategories are crowdfunding, which is using online platforms for fundraising, a phenomenon that is gaining more and more scientific attention, reaching a growing number of people and has duplicated its business volume year after year (Bouncken et al., 2015); sharing economy, crowdsourcing, collaborative consumption and collaborative commerce, through socioeconomic systems created around sharing human and physical resources, including the creation, production, distribution, shared commerce and consumption of goods and services by different people and organizations from different places and cultures (Chishti, 2016; Gábossy, 2016; Gruzina et al., 2016; Fonrouge, 2017; Langley and Leyshon, 2017); ethnic entrepreneurship and migrant workers discussing the remittance or transfer of financial resources from migrant populations to their home countries (Chandavarkar, 1980; Fonrouge, 2017) are also relevant issues discussed in the broader context of innovation in fintech companies. The most frequently encountered activity sectors are S6 – Crowdfunding, S5 – Transfers/Remittances and in lesser numbers S3 – Loans and S4 – Investments.

5.2.1.2. RQA (01) on fintech business models – Changes in the business environment. According to Chiu (2016), new participants and start-up companies that do not have a tradition or history of activity in bank business or financial services make use of business models that promise more flexibility, security, efficiency and opportunities compared to the traditional financial services providers. These new participants cannot rely on an existing customer base and thus their solutions must have the potential to convince new clients. Moreover, there are obstacles that cannot be easily overcome by non-banking companies, such as regulatory charges and requirements for banking licenses (patent letter) Thus, for these new entrants, the following question becomes
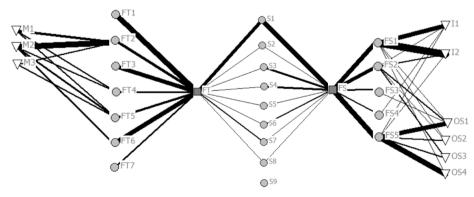

Fig. 9. Framework for the Literature Summary.

important: What are the specific principles of these business models that make these start-ups successful, and often disruptive, in these highly regulated and competitive markets? Research on fintech organizations that represent innovative business models could clarify the main aspects related to risks, opportunity and challenges that these companies faced in order to operate successfully in their business environments. One approach to research into this relatively new phenomenon of fintechs and their business environments could be to conduct multiple case studies of fintechs and start-ups as a way to shed some light on this research question.

5.2.1.3. Financial services (FS): FS5 – Services operation. The main questions in the FS5 category (Services Operation) are related to OS1-Risk/Delinquency, that is, they are the risks associated with financial losses in the service operation of service in operations, such as for example derivatives (Rusinko and Matthews, 1998; Arnoldi, 2004) or loans with a special focus on peer-to-peer lending (Stern et al., 2017; Ge et al., 2017). Nevertheless the highest number of publications was classified as OS4 – Others, since they include a broad range of operational questions such as for example the value chain of financial centres, such as the one in Frankfurt, Germany or the work that identifies and critically assesses the various types of commercial agreements that the United Kingdom could negotiate after "Brexit", with a special focus on the commerce of services, since financial and digital services are key components of its economy (Grote et al., 2002; McCullagh, 2017).

On a lesser scale, articles in this category deal with OS2 (Risk/Security) such as the role of the internal audit function in operational risk management or studies in perspectives on the financial stability of fintech (Fernández-Laviada, 2007; Minto et al., 2017) as examples and OS3 (Compliance) such as fitting to the norms and internal operational controls for regulatory risk or to prevent money laundering (Treleaven, 2015; Wu, 2017) The majority of those focused on service operations do not deal with a particular sector of activity.

5.2.1.4. RQA (02) on Service operations - changes in the social and cultural environment. There are gaps in the research related to the allocation of labour, job opportunities and obtaining income. A question that has been discussed by society, but still not strongly in academia, especially in the retail sector and in other areas of social studies, is the guaranteed minimum income. In the Blockchain/Cryptocurrency sector of fintech activity Richter et al. (2015a) analyzed the advantages and disadvantages of virtual currencies in comparison with real money, but an important research article that addressed the intrinsic risks to the trading platforms of crypto coins, e.g. Bitcoin or Ether, was not identified. With respect to digital insurance, there is no important research article that can be identified. As a result, it is recommended that studies of these fintech business sectors be undertaken to eliminate gaps in the research.

