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## Data mining techniques and its effect in customer relationship management

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**Abstract:** Data mining technology helps in extracting hidden knowledge from the data. It has been researched extensively over a considerable time period. In this paper, the authors look at developments in the area of data mining for the years 2007 to 2012, focussing mainly on customer relationship management, association rule mining, data mining algorithms and application areas relating to data mining. Data mining offers a wide range of tools and techniques which are used across all sectors of business and industry. This paper refers to a number of sources, including online data, international journal articles, conference proceedings, white papers, books and abstracts. Of the 861 research papers reviewed, around 83 are referenced in this paper. The articles listed here are having relevance with a research domain timeline with their purpose. This review is intended to provide a base framework for academics, customer-centric corporate entities and researchers who use data mining techniques and tools.

**Keywords:** data mining; customer relationship management; CRM; association rule mining; industry domains; algorithms.

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## 1 Introduction

Strong competition in the marketplace is forcing organisations to innovate and identify new ways to attract customers in order to increase their market share while simultaneously reducing costs. To address this, Hua (2011) and Yu and Jiahui (2010) presented the data mining (DM) technique as the key to providing customer relationship management (CRM) solutions. Today's market leaders see customers as their primary source of business and retaining existing customers as well as attracting more customers is a critical issue for businesses. According to Guifang and Youshi (2011) customer data and DM are being integrated with IT technology to build a successful strategy. Hamed et al. (2010) defined CRM as a process for acquiring and managing customer knowledge and building loyalty. It creates value for the customer and thus maintains and optimises costs. Researchers believe that in order to maintain long term superiority and keep the market stable, organisations need to retain valuable customers and meet customer demand for a personalised, in-depth corporate customer experience. The customer's value to the company should be of major significance. Verhoef et al. (2010) maintain that with better interaction services, CRM processes can be built more easily and customers retained. According to Ranjan (2009), effective CRM in an organisation is about acquiring, analysing and sharing knowledge about and with customers in order to provide them with quick and timely services. Strategic CRM describes a strategy whereby values such as profitability, revenue generation and customer satisfaction are integrated and optimised by applying customer-centric business models. Researchers are exploring mobile customer relationship management (mCRM) and DM technology with a view to developing a framework for mCRM and its processes.

Liao et al. (2012) believe that DM is a tool which has been of great benefit to industries for a number of years. DM is at the heart of knowledge discovery in databases. The process basically involves scanning and analysing data in order to find recurring patterns or relationships between data elements. Any new or interesting information revealed by the process can be utilised by organisations either to cut costs or raise revenue or both. In recent years, DM technology has attracted a great deal of attention in the business world, both in the private sector and in government organisations, due to the huge amount of data that has been converted into useful information. DM helps firms to analyse customer data and to extract useful information in order to gain a competitive advantage in the marketplace. The operational systems that have been in existence for a long time period, such as government sectors, legacy data can be very useful in the decision-making process, as it may be instrumental in forecasting the strategies of an organisation. In a multi-departmental organisation or in large business environments, making independent decisions often presents a major challenge. Media intrusion and easy access to the media have changed customers from a passive to an active force. In today's competitive world, retaining customers is the ultimate challenge and continued customer loyalty is no longer guaranteed. Better and more effective strategies are needed to meet customer demands in terms of on-time delivery and customer satisfaction.

DM has been used in various papers as described below. Chen et al. (2011) consider association rule mining which involves finding relationships between data elements to be the most researched DM operations. A classic example is searching the buying patterns of customers in a supermarket, more specifically which products they are likely to buy together, like milk and bread. Researchers attempt to categorise similar data into groups which is termed clustering and is a useful method for finding the basic structures in information. Many of these researchers have explored the benefits of using such tools in the CRM applications in various industries and the resulting research papers outline the actual implementation of the algorithms responsible for mining the data. The oldest algorithm in the DM field is the Apriori algorithm and it forms the basis for many other DM algorithms. In this paper, the work of researchers, academics and scientists is explored and categorised so that the authors of the current paper can improve existing algorithms or even attempt to devise their own novel algorithms.

Hamed et al. (2010) and Motorola (2012) researched CRM-specific applications and observed customers in relation to purchasing behaviour, spending patterns and profitability from customer spending. In this research, customers are classified into groups with similar traits so that their needs can be identified and methods devised to calculate the lifetime value of those customers. The authors also analyse markets to identify potential customers and their requirements and to attract those customers using suitable marketing schemes. Pan et al. (2007) found in their study that customer profitability can be increased when organisations understand the reasons for the loss of customers. Those authors analyse past and current customers in order to ascertain why customers leave organisations and suggested the implementation of new measures to prevent them from doing so.

