

As a first step, all the journals related to Customer Churn in Telecommunication have been searched. As a next step, the journals which are published during the year 2005 to 2015 were considered for the review. Finally the selected articles were reviewed in the following four classes:

- Review of Journals published based on the country of authors and year wise (India & Others)
- Review of Journals based on Techniques used for the prediction of the customer churn.
- Review of Journals based on the year of publication.
- Review of the techniques based on the performance of the models.

Figure 1 depicts the overall development of the research methodology described above in more comprehensive way.

4. Classification of Journals

The total of 64 journals been selected and analysed in the above mentioned four dimensions. The objective of this analysis is to get the clear view on the following vision.

- 1)To investigate the level of Research focus on the concept of data mining in the telecommunication industry in India.
- 2)To reveal about the techniques of data mining in the telecommunication industry.
- 3)To study about the performance of the existing models

4)To establish the opportunities and challenges in the advanced techniques of data mining in telecommunication.

4.1 Journals by Country of Authors

Irrespective of the growth of the telecom sector, customer churn is the most challenging task for the industry. In this perspective, more insight is needed to know the reason for customer churn in India. Data mining is the one of the best technique for this. In this view, to know the awareness of data mining in telecommunication in India, the 64 journals are classified as shown in table-1.

Table 1: Year wise No of Journals based on authors country

Year of Publication	No. Of. Research Papers Based on Country	
	India	Others
2005	-	4
2006	-	6
2007	-	5
2008	-	8
2009	-	8
2010	-	4
2011	3	6
2012	1	4
2013	2	5
2014	3	1
2015	3	1
Total	12	52

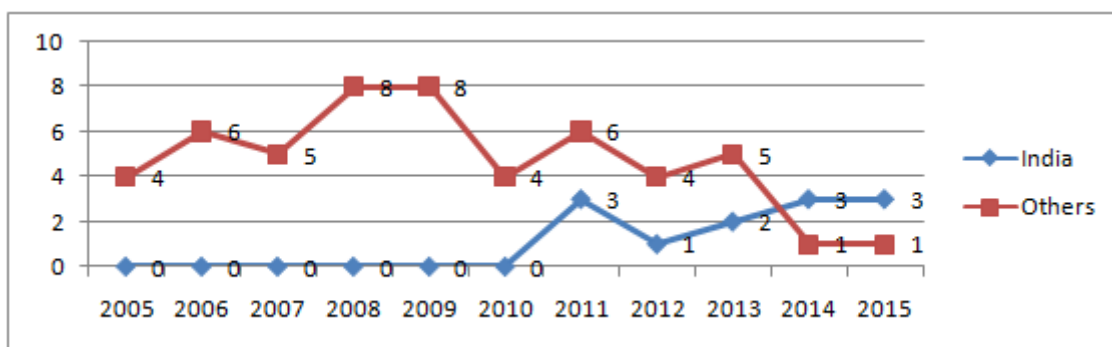


Figure 2: Year wise No of Journals based on authors country

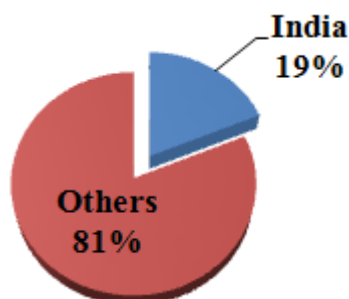


Figure 3: Comparison of Research Journals based on author's country over a decade

The statistical Table-1 clearly reveals that, the awareness of the concept of data mining in telecommunication in India is not matured that much during the last decade. It also state that only 19% (12 out of 64) of research papers only published during a decade.

4.2 Journals by Techniques

To predict the churn, different prediction algorithms used. In this, Logistic Regression, Decision Tree, Neural Networks, Support Vector Machine and Combination of above are the some of the well known techniques. To know about the usage of above data mining techniques in the area of telecommunication, the 64 journals were classified based on the techniques.

Table 2: No of Journals based on Technique

Techniques	No. of Research Papers
Decision Tree	27
Neural Networks	14
Support Vector Machine	11
Logistic Regression	7
Hybrid Models (Clustering + ANN)	3

From the table 2 and Figure 3, it has found that, the usage of Decision Tree was more matured than the other technique.

As next level, the research focus been turned towards Neural Networks and Support Vector Machine. The table also reveals that very limited focus was given on logistic regression and the concept of hybrid techniques has just been started, to improve the performance quality of the churn prediction model.

4.3 Journals by Techniques and Year of Publication

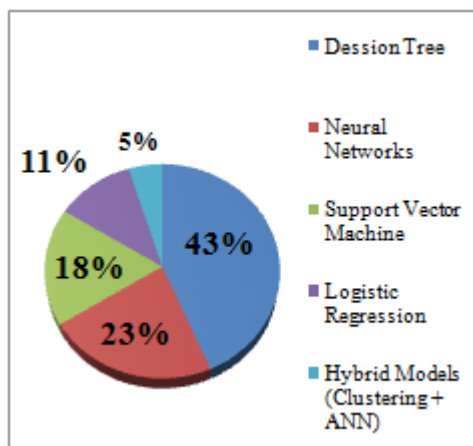


Figure 4: Research Focus Based on Techniques

Table 3: Distribution of Journals based on Techniques and Year of publication

Year of Publication	No. of Research Papers				
	Decision Tree	Neural Networks	Support Vector Machine	Logistic Regression	Hybrid Models (Clustering + ANN)
2005	1	1	1	1	
2006	1	3		2	
2007	4		1		
2008	1	2	4	1	
2009	3	2	1	2	
2010	4				
2011	5	1	2	1	
2012	2	2	1		
2013	1	3	1		1
2014	3				1
2015	2				1

To know the recent techniques of data Mining in telecommunication and to know about the effective techniques which perform best in all the way, the distribution of the journals has done as shown in table 3.