5.2.1.5. Financial services (FS): FS2 – regulation. The major works related to FS2 (Regulation) deal mainly with the issue of regulating fintech activity in markets traditionally occupied by banks and other conventional financial institutions. With increased participation by fintech companies in these regulated markets, due to increased numbers of clients as well as the volume of financial resources involved, there is greater interest (and economic, social and political necessity) by regulatory entities in the operations practised by fintechs (Tapiero, 2014; Zilgalvis, 2014; Inshakova et al., 2017). Many articles deal with the market and Chinese regulation in the function of the importance that fintechs have achieved in that country (Zhou et al., 2015; Barberis and Arner, 2016; Ng and Tang, 2016). There are also recurrent subjects that deal with the importance of self-regulation, with regtechs (start-ups that offer technological solutions to resolve problems created by requirements for regulation and compliance) in addition to the various sets of procedures, laws, and regulations

originating in the most diverse countries and aimed at defining, avoiding, mitigating and punishing crimes related to the financial industry (AML- Anti-Money Laundering Laws and Compliance, Bank Secrecy Act, Organized Crime Control Act, etc.) (Arner et al., 2016; Volosovich and Krivosheeva, 2016; Wu, 2017).

RQA (03) on Regulations – Changes in the Legal and Regulatory Environment What is the future of the automation of activities related to individual finances? In what direction is the automation of personal financial activities headed? What is the future and in which direction is automation in financial industry companies headed? What are the possible synergies and conflicts between these two universes? What problems can result from the interaction of autonomous business processes and people about the identity of participants, responsibilities, legal and regulatory issues, questions about job opportunities and income for people? Theories that attempt to assess the impact of such innovations on the financial industry serve as a useful theoretical background for these issues, here presented as disruptive innovations. As an example, Gold and Kursh (2017) state that the universe of companies, services, technologies and financial institutions in the personal finance and asset management sphere is almost as vast and varied as the customers it serves. Clients of these companies can monitor their bank accounts, credit card expenses, and other financial assets, and the companies offer investment advice via the internet. Conventional banking and investment enterprises add technology services to their financial and asset management offers. Personal asset management therefore is a paramount industry for studies related to disruptive innovation and strategies of traditional operators. In their article, Gold and Kursh (2017) concentrate mainly on robo-advisors and on reactions to this disruptive innovation by those in charge of traditional financial institutions for asset management and related services.

5.2.2. Main subjects and issues in the scientific literature on fintechs related to financial technology (FT)

As shown in the framework for the literature summary (Fig. 9) and according to Table 7, the 61 articles focused on Financial Technology (FT) were categorized by most recurrent subjects, and some publications appear in more than one category, totalling 68 occurrences. The most frequent categories are FT1 (Technology Adoption/Net Externalities) which appears with 18 articles, FT6 (Security) with 16 works representing exactly half of the publications. Then comes FT3 (Blockchain) with 14 publications representing a little over 20% of the total. In the 8 works in the FT2 (Mobile category), about 12% of the total were distributed among the subcategories M1 (Internet Banking) and M2 (Mobile Banking) with 8 publications, and M3 (Self Service Banking) with one. The subjects that most recur in the studies related to Financial Technology (FT) are discussed in the following.

5.2.2.1. Financial technology (FT): FT1 – technology Adoption/Network externalities. The most recurrent themes related to technology adoption/network externalities consider innovative financial technology in its essence and the problems deriving from its implementation, development and use in the banking industry. They highlight the importance and positive consequences of introducing innovative financial technologies into this industry (Lavrov, 2011). Among the adoption technologies studied, the following stand out: Neural networks (Rivas et al., 2017), Artificial Intelligence (AI), the Internet of Things (IoT) (Schulte and Liu, 2018), and the evolution of Bitcoin hardware (Taylor, 2017), among others. The studies related to the subject are based on theories such as Actor-Network Theory (Shim and Shin, 2016) and Metcalfe's Law (Alabi, 2017).

