



Evolution of customer relationship management to data mining-based customer relationship management: a scientometric analysis

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Accepted: 15 July 2022

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Abstract

Scores of researchers have paid attention to empirical and conceptual dimensions of Customer relationship management (CRM). A few studies summarise the research output of CRM focusing on a specific industry. Nevertheless, there is scant literature summarising the research output of CRM in contrast to the data mining-based CRM. This study presents a scientometric analysis that evaluates CRM research output with a special focus on data mining-based CRM. Bibliometric data were extracted for the period 2000–2020 from the Web of Science database to apply descriptive analysis and scientometric analysis to obtain the bibliometric profile of CRM research. Further, we generated the conceptual structure map using multiple correspondence analysis and clustering for CRM and data mining-based CRM research fields. Interestingly, the analysis revealed that the future trend of CRM research would be based on techniques associated with machine learning and artificial intelligence. The study provides extensive insight into the basic structure of the CRM and data mining-based CRM research domain and identifies future research areas.

Keywords CRM · Data mining · Scientometric analysis · Citation analysis · Conceptual structure map

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1 Introduction

Customer relationship management comprises a set of processes and enabling systems supporting a business strategy to build profitable long-term relationships with specific customers (Azadeh et al. 2017; Capuano et al. 2021; Tsou. 2022). The objective of CRM is the personalised handling of customers (Li et al. 2006) by identifying and understanding their heterogeneous needs, interests, and preferences to develop customer loyalty using information systems (Khan et al. 2022). Although the objective of CRM has remained somewhat consistent over the past three decades, the way CRM has been implemented in organisations has been radically transformed on account of the advancement in internet and computing technologies (Nguyen et al. 2020; Herman et al. 2021). This transformation in CRM implementation is warranted by the significant growth in sales volume across all industries and the evolution of distribution channels brought about by digitalisation (Mahdavi et al. 2011).

The digitalisation trend, facilitated by technologies such as IoT, digital twin, and control tower, resulted in the generation of enormous volumes of customer data. i.e., big data (Anshari et al. 2019) further adds to the complexity of business decision-making. To make effective business decisions in such a dynamic and complex business environment, CRM has undergone a phase shift into data mining-based CRM (DCRM) or analytical CRM (Liou 2009; Ngai et al. 2009; Tu and Yang 2013). DCRM is characterised by the application of various data mining techniques such as classification (Lessmann and Vob, 2009; Tu and Yang, 2013; Keramati et al. 2014), clustering (Carpaneto et al. 2006; Hosseini et al. 2010; Wang 2010), regression (Yap et al. 2011; De Caigny et al. 2018; Biswas et al. 2020), association (Liao et al. 2010; Shim et al. 2012) and prediction (Lee et al. 2017; Ahmad et al. 2019; Martínez et al. 2020). These techniques help extract valuable information from large data sets for synthesising useful customer information (Liao et al. 2008; Tsipstis and Chorianopoulos, 2009).

With the increasing practical applications of data mining techniques for CRM, there is a corresponding increase in the number of research articles addressing DCRM across various industries (Ledro et al. 2022). There are a few studies that summarise the recent research output of the CRM domain (Ngai et al. 2009; Sota et al. 2020; Soltani and Navimipour, 2016) and some studies focus on industries such as healthcare (Baashar et al. 2020) and hospitality (Sota et al. 2020). These studies, despite their valuable contribution, have some limitations (i) None of these studies has explored the possibility of scientometric techniques to understand the CRM domain (ii) these studies have considered the research articles only from selected publishers than considering a citation database of peer-reviewed literature such as Scopus or Web of Science. This implies that the datasets analysed currently are not comprehensive in representation (iii). These studies have not captured the evolving nature of CRM with advancements in data-analytics tools and techniques. Thus, a critical and rigorous review is warranted, considering the limitations of the extant studies in this area. Considering the above-mentioned research gaps, we pose the following research questions.

- I. What is the current status of CRM research? How does it compare with the DCRM research?
- II. What are the trends in CRM and DCRM research concerning the output and citations?
- III. What is the future trajectory and evolving areas of CRM and DCRM research?

Since CRM systems are predicted to evolve at an accelerated pace with the integration of technologies like artificial intelligence (AI) (Deb et al. 2018) and with the radical change in consumer behaviour due to pandemics like COVID-19 (Wright, 2020), it is imperative to quantitatively analyse CRM research field to understand its current state and to predict the future directions. To address this research gap, we focus on the following research objectives in this study.

- i. Carry out a bibliometric search to identify relevant articles from the research field of CRM and DCRM for the time horizon of 2000–2020.
- ii. Apply descriptive analysis to identify the leading journals, leading universities, and leading authors based on the research output in the domain of CRM and DCRM
- iii. Apply scientometric analysis to identify the leading journals, contemporary topics, important topics, leading institutes, and leading countries based on the number of citations in the CRM and DCRM.
- iv. Develop the conceptual structure of CRM and DCRM research domain using a word-co-occurrence network.

To meet the objectives mentioned above, scientometric analysis (SA) was carried out to deeply explore and compare the research domains of CRM and DCRM. SA is an analysis technique using bibliometric data to plot the scientific landscape of any research field. It helps a researcher quantify the academic impact and academic scholars' profiling (Mingers and Leydesdorff 2015; Sarkar and Maiti, 2020). The rationale for applying SA tools is that the conventional literature search using keywords may not always provide a good insight to researchers when the topic for research is complex and massive (Rodrigues et al. 2014). SA generates a data-driven version of scientific research output, and its ability to visualise the research output can help the researchers perceive the research status. The application of SA is not restricted to engineering or business rather, this technique has been applied extensively to domains such as health-care (Fang, 2015), disaster management (Sahil and Sood, 2021; Sood and Rawat, 2021), education (Rawat and Sood, 2021) to name a few. SA can be viewed as a combination of various scientometric techniques, information visualisation techniques and text mining to study the development and growth of a research field (Darko et al. 2019). In this study, we have adopted a triangulation methodology (Chandra, 2018) by simultaneously considering the following techniques (i) topic mapping, (ii) journal co-citation analysis and (iii) overlay visualisation.

By comparing the research landscape of CRM and DCRM, we note that there are both similarities and differences. For instance, while there are differences concerning influential journals, there are similarities in the case of leading universities. It is interesting to note the additional insights obtained from the citation-based analysis compared to the output-based analysis. Further, the conceptual structure map developed from the co-word analysis of keywords gives an overall picture of distinct groups in the research domain of CRM and DCRM.

This paper aims to contribute in the following ways (i) The study contributes to the existing body of knowledge by analysing the current status of CRM and its evolution into DCRM. (ii) This study compares the CRM research domain with the DCRM research domain in terms of several parameters with the help of bibliometric and scientometric analysis techniques (iii) This study identifies the future research directions in the domain of CRM and DCRM.

The remaining part of this paper is organised as follows. In Sect. 2, we present the Research Methodology. Section 3 reports the results obtained from descriptive analysis and scientometric analysis. Section 4 deals with the implications of the study, and the study concludes with limitations in Sect. 5.

2 Research methodology

This section outlines the research methods and tools used in conducting this study. Figure 1 shows a flowchart of the research methodology.

2.1 Step 1: Bibliometric search

- (a) *Time Horizon*—The time horizon selected for the systematic review process is 2000–2020. In other words, we have considered only those papers published between 2000 and 2020. Though the CRM and DCRM research domain is growing, we have set the upper limit for the time horizon as 2020 since the data was collected in January 2021.
- (b) *Database selection*—The data used for the analysis is extracted from the Web of Science (WoS) database, which has been commonly used for mining bibliometric data. Further, since CRM systems are essentially software systems and are inclined towards the engineering domain, we selected WoS as a suitable database. The comprehensive coverage of this database for bibliographical and SA (Moed, 2010; Larsen and Von Ins, 2010) has been discussed by many researchers (Michels and Schmoich, 2012; Rubbo et al. 2019). WoS was the preferred choice of the database not only due to the comprehensive coverage but also owing to its frequent appearance in previous literature reviews (Bangsa and Schlegelmilch, 2020) and the availability of refined search options (Prieto-Sandoval et al. 2016)
- (c) *Selection of journals and articles*—It was observed that CRM frequently appears in journals focusing on domains such as business, management, marketing, consumer behaviour, management science and industrial engineering. A search in the WoS database using the keyword “CUSTOMER RELATIONSHIP MANAGEMENT” within the 2000–2020 period has yielded 6710 documents. After screening this dataset of documents to consider only research articles, a set of 3878 research articles were obtained as publications for analysis. Similarly, another search conducted with ‘DATA MINING and CRM’ as keywords within the 2000–2020 period resulted in a total of 357 documents and screening them for research articles led to 203 research papers. Both the datasets containing information such as Title, Abstract, Keywords and References were extracted in CSV (comma-separated values) file format for further analysis. Conference proceedings, conference papers and books were excluded by limiting the search to the document type “Article”. We have considered only those articles which belong to peer-reviewed journals published in English.