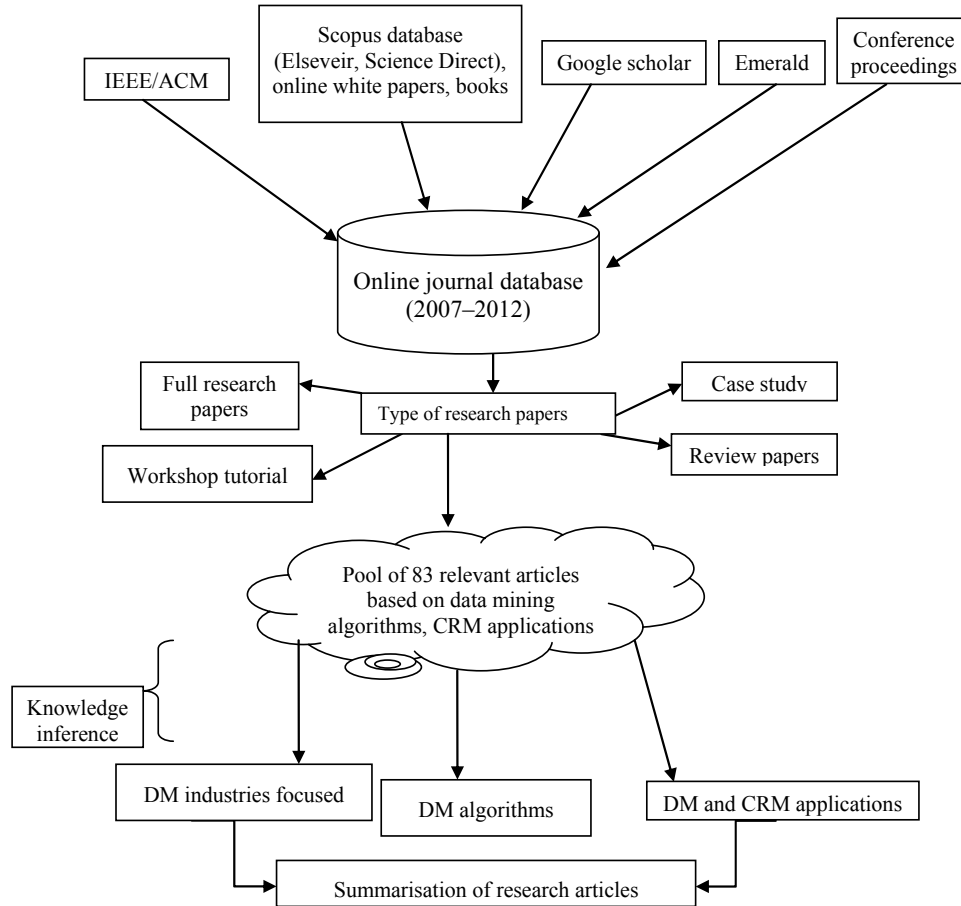
In their 2009 review paper covering the years 2000 to 2006, Ngai et al. (2009) concluded that significant research has already been done in the area of customer retention and one-to-one marketing programs intended to enhance customer loyalty. Their paper recommends that more work be done in the field of customer segmentation using neural networks, decision trees and other DM techniques. Also, researchers should focus more on the application of DM techniques in various industrial domains. Silwattananusarn and Tuamsuk (2012) reviewed research articles from 2007 to 2012 and presented an integrated framework of DM and knowledge management which outlines the most significant challenges in terms of knowledge management practice and describes the role of DM in addressing those challenges. The authors of the current research paper have taken this work one step further by reviewing DM techniques in CRM from the year 2007 to 2012.

The current paper begins with a discussion of research methodology used in the paper followed by the approach to the work. Section 2 shows research methodology and Section 3 begins with a review of research articles. Table 1 shows a review of industry-focussed articles while Table 2 lists DM algorithms and techniques. Table 3 provides a demonstration of CRM applications, quoting related papers and Section 4 demonstrates the highlights and classification of the research articles. Finally, the paper concludes with a summary of the points made and outlines the future scope of the work.

## **2 Research methodology**

A significant number of articles were selected focus on various aspects related to DM algorithms, its applications and customer relations. The data are collected on the basis of the type of data required for research and the purpose of the study. Authors' work can be categorised by conceptual type where the author generally suggests or evaluates how DM can be used in certain scenarios. Data collection and analysis is viewed as a continuing and iterative process. The approach adopted in the research paper/article review can be broken down as follows:

The considerable body of online research based on DM techniques and CRM applications was searched in the Scopus databases, conference data (national and international), IEEE/ACM transactions, Google Scholar, Emerald, online white papers and books. The articles are further categorised into types such as full research articles, case study, workshop tutorial and review paper. Of 861 research papers in total, only 83 relevant papers were selected and then summarised into three categories as shown in Figure 1: DM industry-focussed, DM algorithms and DM and CRM applications.

**Figure 1** Approach of work flow

### 3 Review study of research articles

#### 3.1 Industry-focussed research articles

In Table 1, the authors have attempted to classify papers in terms of the application of DM in various industrial domains.

While the authors carried out an in-depth analysis of DM technology, Table 1 lists only 35 relevant papers, all of which heavily emphasises the application of DM techniques in various industries. The remaining papers are algorithmic in nature and purely focus on CRM applications without specifically mentioning CRM; however, they too would come under the general category of DM and CRM. This category includes papers that discuss the benefits and difficulties of incorporating DM into CRM. The authors found that several papers suggest models that can be used in popular business domains and also contain advice on how this information can be extracted and utilised. The papers using tools for the analyses of data and proposes specific systems to business analysts are categorised under CRM tools.