The most recurring activity sectors that deal with this subject are Payments/Billing, Blockchain/Cryptocurrencies and Institutional/B2B (stock exchange).

5.2.2.2. RQA (04) on technology Adoption/Network externalities. A subject of interest to researchers and practitioners is digital

transformation (Majchrzak, et al., 2016; Leonardi et al., 2016). The following questions can be asked on this subject: How are digital transformation and its technologies being used to maximize innovation in business models in the fintech organizations? How are these innovative business models structured? What is the impact of these new business models on the traditional financial organizations (incumbents)? One business model describes the logic of how an organization creates, delivers, and captures value (Osterwalder and Pigneur, 2010, p. 14) and reflects the central business rationale of any company. In practice, digitalization challenges the business models in many traditional industries, especially in the banking sector (Niemand et al., 2017). The established companies not only fail to adopt opportunities by means of digitalization, but also struggle to adapt their business models to reflect the associated economic resources and with the mechanisms that sustain them (Westerman and Bonnet, 2015; Weill and Woerner, 2015). There are well known structural concepts of the business model In the literature that can be used to create theoretical references so that these questions can be answered, including the structures of Gordijn and Akkermans (2001), Chesbrough (2007, 2010), Johnson et al. (2008), Lindgardt et al. (2009) and Kiron et al. (2013) and among them is the Business Model Canvas (Osterwalder and Pigneur, 2010), considered the broadest and more widely used model in empirical studies of the subject.

5.2.2.3. Financial technology (FT): FT6 – security. As the fintech revolution speeds up, a fundamental challenge threatens to paralyze its progress: cybersecurity, especially for services supported in blockchain and distributed ledger (DLT) technologies (Ducas and Wilner, 2017; Traynor et al., 2017). Given the scope, complexity, and dynamism of fintech solutions (as seen in Table 7), cyberattacks are inevitable, forcing improvements in technological security to assure future growth. Among the most recurrent themes related to information security are privacy and maintaining the secrecy of user data (Gai et al., 2017, 2018; Kim and Hong, 2016; Okamura and Teranishi, 2017; Park and Park, 2017; Qiu et al., 2018). Park and Park (2017) study how to adapt security for blockchain and cloud computing as a way to guarantee the secrecy of user information. The study shows one way to provide security through a method that implements a security protocol to block and remove blockchain users' data (Park and Park, 2017). Questions linked to the authentication of users, especially when they access financial services from mobile devices, is also the origin of concerns with the security of information systems. When the certification of user authentication is insufficient, the opportunity for a third party to invade is greater (Kim et al., 2015). Another concern is the growth of fraud in mobile financial services. There are many methods, algorithms and fraud detection systems. Nevertheless, there are well known problems with these systems. It is difficult to create an appropriate model to discover fraud, and it is difficult to detect new types of fraud in the services offered by emerging fintech companies (Moon and Kim, 2017). In their article, Moon and Kim, 2017 present the technical challenges of avoiding fraud, the functions of a fraud detection system, an adaptive algorithm for a framework based on machine learning algorithms and the validity and applicability of the proposed model. Security concerns are spread over all sectors of fintech activity. Outstanding are the activity sectors of Payments/Billing, Blockchain/Cryptocurrencies that are explicitly cited in the sample.

5.2.2.4. RQA (05) on Security. Among the subjects of greatest interest for research on the security initiatives and challenges in the financial industry generally and for fintechs in particular are cyber security concerns, and the involvement of the government and major software companies as strategic partners in combatting cybercriminal activity. There are strategic solutions to this growing epidemic, such as investing in antivirus software and common-sense approaches to protecting passwords. Nonetheless, despite all these efforts, cybercrime is still growing (Balan et al., 2017; Jhaveri et al., 2017). New studies can

generate strategies, methods and tools to help combat information system vulnerabilities as well as other technologies that support the operations of financial organizations, aimed at reducing the number of cybercriminal activities that occur globally. Especially for fintech organizations, research can be conducted on cybersecurity ecosystems, such as for example, through cloud collaboration (Kopp et al., 2017). Based on defining protection goals and by using internal and external information it can prevent and anticipate possible attack methods and strategies. Thus, companies could orchestrate together solutions to provide intelligence and knowledge to their internal security teams, validating controls and protections before attempts at attacks compromise their operations. Based on empirical works, studies can propose and structure practical methods for fintech companies to validate their techniques and defence process and contain specific damage to their environment and business infrastructure, as well as making the necessary adjustments and corrections for certain types of attacks before they occur. Fintech organizations have a special interest in organic strategic approaches of a global nature to combat fraud in the realm of financial transactions given their reduced capacity to create fraud combat techniques due to high cost and low coverage.