2.2 Step 2: Descriptive analysis

We carried out a descriptive analysis to identify the following (i) Annual publication trend of CRM and DCRM from 2000 to 2020, (ii) Leading Journals in terms of the number of articles from 2000 to 2020, (iii) Leading Universities/Institutes in CRM and DCRM research in terms of the number of articles from 2000 to 2020 (iv) Leading Authors in

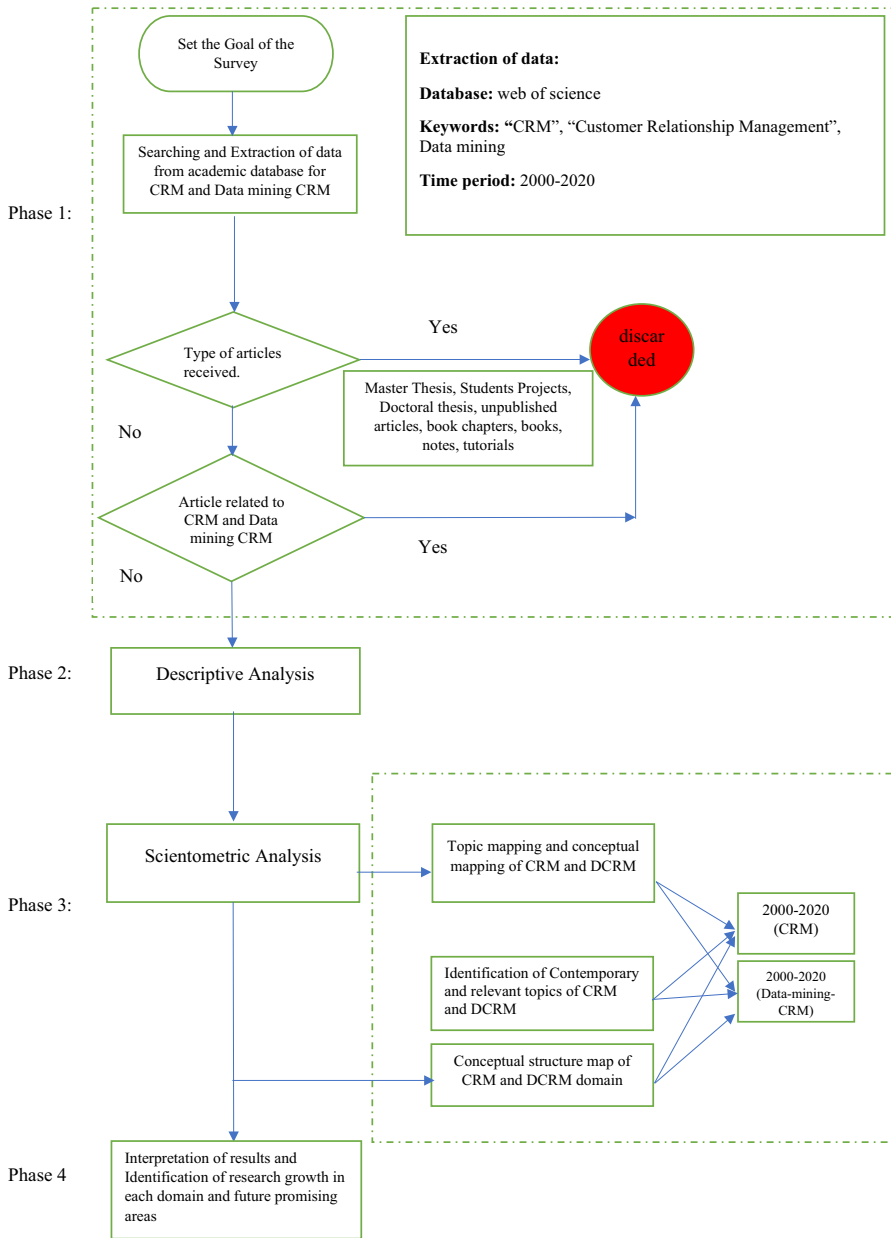


Fig. 1 Flowchart of the four-phase literature review process

CRM and DCRM in terms of the number of articles and their year-wise output from 2000 to 2020.

2.3 Step 3: Scientometric analysis

The central idea behind SA is the knowledge integration of a domain and understanding of the structure and pattern of the field with the help of quantitative and statistical analysis (Van Eck and Waltman, 2011; Rawat and Sood 2021). It provides an interesting way of understanding topics that emerged in a dynamic research field, taking bibliometric data as an input to the analysis (Saini and Sood, 2021). It is mainly used to establish relationships between nodes such as publications, authors, sources/journals or keywords. Relations among the nodes are indicated through edges connecting the weighted nodes. Edges show not only the existence of a relationship but also the strength of the relationship. The most popular type of relationships among the nodes is studied using citation analysis, co-occurrence of keywords, co-citation analysis, bibliographic coupling and co-authorship analysis (Van Eck and Waltman, 2014).

Two software tools are used to conduct SA, viz., R programming and VOSviewer. VOSviewer is freely accessible software based on Java used to construct and visualise large bibliometric networks based on natural language processing and text mining algorithms (Van Eck and Waltman 2011). VOSviewer yields a two-dimensional map where the similarity of items is demonstrated by their position on the map (Van Eck and Waltman 2011). These maps could include any journals, author's name or documents using various bibliometric techniques like citation, co-citation, bibliometric coupling, keyword co-occurrence and co-authorship. The unique feature of VOSviewer is to zoom the large networks helps examine the network closely and quickly obtain information. Therefore, we have selected VOSviewer for visualising and evaluating the CRM and DCRM research domain.

In this study, we have employed VOSviewer for executing (i) Time-based overlay visualisation map, (iii) Citation-based overlay visualisation map, (iv) Author-based co-citation analysis, (v) Journal-based co-citation analysis, (vi) Institute-based co-author analysis.

Further, we relied on the open-source R-package 'Bibliometrix' for generating the conceptual structure map. The function 'conceptualStructure' map in R-package is based on multiple correspondence analysis and K-means clustering. Multiple correspondence analysis, an extension of correspondence analysis, is used to project observations in a continuous space (Le Phan and Tortora 2019). To compare CRM and DCRM as prospective fields of research, a set of analysis were conducted, and maps were created using VOSviewer. In the following section, we report the data analysis and the results obtained along with their interpretation.

3 Data analysis and results

3.1 Descriptive analysis

Firstly, in Fig. 2, we present the growth in the number of research papers in the domain of CRM and DCRM.