**Table 1** Articles on the application of DM techniques in industries

<i>Industries focused</i>	<i>Papers (ref.)</i>
DM and CRM in general	Jain et al. (2008), Zhao (2011), Pabreja and Datta (2012), Kumar et al. (2012), Zhang (2010), Ngai et al. (2009), Liao et al. (2012), Burt et al. (2011) and Verhoef et al. (2010)
• CRM from social media	Wu et al. (2009), Bonchi et al. (2011), Brzozowski et al. (2009), Nitzan and Libai (2011) and Singh et al. (2011b)
• CRM framework and tools	Ranjan (2010, 2009) and Ranjan and Bhatnagar (2008, 2009)
Knowledge management	Silwattananusarn and Tuamsuk (2012), Ur-Rahman and Harding (2012) and Wu et al. (2010)
Telecom	Wu et al. (2009), Ćamilović et al. (2009), Guifang and Youshi (2011) and Ranjan and Bhatnagar (2009)
Healthcare	Chiang (2007) and Ranjan (2009)
Automobile, travel	Tang et al. (2011) and Xie and Tang (2009)
Shipping, retail	Bala (2008), Kleinberger et al. (2007) and Verhoef et al. (2010)
Education, web mining	Nagi and Elhajj (2012) and Ranjan and Malik (2007)
Enterprise mobility	Lenova (2012) and Motorola (2012)

CRM structure design is divided into three layers. The interface layer (interact with the users, access or transmit information, basically user friendly interface), the functional layer (basic function of CRM) and the layer of support (this layer includes database management system and operating system). Functional module design of a CRM system is described as customer relationship (CR) clustering analysis, CR value judgment, CR structure analysis, CR behaviour analysis, CR floating analysis and CR data analysis. Ranjan et al. (2008) described the framework of DM tools to help CRM in steps for the identification and analyses of the business problem.

The other categories represent industries suggesting models or actual algorithms to use DM to maximise business processes. It is interesting to note that there are papers falling under the domains as automobile, travel, shipping, retail and telecom industries all are being popular and important. Other areas are also being explored such as education, medicine and even entertainment travel and enterprise mobility.

Jain et al. (2008) identified challenges faced by developers of DM models. The challenges include countering model aging, communication gaps with users, differing interpretations and insufficient business process integration. Wu et al. (2009) proposed a framework group CRM (GCRM) applied CRM on social groups rather than individuals in the telecom industry. GCRM framework's architecture and analysis methods are shown in detail. The models are capable of effectively detecting groups and track/model their changes. Ćamilović et al. (2009) designed a data mart for telecommunications industry using call detail records and customer demographics. The paper observed valuable results about pricing and marketing. Guifang and Youshi (2011) suggested impression of DM techniques for CRM in the mobile industry. It assesses CRM and DM benefits and gives step-wise process to apply mining in this industry. Ranjan and Bhatnagar (2009) paper highlighted architectural model for mobile CRM and critical issues of customer care, information centre, data storage and data access systems, mobile service and technology. The close relationship with the customers and managers via mobiles brings competitive advantage to the organisation. Researchers not limited their

practice to call record data, but extended to mining of data of mobile applications. Lenova, mobile apps for higher education characteristics are presented. The mobile apps for higher education is termed as ‘anywhere and anytime’ technology. Motorola (2012) white paper benefits of mobile apps for university, their benefits, problems faced by the universities in implementing the solution. The mobile application is developed for the university, discussed challenges and opportunities faced by the university.

Bonchi et al. (2011) imparted insight into DM tools which mine social networks from a business perspective. It highlighted area of research with their problem, DM approaches and future growth. The study showed the importance and usefulness of analysing blogs for CRM. The research explores and explains several approaches currently implemented to scan blogs and their pros and cons. Huang et al. (2011) hit about the advanced concepts of knowledge discovery. It gives insight about social networks, time and sequence series, outlier detection and analysis of imbalanced data. Nitzan and Libai (2011) focused on mining chat conversations with customers to improve their experience. Mining chats and social media portals for issues and preferences allowed better routing of customers to their needs. Singh et al. (2011b) proposed an analytical social DM framework, the importance of customer opinions, views on social websites their effects in further decision making using DM techniques. Using the example of an educational system, conceptual study is done, how students’ posts on social website media can be made useful in various processes of the educational system.

Bala (2008) proposed a methodology for evaluating generalised quantitative techniques. The paper had applied the application of DM techniques in retail sector using pattern mining. Xie and Tang (2009) made use of DM techniques for CRM in travel agencies. It explores DM applications in this industry and provides the framework to include it.

