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Supporting Risk Management in Finance through the Use of ICT. A Systematic Literature Review

Wspomaganie zarządzania ryzykiem w finansach poprzez wykorzystanie ICT. Systematyczny przegląd literatury

Abstract: Risk management is a function performed in every enterprise. However, it plays a particularly important role in organizations from the financial industry. Currently, there are many ICT tools available on the market that facilitate the risk management process in companies. The authors examined the following research problem, namely the tendency of the use of ICT in financial risk management described in the literature. The aim was to show the relation between risk management in finance and ICT tools in the literature. The research method was a statistical systematic literature review which covered five databases: Scopus, Web of Science, IEEE Xplore, ScienceDirect and Google Scholar, over the period from 2010 to 2021.

Keywords: ICT, literature review, finances, risk management.

Streszczenie: Zarządzanie ryzykiem to funkcja wykonywana w każdym przedsiębiorstwie. Odgrywa jednak szczególnie ważną rolę w organizacjach z branży finansowej. Obecnie na rynku dostępnych jest wiele narzędzi teleinformatycznych, które ułatwiają proces zarządzania ryzykiem w firmach. Autorzy zaobserwowali następujący problem badawczy, jakim jest opisana w literaturze tendencja wykorzystania ICT w zarządzaniu ryzykiem finansowym. Celem pracy jest ukazanie związku pomiędzy zarządzaniem ryzykiem w finansach a narzędziami ICT w literaturze. Metoda badawcza to statystyczny, systematyczny przegląd literatury. Badania objęły 5 baz danych: Scopus, Web of Science, IEEE Xplore, ScienceDirect i Google Scholar. Zakres poszukiwań obejmował okres od 2010 do 2021 roku.

Słowa kluczowe: ICT, przegląd literatury, finanse, zarządzanie ryzykiem.

1. Introduction

Risk can be defined as the probability that a company will record losses because of a decision. There are many types of risk that can affect the activities of an organization, such as financial risk, bankruptcy, and reinvestment. The company takes various measures to prevent partial or total losses in the shortest possible time. The concept of risk management is defined as several activities that allow for the assessment, control, and monitoring of risk (Hopkin, 2018). Risk management plays a very important role in the financial industry. The occurrence of financial crises forces financial companies to carefully manage costs, as well as reduce operational risk (Esch, Kieffer, and Lopez, 2005). Numerous ICT tools can be used to manage risk in finance, to facilitate the monitoring of important phenomena. The authors examined the following research problem, namely the trend described in the literature of the use of ICT in risk management in finance. Based on such a problem, the authors set themselves the research goal *to indicate the relation between risk management in finance and ICT tools in the literature*. The structure of the article is as follows. The next section describes the test method, then the research procedure is presented, followed by the results of a statistical systematic literature review. In the final section, the results of the research are shown. The article ends with the conclusions and summary.

2. Research method

To define and determine the research gap, the authors decided to conduct a statistical systematic literature review[1]. On this basis, they selected a representative group of scientific studies, which in the second stage was subject to a detailed analysis of the substantive content. Figure 1 shows the phases that the authors used to carry out the analysis.

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[1] In the literature, one can find publications describing a systematic review of the literature (cf. Czakon, 2011; Grant and Booth, 2009; Mazur and Orłowska, 2018).

Fig. 1. Research method

Source: own elaboration.

"Creating systematic literature reviews can provide information on the functioning of different intervention policies, programs and techniques and the possible damage they may cause (...) on the basis of reviews of the literature on finance, decisions can be made regarding the choice of policy or direction of action ensuring an appropriate ratio of quality and price, other reviews allow to see the pros and cons of various ways of organizing services" (Orłowska, Mazur, and Łaguna 2017, p. 359). The study included five databases: Scopus, Web of Science (all indexes), IEEE Xplore, ScienceDirect and Google Scholar. The search covered the period 2010-2021.

3. Research procedure

The authors, in order to achieve the assumed goal, as well as solve a defined research problem, carried out the following activities:

1. Determination of literature sources.

2. Formulation of criteria for the selection of publications, which will be considered in further analysis.

3. Searching for publications for the query ("risk management" AND "finances") in databases.

4. Identification of keywords and the selection of the most frequently repeated words in the analysed databases.

5. Execution of literature statistics for individual keywords in databases in the period 2010-2021.

6. Implementation of literature statistics for the query with keywords (("risk management" AND "finances") AND ("kw" AND "kw"...)).