It can be observed that the number of research articles in the domain of CRM is steadily increasing, and specifically, there is a noticeable growth in the number of research articles post-2009. Further, there is a cyclical trend with respect to the number

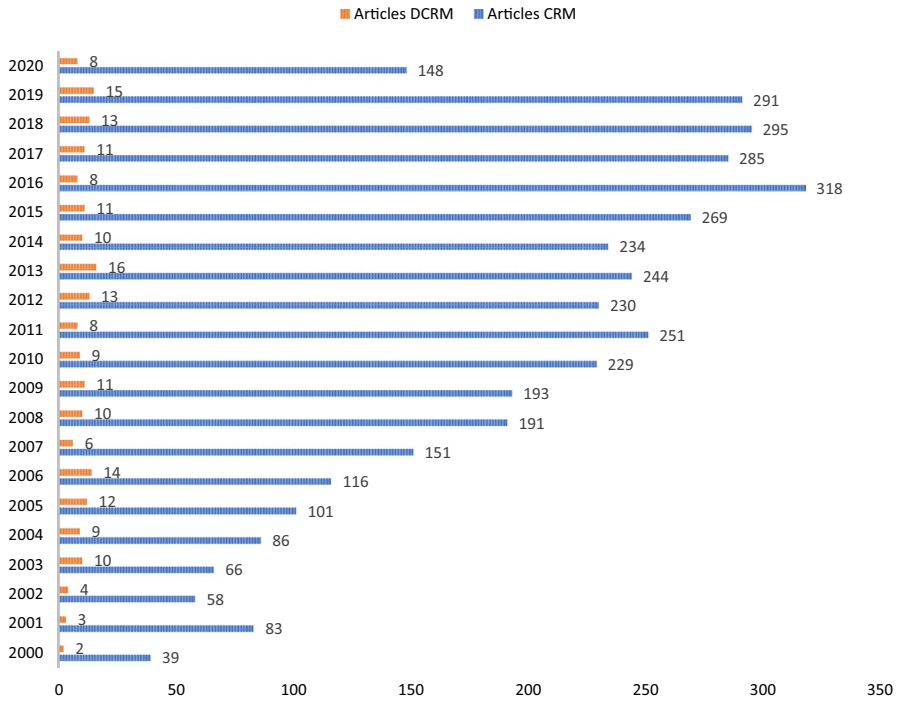


Fig. 2 Annual publication trend of CRM and data-driven CRM from 2000 to 2020

of publications in the domain of DCRM. Nevertheless, recent years have shown an increasing trend. Since the data was collected in June 2020, the number of publications on CRM and DCRM is not entirely captured, which explains the lower number of publications compared to the previous years. Next, we identified five leading journals in the area of CRM and DCRM in terms of the number of articles, as shown in Fig. 3.

In the CRM area, ‘Industrial Marketing Management’ leads the pack with more than 250 publications, followed by ‘Journal of Business and Industrial Marketing’. The difference between these two journals in terms of the number of articles is noticeable, making ‘Industrial Marketing Management’ a clear leader. There is no discernible difference among the journals in the third, fourth and fifth positions. It can be deduced from the nature of the journals that CRM articles appear primarily in the Marketing domain, followed by Operations. In the area of DCRM, the journal ‘Expert Systems with Applications’ holds significant share of the articles with a huge difference in terms of the number of articles between the leader and the immediate follower. Further, it can be observed that the leading journals in the domain of DCRM belong to the domain of Operations Research/Industrial Engineering and Systems. This can be attributed to the nature of the tools and techniques coming under DCRM. Next, we identified the leading universities/institutes in terms of research articles in the area of CRM and DCRM, as shown in Fig. 4.

It can be observed that Hong Kong Polytechnic University is the leading university in the case of both CRM and DCRM research output. In the case of CRM research output, the difference between ‘Hong Kong Poly Technic University and ‘Georgia State

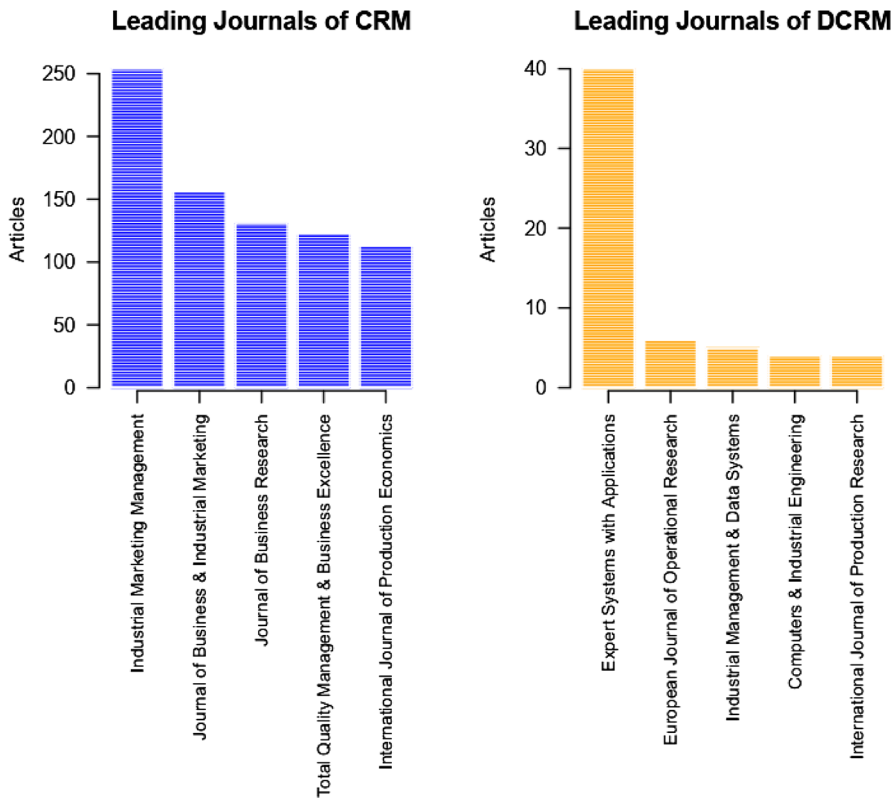


Fig. 3 Leading Journals in terms of number of articles from 2000 to 2020

University’ is minimal. However, in the case of DCRM, the difference between ‘Hong Kong Poly Technic University’ and ‘Aletheia University’ which comes in the second position, is noticeable. Next, we identify the leading authors in the domain of CRM and DCRM, respectively. First, we present ten leading authors in the field of CRM and their output over the years in Fig. 5.

In Fig. 5, the starting point of the purple line indicates the year in which the author has started publishing in the CRM area of research. The ending point of the line can be interpreted in two ways (i) It is the year in which the author has published finally in the area of CRM (ii) It is the year up to which the data has been collected. In the former interpretation, the line can be continued with a break if the authors start publishing articles in the CRM area further. In the latter interpretation, the line can be continued without any break if the authors continue their contribution in the form of research articles.

Prof. V. Kumar, followed by Prof. D. Van den Poel are the leading authors in the domain of CRM research. It can be observed that some researchers produce relatively a smaller number of articles but keep the consistency over a period. In contrast, some researchers produce a more significant number of articles in a short duration and switch to other research domains. The patterns observed in the case of DCRM are random in that there is relatively minimal overlapping among the lines representing the researchers’ seen in Fig. 6.

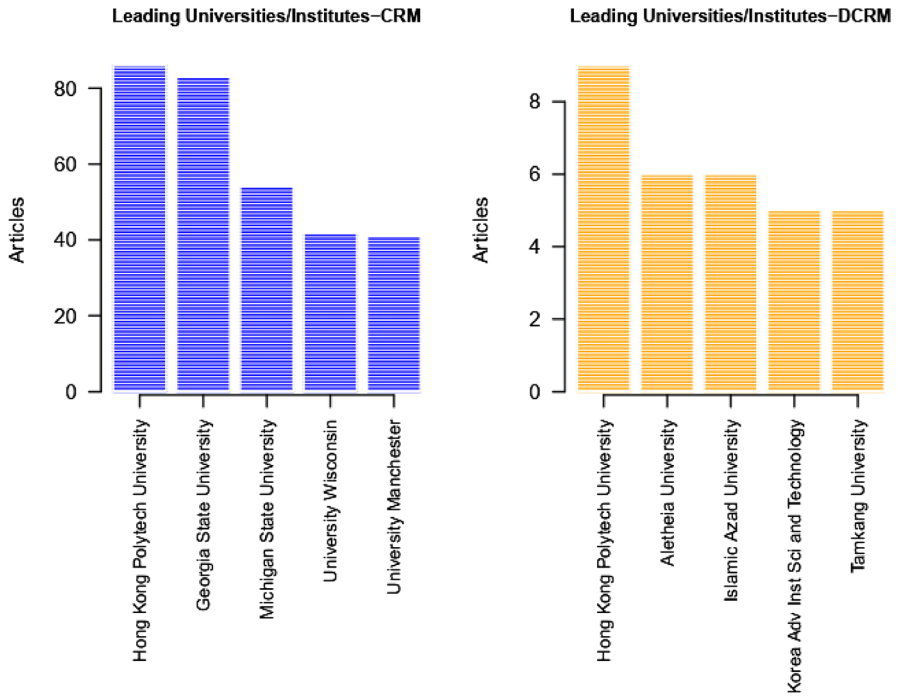


Fig. 4 Leading Universities/Institutes in terms of number of articles from 2000 to 2020