Feng et al. (2008) exercised into the benefits of the CRM and DM combination. It is largely beneficial, since understanding the customer ensures their proper needs are met. Ngai et al. (2009) reviewed DM techniques and its application in CRM, principles, customer acquisition, customer retention and application of DM techniques. Dempster et al. (2008) statistical research paper discussed statistical techniques and calculus in research results. Zvireliene et al. (2009) designed and explained a detailed CRM system based on DM. Various DM techniques can supplement numerous CRM functions. Pan et al. (2007) created a pre-processing framework which helps in predicting customer’s switching to competitors. A framework has been applied in software system and benchmarked. It accurately predicted customer’s likelihood of leaving and thus gives the company a change to act on them. Ranjan and Malik (2007) proposed an educational model based on DM techniques. The model viewed the effect of the processes related to admission, course delivery and recruitments. The paper educational processed and DM effect on the educational model. Adela et al. (2011) paper explored the application of optimisation techniques (OT) on DM and certain predictive model’s efficacy. Models are useful in helping managers take better decisions in time. The customers are appropriately used to improve business. OT with DM should be researched further.

### *3.1.1 Key drivers for DM in CRM*

The steps of application of DM in CRM as follows:

- 1 define business problem.
- 2 build a marketing database
- 3 explore data
- 4 prepare data for modelling
- 5 build model.

*Steps of DM to develop effective and efficient CRM business model*

- *Step 1: Understand business and customer centric problem.*

There is more than one objective in each CRM application in every organisation so to select the appropriate model for the selective business problem is a challenge. An effective CRM includes methods of measuring results.

- *Step 2: Data preparation of the market database.*

The data preparations are vital for the success of CRM as the data are taken from various data resources. It includes collection or integration of data from various sources like, customer, product, master and transactional databases from interdisciplinary different segments of an organisation. It consolidates the data in a single unit. Improper handling, definitions and usage of data from different databases would result in a poor quality of CRM model. Data pre-processing is an iterative process, time and effort consuming technique. For building up the effective CRM model descriptive statistical measure of various attributes should be resolved. Inconsistencies between data values should be removed.

The graphs and box plots play an important role in data exploration. Data visualisation provides a deeper insight to the problem. Proper selection of random sample results in no loss of information and helps in building an effective CRM model.

- *Step 3: Applying DM algorithms to build the CRM model.*

Customer service oriented industry, DM techniques such as classification, clustering and association rule mining can be applied to build better suited CRM model. Classification predicts an accurate detail of each group and develops an analytical model or mines classifying rules. Cluster analysis is the grouping of similar type of data. Various clustering algorithms are available in DM, which are density-based, hierarchical-based etc. Association rule mining is a technique to analyse the customers' behaviour, buying patterns in order to find out the hidden relationship among the customers and the organisation.

- *Step 4: Experiment and result analysis.*

Experiments and results can be found by relatively taking data to generate the best model, by taking sample data measuring independent set to test and evaluate the model for effective and better description of its accuracy and efficiency.



- *Step 5: Deployment of model*

This phase is observed by various industry sectors, primarily by focusing on analysing and applying the extracted knowledge in decision making process in order to achieve the mutual benefits enhancing the profitability of customers as well of organisations.

**Figure 2** Steps of DM to develop effective and efficient business model

Understand business domain and customer centric problem
Data preparation for the market database
Applying data mining algorithm-to build the CRM model
Experimentation and result analysis
Deployment of model

### 3.2 DM algorithms

Researched papers explored are categorised into articles using an algorithmic approach. The algorithms too can be generic types or tailored depends on specific scenarios. DM techniques can be classified as clustering, classification, prediction and association rule mining.

**Table 2** Papers based on algorithms and methodology

<i>DM algorithms</i>	<i>Paper (ref.)</i>
Apriori	Verma and Nanda (2012), Ali et al. (2010), Chiang (2007) and Motorola (2012)
Machine learning	Vijayaraghavan and Kannan (2011)
Decision trees	Yang et al. (2007) and Ouyang et al. (2008)
K-means, optics	Motorola (2012) and Kumar et al. (2012)
Rough set	Chen et al. (2011), Gogoi et al. (2012) and Tseng and Huang (2007)
Naïve Bayesian classifier	Boullé (2007), Hua (2011) and Tamosiuniene and Jasilioniene (2007)
Hash-based	Chen and Zhu (2010), Amornchewin (2011), Tseng and Huang (2007) and Ouyang et al. (2008)
Graph-based	Nagi and Elhajj (2012) and Burt et al. (2011)
Neural networks	Rahman et al. (2012)
Fuzzy theory	Liu et al. (2012) and Ouyang et al. (2008)

Table 2 gives the perception about the algorithms and methodology used in DM applications. The Apriori category consists of papers improving the association rule mining algorithm or other implementations with Apriori as their base scenarios. However the candidate sets can be of large size, thus resulting in long processing times and memory requirements. Many researcher practitioners proposed algorithms where the generation of frequent item sets subset and superset filtering techniques are used. The

algorithm is tested for multiple minimum supports along with the prediction of other items which can be associated. A comparative experiment, computations is done and produces more output with decreased time and resources. Enhancement and the improvement of existing association rule mining algorithm Apriori is experimented using various approaches like rough set theory, hash, tree and graph-based theory. The hash-based (Chen and Zhu, 2010) approach algorithm attempted to improve the procedure of generating item sets so that it is generated in less number of iterations. Chiang (2007) viewed a novel data schema and algorithm. It avoids database re-scans due to changes and association rules should work at any level. The algorithm is used to discover healthcare service patterns and statistically proved better than other known approaches.