7. Searching for scientific papers for queries ((ICT, machine learning, big data, data mining) AND ("financial risk management")).

8. Formulation of conclusions and summary of the conducted research.

Research questions:

The main objective of the literature review undertaken by the authors was to obtain answers to the posed research questions:

(RQ1). How often is the relation between the concepts of risk management and finance demonstrated in the literature?

(RQ2). How has the authors' interest in the analysed issue changed in the period 2010-2021?

(RQ3). What is the number of publications on the combination of ICT and its details with risk management in finance?

4. Research results

In answering RQ1, a relation was observed between the concepts of "risk management" and "finance". The search results are shown in Table 1.

Table 1. Queries for databases containing the publications

Database	Query	Publication number
Scopus	("risk management" AND "finances")	2072
Web of Science	("risk management" AND "finances")	53
IEEE Xplore	("risk management" AND "finances")	1265
ScienceDirect	("risk management" AND "finances")	8
Google Scholar	("risk management" AND "finances")	20 200

Source: own elaboration.

In the presented table, it can be noted that the largest number of publications can be found in the Google Scholar database, while the least are available in the ScienceDirect database, and in the Web of Science. The presented discrepancy in the results may result from the fact of the indexed publication sources in which the authors do not raise this issue.

Table 2. Annual cross-section of the number of publications

("risk management" AND "finances")	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Scopus	152	141	136	131	180	161	170	165	168	184	208	276
Web of Science	3	4	3	1	4	7	3	4	4	6	5	9
IEEE Xplore	243	199	87	63	58	58	55	60	54	93	128	167
ScienceDirect	0	1	1	0	0	0	1	0	0	1	2	2
Google Scholar	3860	4370	4800	5140	5870	6240	6490	6800	6870	6900	7320	8400

Source: own elaboration.

In Table 2, it can be noted that the number of publications on the relation between risk and financial management in the analysed databases changes over the years. The indexed publications in the Google Scholar database show a clear upward trend from year to year, while in the case of the Scopus database, a gradual increase in the trend can be observed. On the other hand, in the ScienceDirect and Web of Science databases, a zero trend can be seen, whereas in the case of the IEEE Xplore database, a gradual downward trend is shown.

As a result of the queries carried out in the databases, keywords were established, and 8926 of those were identified. Next, the authors assumed that the keywords subjected to further analysis were those that repeat in the range of 20-99 repetitions, as presented in Figure 2.
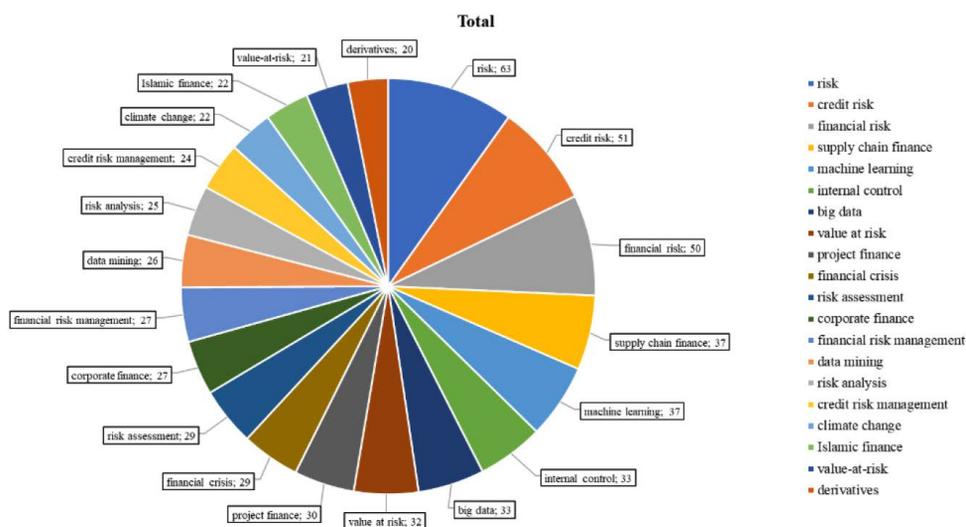
Fig. 2. The most frequently repeated keywords in the range of 20-99 repetitions

Source: own elaboration.

As a result of the assumption, 20 keywords were obtained. Then it was identified in the analysed databases how many publications refer to them. The results are presented in Table 3.