5.2.2.5. Financial technology (FT): FT3 – blockchain. The subject that most frequently recurs with respect to blockchain is cryptocurrencies (Soslovskyi and Kosovskyi, 2016), with a special highlight for Bitcoin, verification and validation of smart contracts (Magazzeni et al., 2017), DLT (Distributed Ledger Technology) technologies and applications and global consortiums such as Hyperledger Fabric, R3 Corda fabric or Ethereum, created to standardize DLT technologies among financial and regulatory organizations and other players interested in its consolidation. The consortiums are justified, since there are still some issues regarding speed, processing costs, security, transparency and privacy, the finality of legal liquidation, scalability and effects of the technology network (Khan et al. 2017). The sectors of activity that recur most frequently are Payments/Billing, Crowdfunding, and Cryptocurrencies.

5.2.2.6. RQA (06) on blockchain. Among the issues of major interest which have still not been researched are the development of trust–free systems based on blockchain technology and the development of new types of platforms and digital services based on open code. For Hawlitschek et al. (2018) blockchain ecosystems can be of great interest for new types of platforms and digital services, especially for fintechs active in the Payments/Billing, Transfers/Remittance, Crowdfunding, and Cryptocurrency sectors and that have common challenges to their use. Shareconomy is a science field with the potential to change the behaviour of consumption (Richter et al., 2015b). Peer-to-peer platforms to share resources are applications that can be implemented as trust-free systems, based on blockchain. Nevertheless, trust among peers plays a crucial and complex role in practically all interactions within a sharing economy. In order for trust-free systems to share economic interaction it is necessary to develop reliable interfaces for shared economy ecosystems based on blockchain technology. These interfaces can be developed like an open code platform as a way to increase the trust of the sponsors involved. In their work, Lindman et al. (2017) recommend that for new opportunities for platforms and digital services, a three-part research agenda should be considered focusing on 1) organizational issues; 2) questions related to the competitive environment, and 3) questions of project technology

5.2.2.7. Financial technology (FT): FT2 – Mobile. The sectors of activity that most frequently recur grouped around mobility are Payments/Billing, Loans, Investments and Transfers/Remittance. Among the most recurrent themes related to Mobility (M1 – Internet Banking, M2 – Mobile Banking and M3 – Self Service) are Secure Authentication Systems (Kim et al, 2015) and the use of Biometrics (Kim and Hong,

2015, 2016). Moreover, significant changes in the banking system brought about by progress and the dissemination of IT are discussed. In his article, Iwata (2017) analyzes the changes in the Japanese banking system, introducing a new relationship between financial organizations and technology based on the changes in role of technology and in customer relations.

5.2.2.8. RQA (07) on Mobile. Customer contact opportunities with financial institutions are significantly reduced through the extensive use of electronic channels. This fact results in a more distant and colder relationship. In the case of fintechs, due to the very nature of their operations with mobile devices, this opportunity for face-to-face contact with customers is non-existent in practice. Augmented Reality (AR) and Virtual Reality (VR) stand out among rapidly developing technologies (Yuan, 2017). Virtual reality devices coupled to modules that create business opportunities and experiences with financial products and services can be used to improve the sales environment and the buying experience, providing clients with experiences in using these products and thus increasing the success rates for these businesses, as well as nudging clients toward the culture, the image of the brand and the organizations' way of doing business. Nevertheless, since structured research works and practical applications of the subject have not been found, undertaking a comparative chronological analysis of research and adopting AR and VR applications in the fintech organizational context, can be extremely useful to lay the foundation for an agenda for future research. Another approach would be to adopt one of the paradigms that characterize scientific research in the Information Systems (IS) area, such as Design Science Research (DSR). This paradigm "seeks to broaden the limits the human and organizational capacities to create new and innovative artifacts." (Hevner et al., 2004, p. 75)