Chen et al. (2011) defined rough set theory to improve the Apriori algorithm to create R\_Apriori algorithm. R\_Apriori has been proven to generate associations with more effectiveness than Apriori. Tseng and Huang (2007) used rough-set theory to improve DM. During the mining process itself, the data pre-treatment is also done. This is proved as a practical and effective method. The algorithm is more tolerant to noise and incomplete data.

Chen and Zhu (2010) attempted to further enhance the hash algorithm by introducing a sampling method. Hash-based approach successfully reduced the algorithm's work (by shifting frequently accessed buckets to faster accessible locations) and hence the time taken. Amornchewin (2011) proposed an efficient algorithm for frequent item set. A new algorithm that uses hashing techniques to store DM results, but requires no hash function and results in fewer collisions.

Neural network processing, it does not follow any statistical distribution unlikely in regression. It is modelled after the function of the human brain. The process is one of pattern recognition and error minimisation. This can be viewed as taking in information and learning from learned data. Neural networks are made up of nodes that are arranged in layers. This construction varies depending on the type and complexity of the neural network.

### *3.2.1 Association rule mining*

Singh et al. (2011a) proposed an algorithm for pattern mining, which is based on graph theory, an improved approach upon the existing approach. This algorithm generates all rules with no rule missing. A new methodology to generate all the rules using association rule mining technique, using adjacency lattice with less complexity. Venkatesan et al. (2007) used Bayesian classifier in CRM for predicting results and generating patterns. Rahman et al. (2012) projected an approach with decision trees and neural networks as a basis for study for the proposed algorithm. It used decision trees to provide better input to neural networks, thus improving the algorithm, however there are some limitations. Miao and Shen (2010) produced an association rule mining algorithm which considers the time aspect of the data. The algorithm proves to be efficient in terms of time and space. Also, it is capable of selecting appropriate data and producing better rules due to time consideration.

Association rule mining used in a huge data warehouse to discover linkage between various item sets which are used in several crucial decision making process in many fields ranging from remote sensing to university. It is a process of nontrivial extraction of implicit, previously unknown and potentially useful information. The problem of

discovering association rules can be followed by first finding large item sets and generating rules from these frequent item sets.

Boullé (2007) association rules can be represented by  $X \rightarrow Y$  where  $X, Y$  data item sets of a database  $D$ . It reflects a transaction  $T$  in the database  $D$  contain  $X$ , there is possibility of  $Y$  also in the same transaction. Chen and Zhu (2010) stated that the two basic parameters of association rules are support and confidence. Support is the percentage of the population which satisfies the rule. If the percentage of the population in which the antecedent is so satisfied and then the confidence is that percentage in which the consequent is also satisfied.

### 3.2.2 *Apriori algorithm*

Verma and Nanda (2012) proposed an algorithm where DM is applied upon a transposed form of the database. This reduces the CPU and I/O overhead, greatly increased the speed of the proposed algorithm. This algorithm successfully resulted in the faster generation of association rules than the traditional Apriori algorithm. It also used fewer resources during its computation. Tang et al. (2011) analysed and compared four algorithms by applying. With 500 core data sets in two related scenarios, the Apriori algorithm and J48 classifier performed best. It also proved the use of DM in CRM, since it helped invalidations of decisions projected. Aggarwal and Yu (2008) explored DM models and algorithms. The paper explains predictive regression and various other modelling techniques. It also discusses a range of DM algorithms.

Apriori algorithm is a popular candidate generation algorithm.

It is divided into two steps:

- Step 1 Generation of candidate item set.
- Step 2 Validating the generated candidate item set, by computing their support and confidence.

It is assumed that item within the item set are kept in lexicographic order. It is based on anti-monotone property. For all  $x, y$  ( $x$  belongs to  $y$ )  $\Rightarrow s(x) \geq s(y)$ , the support of an item set never exceeds the support of its subset. The Apriori is based on breadth first search (BFS). In the first pass, transactions with one item are counted, now one frequent item set is used to generate candidate set, once the candidates are generated there support is found, this iteration process terminate when no new large item sets are found.

### 3.2.3 *FP-growth algorithm*

It is one of the fastest and most popular algorithm for frequent item set generation. It is an algorithm in which transaction of a database is represented by the prefix which requires less memory for storage of database. Ali et al. (2010) explored a more optimal and compact representation of the database to speed up subsequent iterations of the FP-growth algorithm. The transactional pattern-base format was tested with FP-growth algorithm and showed an increase in performance and reduction in costs. This research introduced a new association mining algorithm named FP growth algorithm. The technique was implemented and produced better results than other famous algorithms, including Apriori.

Each path reflects a set of item set of transactions that share the same prefix. Each node represents one item; all items referring to the same node are linked together in a list.