In the collected keywords, one can find phrases derived from the area of finance, management, risk management and ICT. Among the most recurring keywords, „value-at-risk" and „value at risk" stand out. Despite the difference in spelling, the phrase generates the same results in all the analysed databases.

In response to RQ3, the authors analysed the following relations in the designated databases: ICT, machine learning, big data, and data mining, with financial risk management. As with the previous queries, the period 2010-2021 was also used, and the results are presented in Table 4.

Table 3. The number of publications in databases by keywords

Keywords	Scopus	Web of Science	IEEE Xplore	ScienceDirect	Google Scholar
Risk	2 942 763	2 318 369	13 765	593 262	820 000
Credit risk	6188	4813	432	1446	87 300
Financial risk	6846	3864	396	1300	120 000
Supply chain finance	572	388	83	106	7930
Machine learning	305 632	158 899	82 654	34 884	1 960 000
Internal control	613	5140	352	1235	1 010 000
Big data	119 530	56 909	44 618	9870	1 020 000
Value at risk	6458	5301	795	2150	28 600
Project finance	512	2016	35	284	20 200
Financial crisis	35 792	23 678	519	5538	921 000
Risk assessment	55 633	91 603	4 812	32 860	1 510 000
Corporate finance	1510	1187	30	363	132 000
Financial risk management	702	487	72	110	18 800
Data mining	152 483	41 783	28 181	9334	1 470 000
Risk analysis	33 186	15 306	2086	5403	469 000
Credit risk management	490	324	48	75	18 100
Climate change	277 468	231 499	4578	51 350	1 490 000
Islamic finance	1504	735	25	176	41 900
Value-at-risk	6458	5301	795	2150	28 600
Derivatives	1 324 182	353 863	4772	119 479	1 999 000

Source: own elaboration.
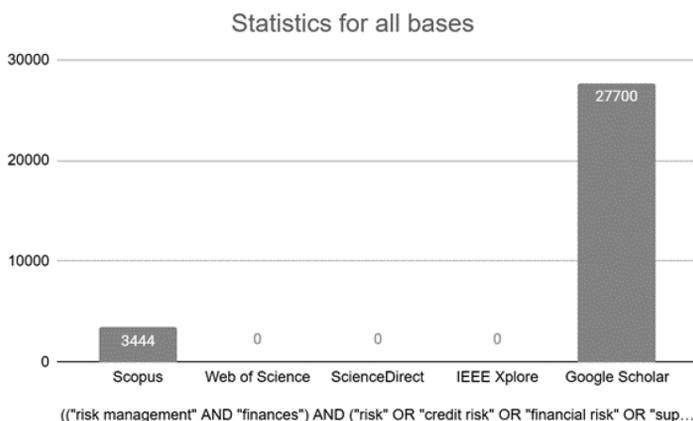
Fig. 3. The number of publications in databases based on query (("risk management" AND "finances") AND ("risk" OR "credit risk" OR "financial risk" OR "supply chain finance" OR "machine learning" OR "internal control" OR "big data" OR "value at risk" OR "project finance" OR "financial crisis" OR "risk assessment" OR "corporate finance" OR "financial risk management" OR "data mining" OR "risk analysis" OR "credit risk management" OR "climate change" OR "Islamic finance" OR "value-at-risk" OR "derivatives"))
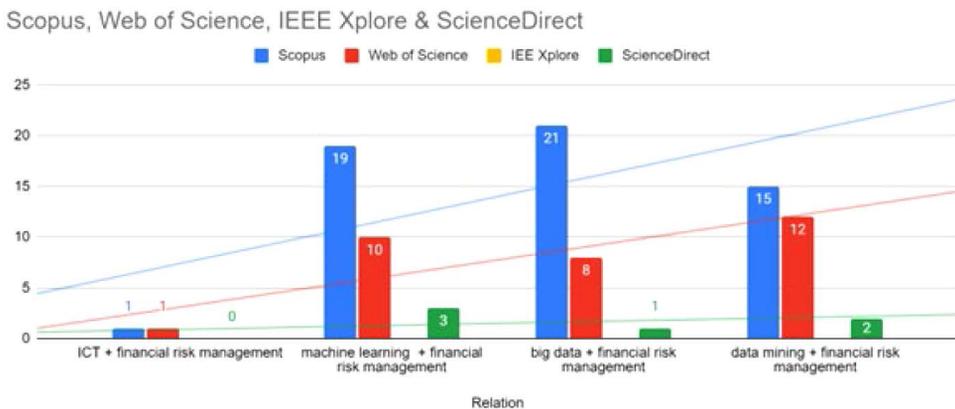
Source: own elaboration.