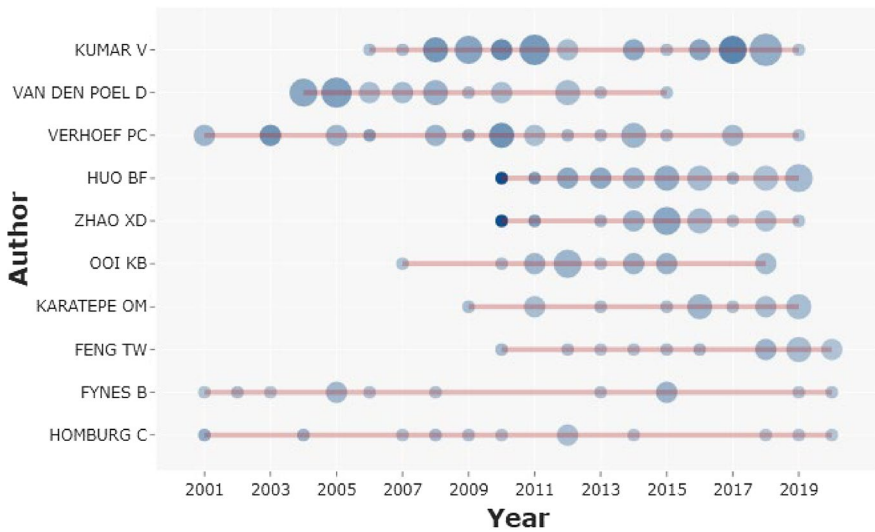


Fig. 5 Leading Authors in CRM in terms of number of articles and their year wise output from 2000 to 2020

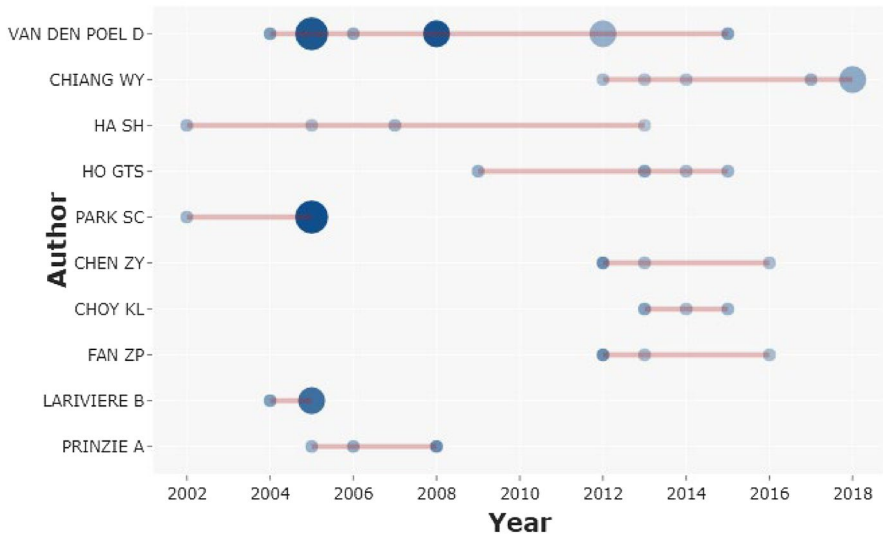


Fig. 6 Leading Authors in DCRM in terms of number of articles and their year wise output

Prof. D. Van den Poel is the leading author in terms of his contribution to research articles in the area of DCRM. The emergence of new researchers in this domain, like Prof. WY Chiang, indicates the dynamics of this domain.

3.2 Scientometric Analysis

Scientometric analysis was carried out in VOSviewer. The same settings were applied for all the techniques. For instance, the frequency of keyword occurrence was set four times, and sixty percentage of the most relevant keywords were included in the network maps.

3.2.1 Leading journals in the field of CRM and DCRM research in terms of citations

It is important to identify the leading journals in a research domain as it can benefit researchers to obtain the most relevant and latest content and to publish their works further. It can also help the editors reconsider and refine their policies to improve the journal's citation performance (Hosseini et al. 2018). Leading journals can be identified by employing the technique of journal co-citation analysis. This technique quantifies and visualises the number of citations imported and exported between a pair of journals (Hsiao and Yang, 2011). To identify the leading journals in CRM domain, journal co-citation analysis has been carried out, and the results are shown in Fig. 7. It shows the leading journals in terms of the number of citations received by research articles focusing on CRM. The filtering criteria set for identifying the journal is that at least five research articles should have been published having the keyword CRM and a minimum number of citations is 10.

The node's size in the network represents the number of citations received by a particular journal for the articles published in it. It can be seen that 'Journal of Marketing', published by Sage publishers, is the leading journal in which a maximum number of citations are received for CRM-based research articles during 2000–2020. The journal

Table 1 Leading research journals based on no. citations in CRM research

Rank	Research journal	No of articles	Total citations	Normal citations	Average citation	Link	Total link strength	Average normal citation
1	Journal of Marketing	69	14,428	216.9098	209.1014	121	1838	3.1436
2	Industrial Marketing Management	254	8474	230.437	33.3622	118	1435	0.9072
3	Journal of Operations Management	51	7626	143.4104	149.5294	77	763	2.812
4	Journal of The Academy of Marketing Science	57	6905	216.32	121.1404	106	703	3.7951
5	Journal of Business Research	131	5060	180.8524	38.626	104	684	1.3806
6	Supply Chain Management-An International Journal	101	4636	104.8469	45.901	63	529	1.0381
7	Expert Systems with Applications	111	4251	86.1531	38.2973	65	261	0.7762
8	Journal of Service Research	50	4224	93.8432	84.48	78	444	1.8769
9	International Journal of Production Economics	113	4089	160.7994	36.1858	72	537	1.423
10	International Journal of Operations & Production Management	93	3853	86.0408	41.4301	68	422	0.9252

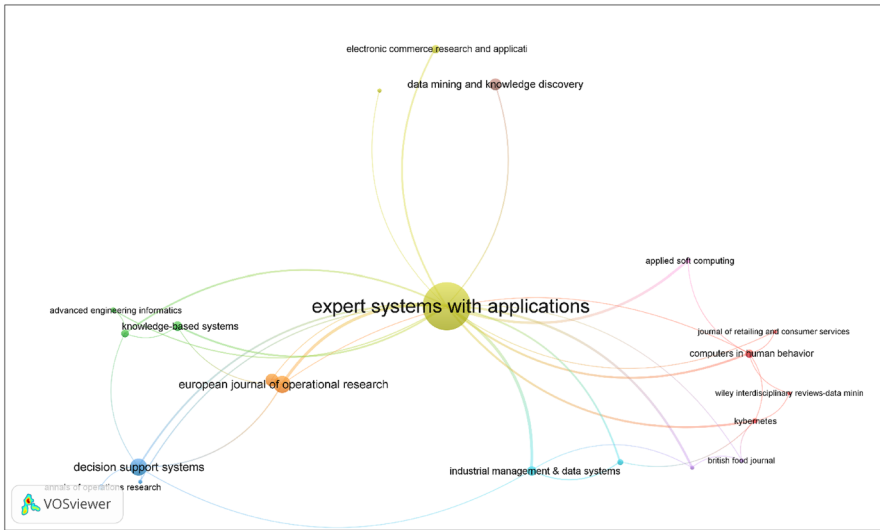


Fig. 8 Leading journals in DCRM based on the number of citations from 2000 to 2020

representing ‘Journal of Marketing’ and the journal ‘Industrial Marketing Management’, which are the two leading journals in terms of link strength.

Next, we present the journal co-citation analysis for obtaining leading journals regarding the number of citations in DCRM in Fig. 8. The filtering criteria used for identifying the journal is that at least two research articles should have been published having the keyword CRM and minimum number of citations is 5. It can be observed from Fig. 8 that ‘Expert Systems with Applications’ published by Elsevier publishers, is the leading journal in the field of DCRM. ‘European Journal of Operational Research’ published by Elsevier publishers appears in the second position. Owing to the lower number of research articles in DCRM compared to the number of research articles under the CRM area, clusters are dispersed with a more significant average distance among the nodes.

To obtain a deeper understanding, we present Table 2, which ranks the leading journals in the area of DCRM in terms of the number of citations. The difference between the leading journal, i.e., ‘Expert Systems with applications’ and the second leading journal, i.e., ‘European Journal of Operational Research’, is noticeable not only in terms of the number of citations but also in terms of the number of articles, links and link strength. Though the ‘Average Citations’ is comparable to ‘Expert Systems with applications’ and ‘Information & management, the small number of research articles in the latter makes the former a clear leader in this field.