The list can be accessed by the head element which states the total number of occurrences of a particular item in the database. This list is sorted by order of occurrence of these elements. This list is further converted into FP tree. The number of times a database scan is twice. During the first scan of a transactional database, number of occurrences of item sets are detected and infrequent item sets are discarded, these frequent items are arranged in descending order of their support. During the second scan, transactions are read and inserted into the FP Tree structure.

Steps for the algorithm:

Step 1 Building of FP-tree.

Step 2 Mining the tree to find the frequent item sets.

Complexity:

Complexity  $\sim O(N) \Rightarrow$  depend upon scanning of the database and then mining it.

*The complexity of the algorithm can be reduced by:* Either by partitioning the database or by paralleling the database.

#### 3.2.4 *K-means*

This is the partitioning technique which takes  $N$  objects into  $p$  clusters, in order to have high intra cluster similarity and low inter cluster similarity. It is the incremented process in which every time the centroid of the cluster is identified depending upon the minimum distance which is calculated by using Euclidean distance formula. All the data items are grouped into a final required number of clusters.

Complexity:

The complexity of the algorithm is  $O(k)$ ,  $k$  = number of iterations.

#### 3.2.5 *Decision tree induction*

This algorithm is used by DM also termed as classification or regression trees. It has leaves as class labels and branches represent a criterion leading to leave. The objective of this algorithm is to predict the target variable based on several input labels. This algorithm helps to propose a model for class attribute as a function of the values of other attributes. It has two phases one to apply the model to the unprocessed data and secondly to deploy the model in the system. There are many decision tree algorithms ID3, C4.5, CART and CHAID.

This can be easily examined that a lot of papers still use neural network concepts in their algorithms. K-means are also still popular for clustering technique. Researchers also used rough set and naïve Bayesian classifier. Many researchers have found their own novel ways of mining through the data. The authors come across papers that use decision trees which focus on DM treatment, i.e., extract actionable knowledge or even direct actions from the DM results. This shows that DM is becoming more mature now. A new research direction finds the combinations of optimising techniques with DM. Many optimised DM techniques have been found and listed.

### 3.3 DM-based CRM models

The articles studied provides insight about various models which can be developed based on DM and CRM model like risk model where it calculates the potential of loss, especially targeting financial industries, providing loans, credits and response model which helps in campaign management and helps in increasing the response of customers in availing service and products. The conversion/activation model calculates the conversion rate from passive customers to prospect active customers. The customers switching companies, products and services can be computed using attrition rate. The customer lifetime value (CLV) predicts the potential stay of customers with the organisation over the period of time. Researchers designed various models for measuring CLV based on the industry type. Ideally, business decisions are refined over time based on the customers' feedback from earlier analysis and decisions. Therefore, the most successful analytical CRM projects take advantage of a data warehouse to provide suitable data.

In Table 3, authors show the papers which focus on a particular CRM domain. One of the immediate observations is the study focusing on segmentation of customers'. Identification of the potential customers' type or value is the first and foremost step. The amount of research in this area is most likely a result of DM being adopted into many industries. Trend and market analysis is also useful to evaluate the business's current position among competitors. The focus has shifted to customer loss analysis. Nitzan and Libai (2011) accepted the fact that customer retention is far cheaper than customer attraction.

**Table 3** Papers on DM-based CRM models

<i>CRM applications</i>	<i>Papers (ref.)</i>
Trend analysis	Zhao (2011), Chiang (2007), Zhang (2010) and Richards and Jones (2008)
Customer segmentation	Al-Mudimigh et al. (2009), Chan (2008), Guifang and Youshi (2011), Yu and Jiahui (2010), Ranjan and Agarwal (2009), Ling et al. (2010)
Marketing analysis	Jain et al. (2008), Kim and Mukhopadhyay (2011), Kleinberger et al. (2007), Richards and Jones (2008), Burt et al. (2011)
Customer feature selection	Garrido-Moreno and Padilla-Meléndez (2011), Becker et al. (2009), Liao et al. (2008), Sheng and Teo (2012), Neslin and Shankar (2009), Hung et al. (2010), Tseng and Huang (2007) and Lim and Teo (2009)
Customer lifetime value	Yu and Jiahui (2010), Kumar and Shah (2009), Kumar et al. (2008a, 2008b), Kumar (2008) and Ling et al. (2010)

Ngai et al. (2009) defined DM as a pattern analysis on large sets of data, uses tools like clustering, segmentation and classification for helping better manipulation of the data. The techniques of DM like prediction, clustering, association, genetic algorithms and neural networks can be applied in CRM to gain knowledge. The process of DM helps firm to analyse customer data and extract the useful information. Ranjan and Bhatnagar (2010) stated DM categorises two different kinds of information as descriptive and predictive. In a descriptive data analysis information is extracted from unknown customer data. In predictive analysis, it uses the descriptive information to predict future trends. Ranjan (2009) perceived clustering as an extensive study in statistics, machine learning,

pattern recognition and image processing. The paper recommended that efficient detection of clusters is very important to increase the usability.

Huang et al. (2011) emphasised on transforming CRM from operational to analytical CRM to reap organisational benefits. The expanded CRM cycle is explained by the exploitation of data and background knowledge of customers, their beliefs and prior models lead to patterns contributing to customer's understandings. CRM consists of four dimensions.