Table 4. The number of publications in databases depending on the relation (ICT, machine learning, big data, and data mining) with financial risk management

Relation	Query	Scopus	Web of Science	IEEE Xplore	ScienceDirect	Google Scholar
ICT + financial risk management	(("ICT" OR "information-communication technology") AND ("financial risk management"))	1	1	0	0	1240
machine learning + financial risk management	(("ML" OR "machine learning") AND ("financial risk management"))	19	10	0	3	5040
big data + financial risk management	(("big data") AND ("financial risk management"))	21	8	0	1	2420
data mining + financial risk management	(("data mining") AND ("financial risk management"))	15	12	0	2	1640

Source: own elaboration.

In addition, the contents of the table were visualized using charts. This was a deliberate procedure because it allows to determine the trend line. The trend in Scopus, Web of Science, IEEE Xplore and ScienceDirect is shown in Figure 4, and the trend line in Google Scholar in Figure 5.

Fig. 4. Trend lines in Scopus, Web of Science, IEEE Xplore and ScienceDirect databases

Source: own elaboration.
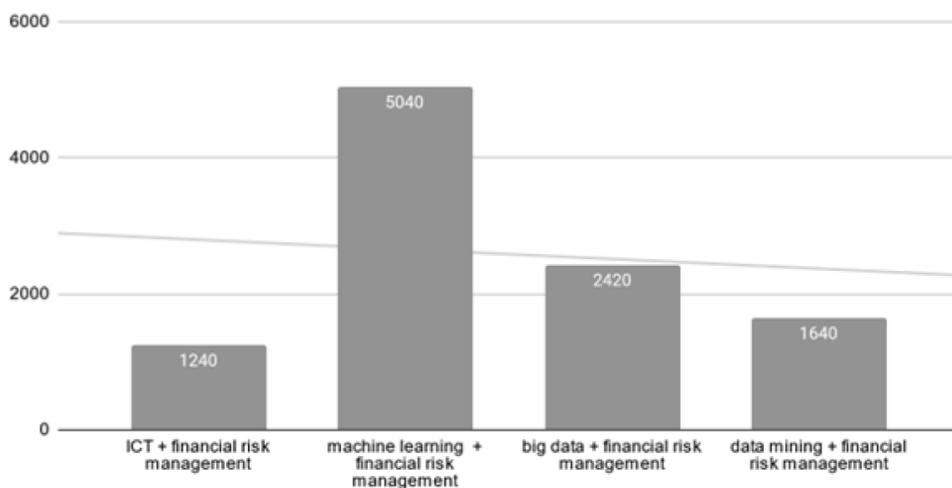
Fig. 5. Trend lines in Google Scholar database

Source: own elaboration.

The trend of the amount of literature in individual databases is distributed at different levels. It can be noted that in databases other than Google Scholar, the trend is upward, with varying intensity. It can be observed that rapid growth occurs in the Scopus database, moderate in the Web of Science database, and the slowest growth appears in the ScienceDirect database. It is interesting that Google Scholar, which indicated the most publications in the analysed reports, shows a gradual decline in the trend.

5. Conclusions and summary

When identifying the number of publications occurring with the main phrases and keywords, it can be observed that the databases have limitations in the number of words entered in the fields. The ScienceDirect database is limited to eight elements, so the search is already limited, whilst Web of Science and IEEE Xplore are not able to cope with the search for complex queries. Finance as a scientific field benefits from the achievements of other fields and solutions. In the analysed keywords, it can be noted that there was a strong relation with risk management, as well as with technological solutions. It can be seen that the authors from the analysed scope referred to such ICT solutions as machine learning, data mining and big data. Such a reference should not come as a surprise because the development of ICT nowadays is beginning to be increasingly used in various fields, including scientific. In the literature, there are publications that clearly combine risk management in finance with ICT. In addition, it should be pointed out that further research and scientific work can

be expected, which will develop ever newer ways of predicting financial decisions, including the creation of concepts and solutions in such an area as blockchain, as well as the impact of new technologies on finance, to counteract fraud.

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