5.2.2.9. Financial technology (FT): FT5 – Biometrics. Biometrics are technologies using physical features such as fingerprints, facial recognition, iris, finger and palm veins to identify and authenticate people's identities. One of the most recurrent themes related to biometric technology proposes that fintechs adopt Single Sign-on systems using FIDO (Fast Identity Online). Among these works a secure framework for biometric authentication based on fingerprints is proposed. It offers a centralized authentication structure for a variety of services that need interoperability of users' biometric information, protecting privacy and increasing convenience (Kim and Hong, 2016a,b). For the same purpose, Kang and Lee (2016) proposed a method to create an authentication key by applying an algorithm to obtain an OTP (One Time Password) based on biometric data from the individuals' heartbeats (Kang and Lee, 2016). Another frequent concern, where technology-based solutions have gained attention is preventing the leaking of personal information (Kim and Hong, 2016a,b; Lee and Lee, 2017). The activity sectors most cited in works on biometrics are Payment/Billing and Transfers/Remittances.

5.2.2.10. RQA (08) on biometry. Among the subjects still not studied there could be interest in researching what the different biometric technologies are and how they can be applied to the various services offered in the fintech activity sectors. For example, one could research how biometric technology could be used in the lending sector to identify non-banking microcredit borrowers. The single identification of credit users will reduce the risk of operations and therefore, of delinquency. How can the different biometric technologies be employed when the benefits of user convenience and privacy are considered? Some biometric technologies, such as fingerprinting, require individuals to be carefully inserted into the user databases under the penalty of compromising the levels of accuracy in identification, and require specific environments and equipment for this purpose. Other biometric modalities, in turn, are considered excessively intrusive, which makes their large scale use impossible,

even though they have high levels of reliability – iris identification, for example.

5.2.2.11. Financial technology (FT): FT4 – big data. Trelewicz (2017) discusses the importance of big data approaches to the financial industry, detailing the challenges to its adoption, as well as future opportunities to develop the technology. The financial markets, especially retail banking and corporate credit, involve massive volumes of transactions and capital resources, making it a promising target for these new IT technologies. Among the applications suggested by Trelewicz (2017) are credit classification by developing applications capable of processing data to generate real time scores for credit applicants or developing adaptive models for standards in market negotiations that could provide information to subsidize investment strategies for buying and selling assets, such as Americans ADRs or in ex-dividend date stocks, i.e. when the stock loses its right to dividends. Tao et al. (2017), using a large sample of operations of one of the largest Chinese online P2P loan platforms, explore how financial and personal information of the borrowers, characteristics of the loans, and loan models affect the financial results of peer-to-peer (P2P) loans and discuss the implications of the work results for this big data based lending market model. According to Paul et al., (2016), the increase in big data analyses by retail banks permits them to estimate more precisely credit risks, as well as the users' disposition toward paying, the propensity to change and the response capacity to marketing offers. This does not just affect the competition but represents large challenges for these banks. In the selected sample, the activity sectors that most suggest recourse to the use of big data are Loans and Institutional/B2B.

RQA (09) on Big Data: What are the most interesting questions about fintechs and big data that remain under- researched (the gaps)? Loebbecke and Picot (2015) state that digitalization and big data analysis are elements which are increasingly fundamental and constitutive of society, becoming significant questions of interest to Information Systems (IS) researchers. For these authors, a systematic approach requires interdisciplinary research at the intersection of IS, engineering, organization and social studies, seeking to comprehend issues as well as to deepen economic theory and incentive systems, which seem to subjugate at least a large part of the consequences related to the use of digitalization. Among the most important aspects of digitalization and big data analysis are new business models and societal effects associated with work and employment and with the fact that the data collected and produced can be used or even exploited in a different form than originally proposed – leading to violations, control or unintended premises of privacy. Thus, it is also appropriate to consider big data analysis as a theoretical foundation to deal with the research question *Research Agenda RQA (01) on Fintech Business Models*, set forth earlier. Loebbecke and Picot (2015) point out that this research flow will probably be followed by regulatory actions, aimed at a radically different digital society, beneficial to its citizens and its companies.