- 1 customer identification
- 2 customer attraction
- 3 customer retention
- 4 customer development.

Hamed et al. (2010) investigated about the key of DM challenges and opportunities in CRM where he discussed various issues regarding DM and CRM. Hua (2011) imparted knowledge about the effectiveness of a CRM model developed by various DM tools.

Ranjan (2010) presented a novel idea where these results are taken as inputs and generate actions to convert undesirable types of customers to desirable ones. The algorithm used a greedy heuristic approach which uses a collection of decision trees to generate a list of actions. Ranjan (2009) work focused on to applying DM techniques in the pharma sector and with DM technique it analysed the pros and cons. DM techniques can do wonders in drugs and pharma industry. The paper explored extensively DM techniques in statistical and clinical analysis of drugs.

The authors viewed various techniques of DM in CRM to build a profitable business model. Researchers applied best DM tools according to the needs and requirements of the customers and the organisation. The current study details about the realisation of customer information and tells how DM techniques are applied in developing user friendly and low cost CRM implementation in various sectors.

Lin and Xu (2008) hit upon a global customer retention pattern using fuzzy set theory,  $\alpha$ -cuts and DM techniques. Experiments showed decently accurate prediction in the percentage customer's leaving. This methodology was verified, feasible and guides further research in this field.

Zvireliene et al. (2009) learnt CRM's impact on business and systems available to monitor CRM. The supplier service system is indeed important to help and to improve CRM. CRM should be involved in every stage of the business.

Kumar and Shah (2009), Kumar et al. (2008a, 2008b) and Kumar (2008) investigated about CLV. Kumar computed average CLV, customer purchase and evaluation in the competitor's firm. The research proposed share-of-wallet metric for a focal brand and the importance of CLV, applying CLV in decision making. Richards and Jones (2008) the work focused on various clustering techniques of customers, mutually exclusive. Also empirical study is done using RFM analysis. The progressive evaluation of customer data helps the organisation to gain deeper understanding of customers, hence cementing strong relationships with customers. Many researchers used intelligent customer value to build and deploy CLV into a practical decision support environment especially in campaign management. Zhao (2011) looked at CRM's stats before and after applying DM. The work identified the procedure to apply DM with CRM to maximise benefits and to decrease issues stated. Al-Mudimigh et al. (2009) glared at a technique of extracting

understanding of and improve customer's behaviour to improve business. The paper proposed a model which evaluates customer inquiry with respect to customer clusters to generate rules. The defined rules which further helps in decision making activities.

Chan (2008) experimented in an automobile business applications, issues and customer buying trends. The paper assumed customer as an intelligent entity and emphasised on customer segmentation for campaign management. The paper identified the value of customers in the automobile sector. The above researched papers investigated customer data and related that analyses of data can be done in one of the following as shown in Table 4.

**Table 4** Phases in CRM

Campaign management and analysis
Contact channel optimisation
Customer acquisition/reactivation/retention
Customer segmentation
Customer satisfaction measurement/increase
Sales coverage optimisation
Fraud detection and analysis
Pricing optimisation
Product development

CRM provides an integrated view of customer interactions, management perceptions and actions. Ling et al. (2010) worked to redefine customer value. The customer value can be perceived as 'enterprise-customers' value, i.e., customers from enterprises to provide products or services and 'customer-business' value (referred as value for enterprise customers). The customer value matrix method is designed where customer historical value and customer potential value are the main indicators. To stay in the market competition today, it has become necessary to build a relationship with your customer and to keep updating him about your new product, policies and strategies is a way to keep in touch with your customers. The customer transaction database should contain demographic details and socioeconomic variables like, age, gender, income, contact details, temporary, permanent address and marital status in promotions make your potential customers' birthday and anniversary special with lucrative offers. The profile analysis is a vital measure to know your customers.

DM and CRM-based models are designed in order to strategise the market plan. Information analysis of customer data is an effective in the segmentation of customers and markets. The customers can be grouped according to loyal, profitable and active customers. Share-of-wallet method can be defined as, to identify customers' buying capacity. The DM technique, clustering can be used to segregate market type and further the market patterns are generated using association rule mining. These patterns are used in strategic marketing and campaign management.

Yu and Jiahui (2010) proposed a concept to organise customer value according to management levels. This concept was applied and used DM techniques to predict the future value of customers. The concept introduced was more subjective in nature. Rahman et al. (2012) investigated a DM technique, feed-forward neural networks to

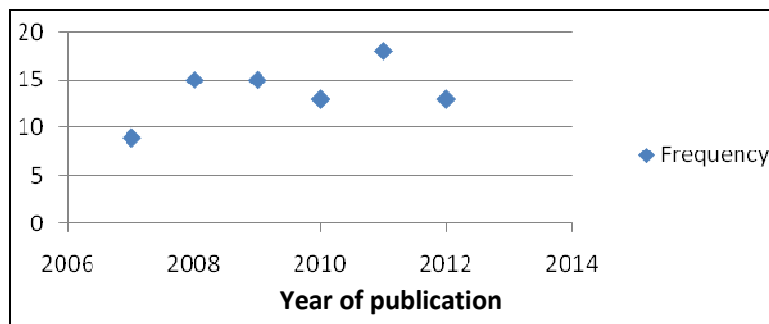
analyse unlabeled data for potential customers. Venkatesan et al. (2007) generated a model to segment customers in shipping industry with the help of DM. It created clusters then classified by Bayesian network and finally segment them. It modelled accurately segmented customers.