3.2.2 Contemporary and important topics of CRM and DCRM research

In this section, we employ the overlay visualisation technique (OVT) to identify contemporary (latest) and important topics in the field of CRM and DCRM. The general idea behind overlay visualization technique is to make a map based on relations of a type of element (e.g., journal, author) and then overlaying on each element information such as number of articles, growth etc. (Rafols et al. 2010). OVT is a network visualization technique with different colours assigned for item under consideration with the colour indicating the score

Table 2 Leading research journals based on no. of citations in DCRM

Rank	Research journal	No of articles	Total citation	Normal citation	Links	Total link strength	Average citation	Average normal citation
1	Expert Systems with Applications	40	2159	63.9693	18	71	53.975	1.5992
2	European Journal of Operational Research	6	275	7.7043	5	14	45.8333	1.2841
3	Decision Support Systems	3	273	3.8874	6	10	91	1.2958
4	Information & Management	3	161	4.0043	2	2	53.6667	1.3348
5	Data Mining and Knowledge Discovery	2	129	3.1653	1	2	64.5	1.5826
6	Knowledge-Based Systems	3	88	4.0974	3	6	29.3333	1.3658
7	Industrial Management & Data Systems	5	85	7.6433	4	13	17	1.5287
8	Computers in Human Behaviour	2	71	5.3891	6	10	35.5	2.6946
9	Electronic Commerce Research and Applications	2	65	3.4914	1	4	32.5	1.7457
10	Computers & Industrial Engineering	4	54	4.8069	4	7	13.5	1.2017

of the item. The importance of the topic is operationalized as those topics which have appeared in highly cited journals.

Contemporary Topics of CRM and DCRM Research: A time-based OVT is used to identify the contemporary topics. The complete bibliometric data extracted has been employed as an input to this technique. The keywords that have occurred at least 5 times have been included by the algorithm. By analysing the clusters that are formed out of recurring terms, a set of topics can be identified. The year 2017, is set as the average mid-point at 0.0 of the scale (green). Contemporary topics under the area of CRM are visualized using colours based on the colour bar as shown in Fig. 9. Latest topics were illustrated using colour ranging from yellow (relatively latest) to red (latest), while older topics were illustrated using green (relatively old) to Blue (oldest) based on a normalized scale of -1 to 1. In other words, terms that were used more towards 2020 are shown in red colour whereas the terms that were used more towards 2000 are shown in blue colour.

From the data set emerged from the citation based-OVT, it was observed that some of the most occurred terms in the highly cited journals related to CRM are strategic integration, firm performance, organizational performance, competitive advantage, value creation, innovation, product development, loyalty, customer satisfaction, trust, service quality, product quality, manufacturing integration and supply chain management. It is interesting to observe the nature of the terms that emerged as most occurred terms in the CRM literature. By examining the terms, it can be understood that there are terms related to customers perception and there are terms related to operations. Therefore, it can be deduced that CRM is critical link between the operations and the desirable customer perception outcomes. Further, the terms such as firm performance, organizational performance and competitive advantage indicates the significance of CRM in organizations.

To identify the contemporary topics under DCRM, we carried out OVT in the respective data set and the result is shown in Fig. 10.

The results from the time-based OVT shows that the contemporary topics in the recent literature of DCRM are data mining, text mining, RFM model, churn prediction,

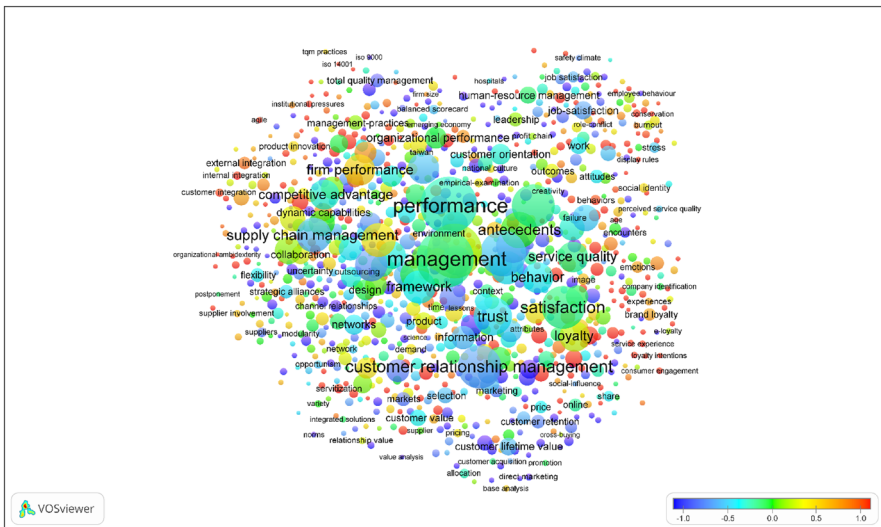


Fig. 9 Contemporary topics under the area of CRM

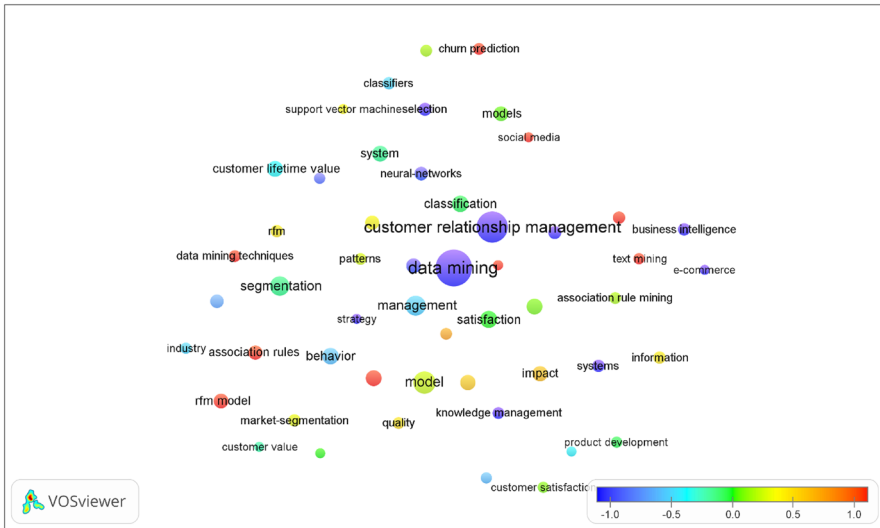


Fig. 10 Contemporary topics in DCRM

segmentation, and satisfaction. These terms throw light on the recent data analytics tools and techniques applied for the purpose of segmenting the customers such as neural networks, text mining and association rule mining. It can also be observed that the techniques are applied in the areas of churn prediction, customer satisfaction and customer value. Thus, it can be deduced that recent data analytics techniques have helped to improve the effectiveness of CRM with accurate segmentation of customers. The presence of the node ‘e-commerce’ indicates the applicability of data mining techniques in the e-commerce industry.

Important Topics under CRM and DCRM Research: In this section, we report important topics in CRM and DCRM using citation-based OVT. The ‘importance’ is defined by the number of occurrences in highly cited research papers (Chandra, 2018). Under citation-based OVT, the topics are matched with the citation score of the research papers where the topics have appeared. The data was normalized by dividing the difference between each research publication’s number of citations and average number of citations with the standard deviation of citations. Thus, a score of 0 means that the number of citations obtained by a research publication is equal to the average number of citations received by all publications that appeared in the same year. The normalized citation scores were then plotted with red colour indicating topics high average citation impact and blue colour indicating topics with low average citation impact. In Fig. 8, we plot the important topics under CRM.

From Fig. 11, the following topics have been identified as the important topics under CRM in the order of their average citation impact. (i) strategic integration (ii) PLS-SEM (iii) store loyalty (iv) sustained competitive advantage (v) supply chain collaboration (vi) information integration (vii) confirmatory factor analysis (viii) survey research (ix) marketing strategy (x) Manufacturing integration. The topics can be classified into application areas or outcomes and the tools, techniques and methodology employed in the research articles. From the recurrence of the term ‘integration’, it can be stated that CRM plays a crucial role in the integration of functions in an organization as corroborated in the theory. It can also be observed that the research articles in the realm of CRM have primarily

machines. It can be deduced that the important topics come under three categories (i) Techniques (ii) Application (iii) Industry. The presence of terms such as neural networks and classification shows the important techniques that are applied to segment the customers or to extract inputs from the customers for the new product development. The increased availability and accessibility of customer sentiments from social media platforms justifies the term ‘social media’ under high average citation impact. This also indicates the emerging trend of social CRM (Dewnarain et al. 2021).