5.2.2.12. Financial technology (FT): FT7 – Risk management. What are the most recurrent risk-related subjects? In the context of this topic, research questions on employing technologies, especially IT, are considered so that financial institutions can manage the risks inherent to their operation, seeking to avoid or reduce the losses resulting from the occurrence of adverse events to their businesses related to these risks. In their work, Faloon and Scherer (2017) propose that fintech companies use robo-advisors who attribute a risk level to individual investors' portfolios using web-based investment algorithms with a minimum of human interaction. With the literature review on the global regulatory environment and the underlying risks to fintechs, Ng and Kwok (2017) analyze the formulation and implementation of complementary regulatory policies in the case of Hong Kong, such as the Global Financial Centre (GFC). The financial regulator uses broad ranging risk-based mechanisms to adopt limitations on exposures to cyber risks, promoting the institutionalization of cybersecurity among

the regulated companies with strategic controls, as a strategic approach that takes advantage of opportunities associated with fintechs.

RQA (10) on Risk Management: Automated web-based consulting especially with robo-advisors, also known as chatbots, promises many advantages to banks and customers. They are emerging in all financial service activity sectors, helping consumers to choose investments, bank products or insurance policies. Robotic advisors have the potential to reduce costs and increase the quality and transparency of financial counselling to consumers. In addition to the fact that consumer acceptance has been slow until now (Nikiforova, 2017) these robots also represent new and significant challenges on several fronts: technology, regulation, for jobs and for the job market. New studies are also suggested to discover in greater detail the potential and opportunity that this new type of interaction with clients represents. For example, acquisition techniques and data processing could be compared to find preferential projects to create investment counsel. Likewise, it is also appropriate to consider big data analysis as a theoretical foundation for dealing with these techniques for acquisition and data processing. Therefore, there are clearly research questions such as: How has the technology for robotic advisors evolved? Which roles can these robotic advisors play in fintech organizations? (*background* teórico de gestão da inovação e adoção de novas tecnologias) What are the regulatory limitations and how should these robotic consultants be introduced (Baker and Dellaert, 2017)? Accepting robotic advisors as part of the IT infrastructure to support fintech business can utilize as background theories of innovation management and adopt new technologies such as the Technology Organization-Environment (TOE) model (Zhu et al., 2006), the Theory of Planned Behaviour (TPB), the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA) or the Innovation Diffusion Theory (IDT), since this depends on the conscious assessment of the factors that influence the users of robot consultants.

5.2.2.13. Financial technology (FT) – other financial Service technologies. In this subsection are articles selected for their focus on Financial Technology (FT), but which cannot be classified in any of the former seven subcategories. Among these are articles important to this bibliographic study, since they have a high number of citations, such as is the case of Berger (2003), Preda (2006), Barnett and Pasupathy (2003) and Patel and Broughton (2002). Alex Preda (2006) presents a sociological study on the practice of financial analysis of the stock ticker. The author studies the rise of technical analysis (that is counterposed to fundamentalist analysis), showing how graphics were legitimized by a two-way movement between construction groups and users of technical graphics, and highlights the ways by which interest in using graphics as a tool for prediction was created. Financial graphics as a financial technology was created not just to interpret the stock market, but also as a decision-making tool.

In their work, Patel and Broughton (2002) argue that United Kingdom officials, unions, voluntary organizations, employers and employees show a concern that there exist risks to workers' health and security at call centres. One of the possible dangers reported in the press is hearing loss due to use of headphones. In a project financed by the Health and Safety Executive, exposure to noise by 150 operators was evaluated at call centres that included financial services, home purchases and telecommunications services. The results show that it is improbable that these operators' daily exposure to noise exceeds the noise action level of 85 dB(A) defined in the *Noise at Work Regulations*, 1989. Therefore, the risk of auditory damage is extremely low, the authors conclude. In an econometric study, Barnett and Pasupathy (2003) argue the need to impose curvature and monotonicity on works of production modelling (at least verification of monotonicity) to the technical specifications, since regularity requires the satisfaction of both the conditions of curvature and monotonicity.