The above table clearly states that, the recent trend also focuses on the decision tree to predict the customer churn. Even though the focus over the neural networks and Support Vector Machine has been slightly reduced, reviews show that they are used in the hybrid models.

Apart from that from the analysis it was proved that, research focus has slightly turned towards the Hybrid models such as **cluster + MLP** and **cluster + SOM** to improve the accuracy over the churn prediction.

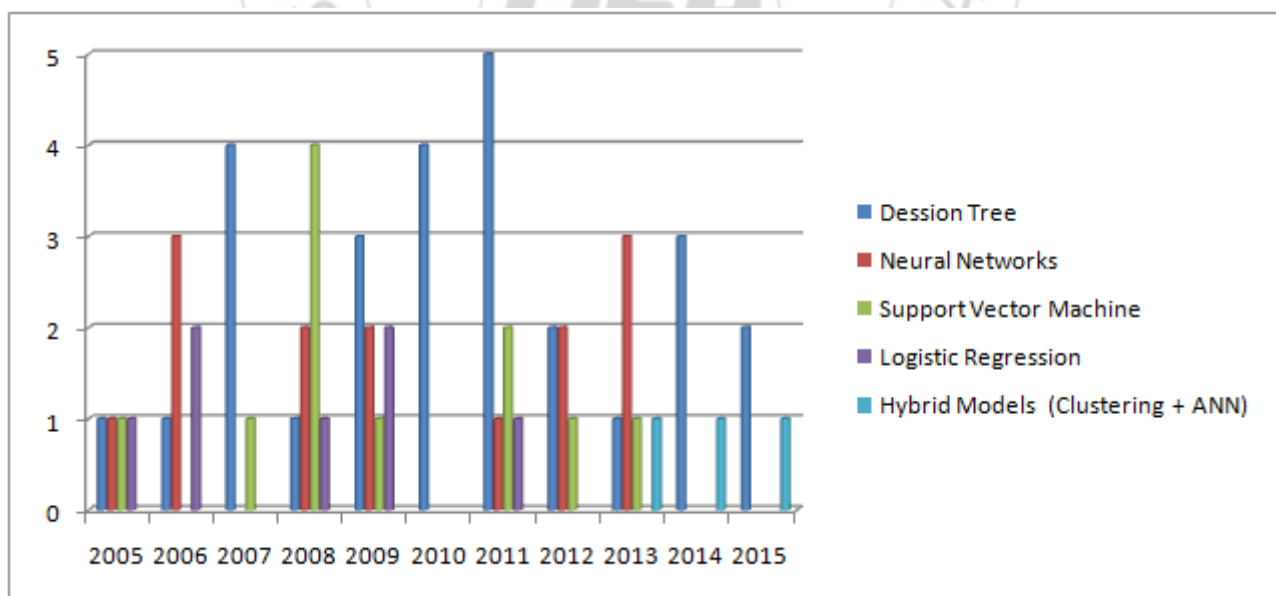


Figure 5: Comprehensive representation of journal distribution based Techniques and year of Publication

4.4 Journals by Performance

To establish and to identify the opportunities and the challenges in the advanced techniques of data mining in telecommunication, the comparative study has been done

based on the accuracy of results produced by various models.

The statistical data of table 4, depicts that model based on Logistics Regression performs poor than Decision Tree [28]. According to the analysis done by [44], it was

concluded that, Support Vector Machine has also produces best accuracy in prediction of customer churn. In addition to the above, through the table-4 it is also identified that, the recent challenges has focused on hybrid models to improve the performance quality on the prediction of churn. Based on the result comparison done by [62], hybrid models perform and produce best accuracy than the single models.

Table 4: Comparison of Hybrid model and Single model based on results

Techniques	Other Models				Hybrid Models		
	Logistic Regression	Support Vector Machine	Decision Tree (c4.5)	ANN	K-Means + MLP	Hierarchical Clustering + MLP	SOM + MLP
Reference	4	5	6	6	6	6	6
Accuracy (%)	Poor Than Decision Tree	88.56	94.3	94.3	97.2	94.8	95.9

With this idea, the research has been started in this area. This paper focuses on reviewing the literature over a decade in the area of customer churn in telecommunication. On the process of review 64 papers has been selected and analyzed in four different dimensions, to know about maturity of data mining in Indian telecom and to know about the recent techniques in churn prediction.

From the analysis, it is concluded that till 2010, there was no focus on Indian telecom and during the last five years only there was a slight focus on Indian telecom. So the researchers can initiate their research on Indian telecom to predict the customer churn.

As next, it has been concluded that current research is focusing on decision tree and neural networks. Apart from that, recent trend initiated Hybrid models to improve the performance of the existing model and it is proved and outperformed than the single models. So the researchers can focus more on the hybrid model to enhance the existing models, to achieve more accuracy than the other models.

6. Limitations of Research

As stated earlier that, not all the research journal are considered for the review. But, only research journals which are reliable in all the perspective are considered. So this review has some limitations.

- As first, 64 journals from the last one decade has been considered for the study. More journals can be selected by extending the duration.
- As Second, the journals were searched based on the string "Customer churn in telecommunication". But churn is common activity which happens in other sector also. So search can be done based on the string "churn analysis" or "churn management" etc. to find other recent models for churn prediction.

5. Conclusion

Today telecommunication industry is facing a critical issue of customer churn. Ultimately revenue loss is the cause of the issue. The only way to avoid revenue loss, which happens due to churn, was the prediction of customer churn well in advance. Data mining techniques aids the telecommunication industry to pick out such customers, so that retention activity can be taken against them.

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