Becker et al. (2009) proposed a conceptual model that strengthens the link between technology and organisational implementations. The impact of CRM process is deliberated in four industries of European countries and initiated that if CRM not implemented properly will not yield performance. Garrido-Moreno and Padilla-Meléndez (2011) applied knowledge management in 153 Spanish hotels. It imparted insight into the relationship between knowledge management and CRM success using a structured equation model. Various factors are identified in implementing successful CRM. It emphasised on the fact that knowledge management is not the only factor for successful modelling. CRM in financial and marketing aspects discussed in detail. Lim and Teo (2009) detailed cyber incivility. The involvement of employees in exploring the cyber world using regression analysis are identified/blamed. Cyber incivility is one of the grave factors responsible for employee job dissatisfaction and commitment. Other means should be discovered for employees, online entertainment some policy to discourage more intervention of cyber world.

Hung et al. (2010) explored the impact of IT in the healthcare sector. It looks for the factors to improve service facilities and quality. CRMS is the process to acquire and retain customers. The case study of Taiwan hospitals, medical centre and community hospitals is discussed. The work uncovered the factors affecting CRM system. The results indicated factors like size of hospital, staff capital and knowledge management can improve hospital CRM systems. Kim and Kim (2008) proposed CRM scorecard. The application of work revealed the consequent/antecedent factors in a retail bank in Korea, how processes of organisation can be integrated with the CRM, customer value and customer loyalty. Teo et al. (2009) exposed two major findings how trust in technology and trust in government related to trust e-government websites. Also, it finds the relation between e-government websites are related to information systems success using framework defined by Mclean's and DeLeone.

#### 4 Classification and highlights of articles

**Figure 3** Classification of articles by year of publication (see online version for colours)



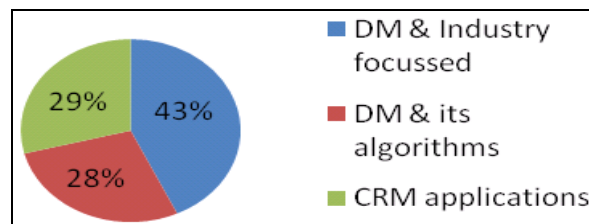


**Table 5** Classification of articles by year of publication

<i>Year of publication</i>	<i>Frequency</i>
2007	9
2008	15
2009	15
2010	13
2011	18
2012	13

**Table 6** Classification of articles by type of research article

<i>Type of research article</i>	<i>Frequency</i>
Transactions	4
Conference	20
Workshops	5
Journals	52
White papers	2

**Figure 4** Classification of articles by type of research topics (see online version for colours)

#### 4.1 Highlights and implications

The detail observations infer that the industry has been benefited and applied DM techniques, algorithms to maximise CLV to retain customers. 43% different domain industries have accepted and applied DM techniques and technology. 29% work has been done in improvising and maximising CRM applications. 28% work implied inventiveness in DM technique, association rule mining algorithms. To retain the potential customer was the focus of all the research and was the calculated challenge.

- The authors found that though DM techniques are applied in various industry domains. But few Industry domains are still unexplored like enterprise mobile apps industry working on android, tablet apps and fraud detection.
- The authors believe that more work is required in optimising clustering and classification algorithms for DM. The researchers have the challenge to take more parameters into account like lift, correlation analysis and relevant constraints while generating frequent item sets.

- The authors recommend that while calculating CLV, social interaction website customer response contributes majorly and power of product recommendations on social website cannot be ignored. The frequency of using mobile applications like WhatsApp and many more is quite high and the opinion and sentiment classifications of customers should be analysed using DM techniques. The authors come across fewer research works in enterprise mobile applications and social network domains.

Still, the biggest challenge is in the request and response of the customers' complaint management system and leave researchers with more scope in it.

## 5 Conclusions

In the current paper the attempt is to provide the reader with the consolidated research study of a number of articles based on DM techniques and CRM from year 2007 to the year 2012. The authors believe that although this data is not sufficient to draw concrete conclusions, Authors mentioned that the papers are still being made focused on the basic concept of merging DM with CRM. By now it is ascertained that both the technologies, DM and CRM go hand-in-hand and perceived that future foci should be deeper into other specific industries or suggest specific ways of using DM applicable to all or most industries. The review research study provides information for the scholars, academicians, research practitioners about the applications and usage of DM algorithms in customer centric organisations. This work may help the researchers in identifying their research domain of study and can further dig into it.

### 5.1 Future scope of the work

The authors feel that this work can be further extended by including the more reputed international journal and conference's articles based on DM and its applications. By targeting precise areas of CRM, marketing strategies more articles can be included.

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