5.2.3. How main subjects and issues in the scientific literature on fintechs interact with one another

An analysis in the vertical direction of the Financial Technologies (FT) axis of the literature summary structure (Fig. 9) helps the reader to understand how main subjects and issues interact with one another. Challenges in Financial Technology (FT) as personal data protection and privacy issues, such as threats, malicious behaviour, attacks, insufficient certification or authentication are frequently found in studies on FT1 – Adoption/Externality (Traynor et al. 2017, Schulte and Liu, 2018) and papers on FT3 – Blockchain (Park and Park, 2017; Magazzeni et al., 2017), showing a great concern for security and privacy (FT6 – Security), since organizations that collect, store or use personally identifiable information related to a blockchain network, or suffer a cyber attack or other breach of a proprietary blockchain network, may experience legal or compliance issues with their privacy practices and data security.

Fork problem is another very important issue because it involves a wide range in blockchain (Nordrum, 2017). It is related to a decentralized agreement when the software is upgraded. When the new version of blockchain software was published, a new agreement in consensus rule also changed to the nodes. Also, with *Proof of Work* blockchain mechanism, the probability of mining depends on the work done by the miner (e.g. CPU/GPU cycles spent checking for hashes) (Aste et al., 2017). Because of this, peers will want to join together in order to mine more blocks, and become "mining pools", the place where holding most computing power. Once it holds the majority of computing power, it can take control of this blockchain. Apparently, this also causes security issues.

Among the several studies on the adoption of mobile banking M2 (Mobile Banking), several factors such as navigation problems, a small screen size, and transaction issues can increase the complexity of its adoption (FT1 – Adoption/Externality) in developing countries and also about its use and diffusion among elderly people were found in this work (Au and Kauffman, 2008; Kim et al., 2016; Jeong et al., 2018). Issues of security related to financial services transactions (FT6 – Security) such as biometric authentication underlying this technology (Kim and Hong, 2015, 2013a,b) are also relevant in M2 (Mobile Banking).

Also in Fig. 9, an analysis in the vertical direction of the Financial Services (FS) axis shows questions about the regulation of services (FS5 – Service Operation). Among them, the decentralized system characteristics of cryptocurrencies weaken the central bank's ability to control economic policy and the amount of money, forcing governments to be wary of blockchain technologies. Therefore, the monetary authorities have to research this new issue and accelerate the formulation of new policies, otherwise there are risks to the markets (Ducas and Wilner, 2017). Moreover, as a growing blockchain, data become larger and larger, storage loading and computing are also becoming harder and harder. It takes a lot of time to synchronize data, at the same time, data still increase continuously, bringing a big problem to the client when running the system (Park and Park, 2017). The time for confirmation of blockchain data yet is a problem. Compared to the traditional online credit card transaction, where a transaction generally takes two or three days to confirm, transactions with Bitcoin, for example, take about 1 h to confirm. This is much better than usual, but still not good enough for the current needs of organizations. The issues above are considered to be strong inhibitors for the launch of new products (I1 – Product or Service), especially those considered highly innovative or disruptive as mapped in FS1 - Innovation (Au and Kauffman, 2008; Saksonova and Kuzmina-Merlino, 2017) or new business models such as crowdfunding, financial services to micro-entrepreneurs, venture capital financing start-up firms, etc. (I2 – Financial Arrangements) (Chen et al., 2017).

6. Conclusions

This study contributes to improving the understanding of the fintech phenomenon in three ways.

First, it maps the evolution trend of the literature on fintech, greatly influenced by the media, but still fairly ambiguous in the realm of research that created solid relevant academic knowledge, such as that found in the indexed databases utilized here. In addition to the fact that publications devoted to mapping the literature on fintechs are relatively scarce, neither were works found that deal with the fintech subject in a broad, longitudinal manner, as does this systematic review. In perusing the fintech subject, one observes a noticeable increase in the number of publications in recent years, especially from 2016, showing the emergent interest of academic communications in the subject, spread in 142 different journals and involving areas of knowledge such as finances, information technology, physical and digital security, human resources and work organization.