3.2.3 Leading countries of CRM and DCRM research

In this section, we report the leading countries and their network of CRM and DCRM research area in terms of the citations received by research articles published by the universities or institutes belonging to a country. In Fig. 13, leading countries in the CRM research area has been presented. Inclusion criteria of the country is that only those countries are included from which a minimum of five documents are published. We have not set a lower limit for number of citations.

It can be observed that USA leads the list of countries. Nevertheless, the nodes representing the citations are overlapped leading to difficulty in making out the node size and representing country. Therefore, we extracted the data in tabular format and a representative sample of 10 leading countries and the other characteristics of the network diagram are shown in Table 3.

It can be deduced from Fig. 13 and Table 3 that England is in second position in the list of leading countries in terms of the number of citations. The difference in number of citations between USA and England is quite large that makes USA a clear leader in this domain. The difference in the number of citations and the number of articles is somewhat proportional. It is interesting to notice that the countries Germany, Peoples’ Republic of China and Australia are comparable in terms of number of citations though there are noticeably greater number of research articles published by universities from Peoples’

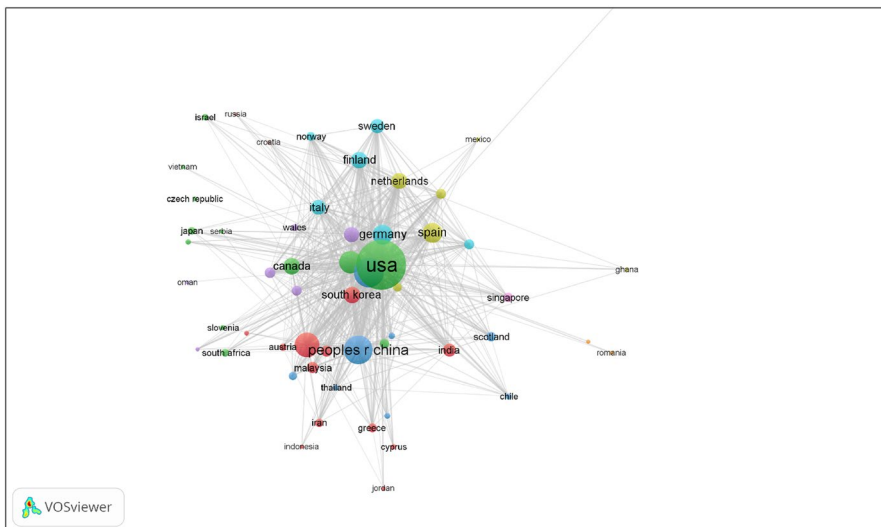


Fig. 13 Leading countries and their network in CRM

Table 3 Leading countries based on no. of citations in CRM

Rank	Country	Link	Total link strength	Documents	Citations	Normal citations	Average citation	Average normal citation
1	USA	55	9246	1342	74,855	1569.72	55.78	1.17
2	England	53	3591	477	16,352	483.98	34.28	1.02
3	Germany	54	2609	215	12,229	331.65	56.88	1.54
4	Peoples' republic of China	52	3068	439	11,976	467.74	27.28	1.07
5	Australia	52	2021	267	11,524	416.89	43.16	1.56
6	Netherlands	51	2022	137	10,850	265.39	79.19	1.94
7	Canada	47	1118	153	7979	177.69	52.15	1.16
8	Taiwan	54	1646	334	7567	226.57	22.65	0.67
9	South Korea	50	930	152	4592	128.44	30.21	0.85
10	Spain	51	1550	221	4328	166.37	19.58	0.75

Republic of China. Thus, it can be deduced that the number of published research articles is not always a predictor of citation impact. Next, we examine the leading countries based on number of citations in DCRM research field. To obtain deeper insights, we report both the network diagram as well as the Table as follows.

From Fig. 14 and Table 4, it can be observed that USA leads the list in terms of number of citations followed by Peoples' Republic of China. Nevertheless, both countries are at par with respect to the number of research articles published. It is interesting to notice that the countries South Korea and Taiwan, which were in the 8th and 9th position respectively in terms of number of citations under CRM research, are in 3rd and 4th

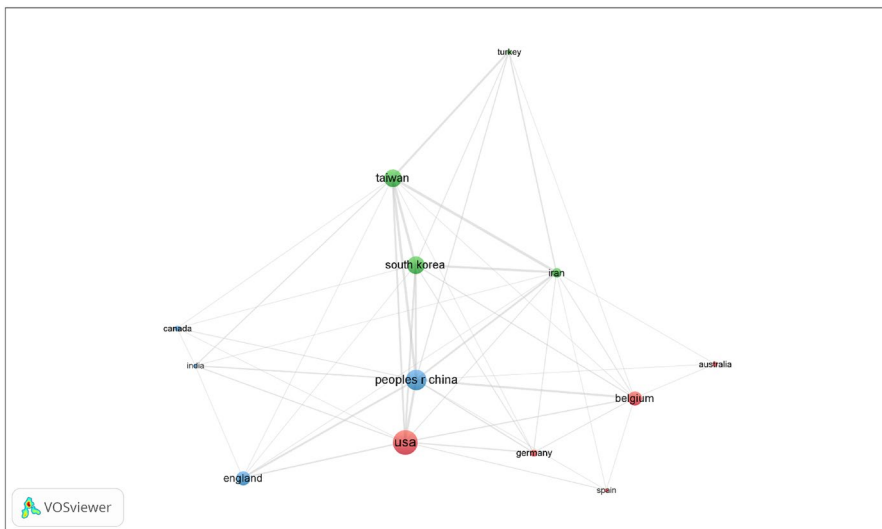


Fig. 14 Leading countries and their network in DCRM

3.2.4 Leading universities/institutions of CRM and DCRM research

In this section, we report the leading universities/institutions and their network of CRM and DCRM research area in terms of the citations received by research articles published by the universities/institutions. Co-citation of universities/institutions occurs when research articles from two universities/institutions reference research articles from a third common university/institution (Mas-Tur et al. 2021). In Fig. 15, the co-citation network of leading universities/institutes in the CRM research area has been presented (Fig. 16). Inclusion criteria of the University/Institute is that only those institutes/universities are included which have published a minimum of five documents that have received a minimum of five citations.

It can be observed that University of Maryland leads the list of universities/institutions. Nevertheless, the nodes representing the citations are overlapped making it difficult to assess the node size and representing country. Therefore, we extracted the data in tabular format and a representative sample of ten leading universities and the other characteristics of the network diagram are shown in Table 5.

It can be observed from Table 5 that there is a noticeable difference between University of Maryland and Texas University which comes in the second position making University of Maryland a clear leader in the field of CRM research. Newcastle University takes the leading position in terms of average normalized citations and Nova University Lisbon takes the leading position in terms of average citations. It is interesting to note that the leading authors in the CRM research area are not from the leading universities. This indicates that in the leading universities a team of researchers are engaged in advancing the literature of CRM. Next, we examine the leading universities/institutions based on number of citations in DCRM research field. The inclusion criteria are minimum of a publication from the university/institution without any lower limit on number of citations. To obtain deeper insights, we report both the network diagram as well as the Table as follows (Fig. 16, Table 6).

It can be observed that South Korean universities are in the leading position when it comes to DCRM with Korea Advanced Institute Science and Technology in the leading position and Korea University in the second position. This is evidence of the advancement of South Korea in the digital space and the adoption of advanced data-mining techniques for CRM. This trend is complemented by the increased number of South Korean scholars publishing in English language. This finding supports the finding obtained under leading countries under DCRM and validates the supremacy of South Korea in terms of Average Normal Citation Score.

3.2.5 Conceptual structure map of CRM and DCRM

Conceptual Structure Map has been generated with the help of the function “conceptual-Structure” in Bibliometrix package. The “conceptualStructure” function in executes multiple correspondence analysis (MCA) of the keywords (Meghana et al. 2021) first for obtaining the conceptual structure of the field and then carry out a K-means clustering (Aria and Cuccurullo, 2017) to group the keywords that express common concepts. MCA is an extension of Correspondence Analysis (CA) to tackle a multiway matrix. In this study, the multiway matrix is the co-word matrix formed by the keywords extracted from the research articles.