Second, the article shows the key topics and trends on fintechs. The literature was attempted on two very different axes in the nature of the studies: Financial Services (115 publications) and Financial Technology (61 publications). The literature focuses on financial services and innovations, dealing with issues of financial industry regulation and local legislation or the financial system globally. The subjects related to financial services operation particularly deal with risks of financial loss related to different factors involved in the business environment of these organizations. The research subcategories Innovation (Technology adoption/Network externalities), Blockchain and Security appear with great emphasis in this work and represent the current most sensitive aspects also linked to the more global theme of digital transformation. These issues reflect the concerns of researchers and practitioners in the industry with the fundamental decisions for managers and technicians involved in this inevitable far reaching process. This has a strong impact on society, not just on the ways people save, take loans or make payments and send remittances, but also how it organizes and manifests in the social media to maximize perceptions of successful or failed experiences.

Third, the study surveyed a set of definitions for the term fintech towards a consensus and suggest as a comprehensive understanding as innovative companies active in the financial industry making use of the availability of communication, the ubiquity of the internet, and the automated processing of information.

As implications for practice, in this work there are a significant number of concerns of researchers, practitioners and managers at the highest levels of the traditional financial organizations or of fintechs, and which now can help their decision-making processes. Inevitably, the work has intrinsic limitations deriving from its research design, particularly from the determination of the sample, such as the selection of the timeliness, the databases, the search strings and inclusion and exclusion criteria that may have narrowed the research sample. There is also acknowledged the exploratory nature of this research, with subjectivity in the content analysis of the surveyed sample. Moreover, the authors opted to direct the major effort of their research agenda to subjects related to Financial Technology (FT), which made it possible to deepen the work with a 7 topic research agenda posed as a series of questions, accompanied by the theoretical justifications for their formulation, as well as a theoretical basis for conducting future works meant to answer the emerging and important research issues suggested here. Nevertheless, limiting the subject to the topic of Financial Technology (FT) made it possible for a new research agenda to be expanded beyond the three topics associated to the Financial Service (FS) category, now proposed.

Future studies can be undertaken in the area by comparing and validating the results presented here, especially with expanded search criteria and databases. Moreover, other analysis techniques, such as for example semantic analysis, can be used in the search for new concepts, definitions or common terms that would better characterize the works, as well as validating the findings of this systematic review. Other interesting insights for future research are the relation among the research topics that show up in the network analysis as the strong relation among fintech services (FS) and S3 (loans), S4 (investments) and S6 (crowdfunding), as well as the strong relation among Financial Technology (FT) and S7 (Blockchain /Cryptocurrencies) that should be in-depth explored in field research.

Acknowledgments

Appendix

Fourteen articles were found in magazines/newspapers that, despite also meeting the search criteria, did not have the necessary metadata for the analyses developed in the work. Table 9 shows 11 publications from the *Economist* (United Kingdom) found in the Scopus® database. The three remaining articles have their origin in the *"Web of Science Core™ Collection"*, and two of them (Gandel, 2016; Cohan, 2016) in *Fortune* magazine or in *Forbes* (Novack and Schifrin, 2015).

Table 9
The Eleven Articles Found in The Economist (United Kingdom).

Title	Location
A fintech startup tries to shake up American student loans	https://goo.gl/LM71rn
Banking and fintech: Love and war	https://goo.gl/w34Y4W
Banks v fintech: An uneasy symbiosis	https://goo.gl/EkskTt
Catching up: The race to become Islamic banking's fintech hub	https://goo.gl/ZMJZ3j
Every little helps: How fintech firms are helping to revolutionise supply-chain finance	https://goo.gl/3dnBCJ
Financial technology: Connect 450	https://goo.gl/HqQ47s
Fintech and insurance: Against the odds	https://goo.gl/Fq3qRF
Fin-tech: Before there were tech startups, there was whaling	https://goo.gl/Ty7jsw
Out of the box: Singapore tries to become a fintech hub	https://goo.gl/nX3Ltv
Ten years on: Financial technology: Financial technology is proving less of a battleground than feared	https://goo.gl/M5BbsW
The age of the appacus: In fintech, China shows the way	https://goo.gl/KwyjYb

Source: Titles Extracted from the Subset of the Sample Originated from the *Scopus® database*.

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