Table 5 Leading Universities based on no. of citations in CRM

# Rank	Label	cluster	Citations	Norm. citations	Avg. pub. Year	Avg. citations	Avg. norm. citations
1	University of Maryland	5	4130	67.13	2008.56	158.85	2.58
2	Texas University	5	3469	38.22	2004.31	266.85	2.94
3	Michigan State University	14	3464	62.37	2010.63	69.28	1.25
4	Arizona State University	14	3354	51.21	2008.67	111.8	1.71
5	Georgia State University	16	3188	95.41	2012.83	56.93	1.71
6	Hong Kong Polytech University	16	2961	83.58	2011.78	40.56	1.15
7	Twente University	15	2929	96.52	2013.72	154.16	5.08
8	Groningen University	9	2917	64.88	2011.71	81.03	1.80
9	Newcastle University	15	2912	142.68	2014.82	264.73	12.98
10	Melbourne University	13	2776	42.58	2009.18	81.65	1.25
11	Nova University Lisbon	15	2725	84.37	2012.78	302.78	9.38

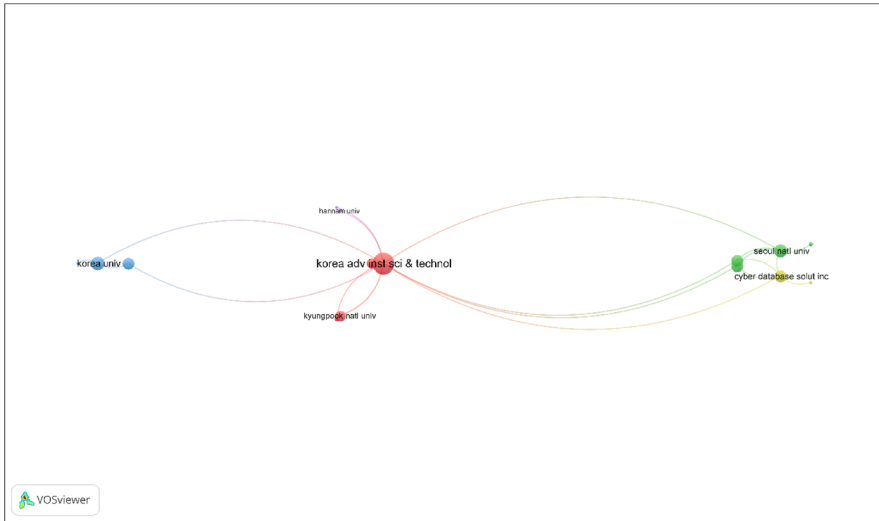


Fig. 16 Leading universities/institutions and their network in DCRM

In other words, the conceptual structure map is the output of co-word analysis (Aria and Cuccurullo, 2017) i.e., word co-occurrence network.

The general formula for a co-word network is $B_{coc} = A' \times A$.

Where B_{coc} is a non-negative symmetric matrix representing keyword co-occurrence.

And A is a *Document* \times *Keyword* matrix.

Here the MCA is applied to the matrix A (*Document* \times *Keyword*) to plot the keywords on a 2-D map. Further, K-means clustering algorithm based on hierarchical clustering method is applied to position the keywords in a 2D map (Cuccurullo et al. 2016; Xie et al. 2020). Under the hierarchical clustering, each cluster of keywords are treated as a class, which will be merged with other cluster to form a larger cluster based on the degree of similarity. This process is repeated until the optimal number of clusters are formed.

In the Bibliometrix package the following settings are used to generate the conceptual structure map.

There are three fields in the “conceptualStructure” function viz. (i) method (ii) clust and (iii) k.max. Under the field method ‘MCA’ has been selected to perform multiple correspondence analysis from the three options i.e., correspondence analysis, multiple correspondence and multidimensional analysis. Further, in the field for selecting the number of clusters, we have selected the option ‘AUTO’ leaving the package to select the optimal number of clusters rather than specifying a number. Furthermore, we have a selected the upper limit for the number of clusters by setting k.max = 5 which was the highest possible number of clusters as per the options given by the package.

We obtained three distinct clusters for CRM research area as shown in Fig. 17. In the blue-cluster, we can observe terms such as customer satisfaction, service quality, profitability, and loyalty indicating the outcomes of CRM implementation. Within a cluster, proximity among the keywords corresponds to shared substance i.e., closer keywords were treated together in a large proportion of articles. Thus, in the blue-cluster, we can see a sub-segment in which the keywords customer satisfaction, quality and profitability are very close. Therefore, it can be interpreted that the outcomes of CRM implementation are better customer satisfaction and

Table 6 Leading Universities based on no. of citations in DCRM

# Rank	Label	Cluster	Citations	Norm. citations	Avg. pub. Year	Avg. citations	Avg. norm. citations
1	Korea Advanced Institute Science & Technology	1	339	9.36	2004.14	48.43	1.34
2	Korea University	3	136	4.69	2012.33	45.33	1.56
3	Seoul National University	2	116	3.89	2010.00	58	1.95
4	Korea Institute Science & Technology	3	105	3.08	2005.00	105	3.08
5	Cyber Database Solutions Inc	4	104	4.56	2001.00	52	2.28
6	Ewha Institute Science & Technology	2	103	2.56	2003.00	103	2.56
7	Lucent Technologies	2	103	2.56	2003.00	103	2.56
8	Kyungpook National University	1	78	2.54	2006.75	19.5	0.63
9	Korea University Technology & Education	1	70	2.06	2005.00	70	2.05
10	Hanbat National University	1	15	0.44	2005.00	15	0.44



Fig. 17 Conceptual structure map of CRM research area

quality leading to improved profitability. In the red cluster, which is the largest, we can notice terms such as firm performance, innovation and information technology are forming a very logical sub-segment. Another logical sub-segment comprises of the terms such as technology, customer, performance, and impact.

The conceptual structure map of the DCRM is presented in Fig. 18. As can be observed, there are three major clusters. The blue-cluster contains terms such as feature selection, segmentation data mining techniques, and RFM (random forest model) model indicating classification techniques used in customer segmentation applications in data mining-based CRM. It is interesting to note the proximity of complementary terms retention and defection in the green-cluster. The topics such as churn prediction, classification, selection, and models form another logical sub-cluster within the green cluster. In the large and dense red-cluster, one can observe several sub-clusters. For instance, the sub-cluster comprising of keywords prediction, neural networks and optimization is logical in terms of their dependence. Similarly, another logical sub-cluster that can be observed comprises of terms such as model, big-data, association rules and patterns.

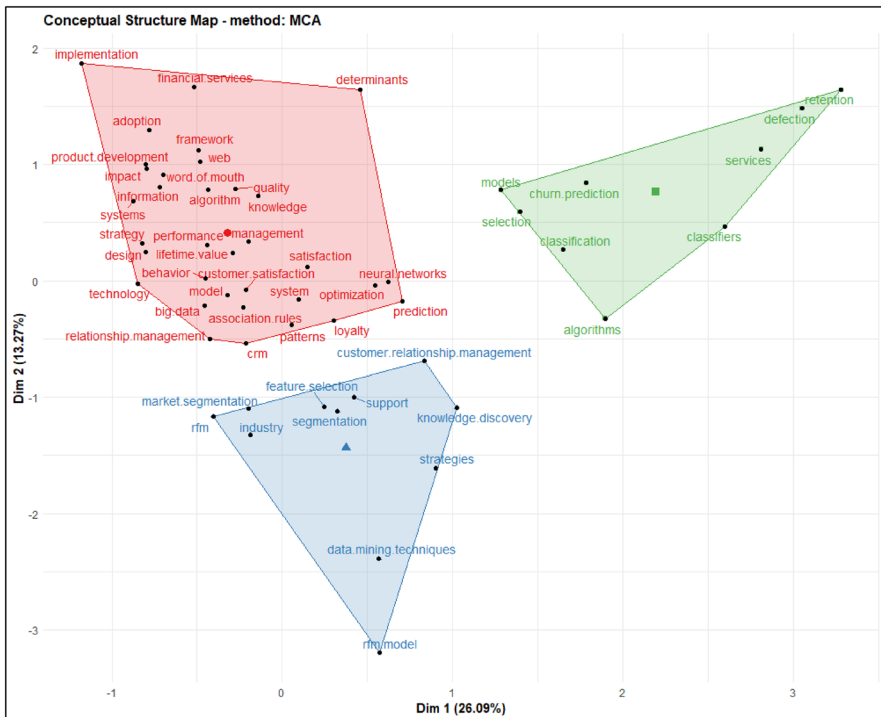


Fig. 18 Conceptual structure map of DCRM research area

4 Discussions and future research directions

The three-phase sequential methodology of bibliometric search, descriptive analysis, and scientometric analysis adopted in this study yields several insights on the evolution of CRM into DCRM. Further, the methodological contribution of the study includes the application of novel techniques such as citation-based OVT and time-based OVT in addition to the development of conceptual structure map.

Compared to the extant research in this field, there are several interesting findings that have emerged in this study. For instance, it was observed that the focus of CRM research varies significantly with time and technological advancement though the primary objective of any CRM system is to improve customer loyalty and to thereby enhance the repeat purchase. Ngai (2005) considered a period from 1992–2005 for conducting systematic literature review on CRM and reported that the CRM literature focus on information technology (IT) or information systems (IS) related aspects. This observation of Ngai (2005) can be corroborated with the rapid developments in technology and internet in the period considered in his study. The finding of the study, conducted by Sota et al. (2018) by considering a period from 2007 to 2016, is that the focus of CRM research is customer loyalty. By combining the conclusions of Ngai (2005) and Sota et al. (2018), it can be inferred that CRM research never focuses wholly on either IT/IS or customer loyalty. It has been and will always be a mix of these two aspects.

Though customer loyalty is a fundamental concept, the way it is being measured is subjected to change. The introduction and wide acceptance of metrics like Net Promoter Score is evidence for the dynamic nature of customer loyalty assessment. On the other hand, with technological advancement, the way the customer data is acquired and analysed, is undergoing phenomenal changes. The frequent introduction of effective algorithms and techniques for handling huge volume and variety of data is giving new dimensions for CRM from the IT/IS perspective. From the rate of change of technological advances, it can be deduced that the evolution of CRM as an information system is much faster than the evolution of CRM with respect to the changes in customer loyalty metrics. This is the rationale behind exploring the domain of DCRM in this study and appearance of terms such as text mining, association rule mining, neural networks, big data, classification, and prediction shows the directions for future research in terms of their applications to different industries.

Text mining is the process of transforming unstructured text into a structured format to identify meaningful patterns to derive new insights. Text mining tools like sentiment analysis can be applied to the huge chunk of text data that are generated in social media and e-commerce platforms for understanding the customer emotions and devise appropriate CRM strategies. Customer centre call records and customer grievance emails are valuable sources of text content that can be mined for actionable insights. Neural networks process training data by mimicking the interconnectivity of the human brain through layers of nodes. The capabilities of convolutional neural network (CNN) for image recognition and natural language processing have several applications in understanding the customer preferences deeply. AI based computer vision has already been integrated into CRM systems for improved customer service and has immense potential for future applications in service sector. Another term appeared in the conceptual structure map i.e., association rule mining (ARM) a rule-based method is used for finding relationships between variables in a dataset. ARM can be applied to large scale databases of sales transactions, either generated from a point of sale or from an e-commerce platform, to carry out techniques like market basket analysis for effective product recommendations.

Broadly, the terms appeared in the citation analysis and conceptual structure map can be related to machine learning (ML) and AI tools and techniques. This observation is supported by the recently published articles in AI integrated CRM systems (Chatterjee et al. 2020, 2021) and ML for CRM (Singh et al. 2020; Chen et al. 2021). It is reported by Singh et al. (2020) that the utilization of supervised learning techniques for CRM is 48.48% whereas the utilization of unsupervised techniques for CRM is only 15.15% and there is a shift from ML to deep learning. This finding shows shift from ML to AI and justifies the appearance of AI integrated CRM in the recent literature. These observations are complemented by the emergence of “Expert Systems with Applications” as the leading journal in terms of citations. The focus of the journal on expert and intelligent systems technology is in alignment with recent advancement in the ML and AI area in terms of their applications.

Further, the contemporary topics identified from time-based overlay visualization map of CRM are service experience, customer engagement, hospitality, brand experience and customer journey. This shows the significance of CRM in the service sector and the shift towards customer experience. This finding is a strong recommendation for the managers in the service industry to take appropriate measures to enhance the customer experience. This is evidence for market transformation into areas such as customer experience management and sustainability especially in the service sector. The contemporary topics in the DCRM area such as churn prediction, association rules, text mining, business intelligence, RFM model and social media throws light on the techniques that are currently applied to process customer data to support managerial decision making.

The study contributes to the literature by presenting the scholarly landscape of CRM and DCRM and thereby provides a deeper understanding on the development and state of the art of CRM and DCRM. Some of the interesting findings derived using descriptive and scientometric analysis techniques can help the research scholars to identify and pursue most relevant and promising topics under CRM and DCRM. It can be stated that the outcomes of this scientometric study have significant implications for evaluation and understanding of scientific output CRM and DCRM.

The study has major implications for the practising managers. For instance, it can be deduced from the results of scientometric analysis that application of data mining techniques to deploy CRM has positive impact on the firm performance. This finding reinforces the significance of both CRM and data mining-based CRM and the summary of the specific techniques reported under contemporary topics, important topics, and conceptual structure map such as RFM model, association rule mining, text mining and neural networks reinforces the managers on the requirement for understanding and adopting the novel techniques for improving the retention and loyalty of their customers. Further, the application areas identified in this study such as prediction, churn management, segmentation, and classification throw light on the areas where managers have to work for optimizing the customer lifetime value.

CRM has evolved its way from its origin as a simple mechanism to manage contacts of customers to a level where it enables prediction of what the customers are going to buy to trigger predictive shipping in which products are shipped to customer location before they place the order. The integration of predictive analytics into CRM is a promising application area for practicing managers and research area for scholars in this domain. The penetration of cloud-based CRM systems makes them vulnerable to cyber-attacks. This signals the need for research studies addressing the cyber security of cloud-based CRM systems and issues such as data theft and ransomware attacks. Further, the emerging concepts like control tower in supply chain, which improves the supply chain visibility based on real time data, treats customer as an integral part of the digital supply chain network. Such radical changes and resulting generation of huge volumes of customer information mandate the application of advanced analytics to enable managerial decision making on a real-time basis.

The future CRM solutions will be based on single source of truth (SSOT) that is the practice of aggregating the customer data from multiple locations to a single a single location to enable a system level understanding of customer sentiments. For processing such massive volume of data, ML and AI technologies are needed and to store and retrieve customer data, cloud solutions are necessary. For enhancing the speed of decision making, the synthesized data should be accessible through mobile devices. To summarize it can be stated that the future of CRM will be focusing on customer experience, and it will be facilitated by cloud-based, AI-optimized platforms that can be accessed via mobile devices.

5 Conclusions and limitations

This study explores and compares the landscape of scholarly works that have emerged in the area of CRM and DCRM. The descriptive analysis gave an overview on the growth of the number of research articles, the leading journals, leading universities or institutions and the leading authors in the domain of CRM and DCRM. The scientometric analysis identified the leading journals, leading countries, contemporary topics, important topics,

and leading universities or institutions based on the citation analysis. Finally, the distinct clusters in the field of CRM and DCRM are presented under the conceptual structure map. This study provides several recommendations for the researchers in the field of CRM and insights for practicing managers.

One limitation of the study is that it has only considered research articles as the input document for the scientometric analysis. Other documents such as conference proceedings, conference papers, reports, books, and surveys have been ignored that might have addressed the CRM and DCRM. Another limitation is the choice of only one database i.e., Web of Science for the study for the purpose of obtaining uniform references. Since the data has been extracted from only one database, there is a possibility that some of the research articles indexed in another database such as Scopus, Google Scholar and PubMed are excluded. This work can be extended further by carrying out scientometric analysis techniques such as document co-citation network analysis, co-authorship network analysis and keyword co-occurrence network analysis for obtaining deeper insights in the field of CRM and DCRM.

Funding This research received no specific grant from any funding agency.

Declarations

Conflicts of interest The authors declare that they have no conflict of interest.

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