



USING TREND ANALYSIS AND SOCIAL MEDIA FEATURES TO ENHANCE RECOMMENDATION SYSTEMS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Recently, Recommendation Systems (RSs) became widely used applications to recommend items to users according to the preferences of users on items. This Systematic Literature Review (SLR) aims to collect evidence on ways of using social media and trend analysis to enhance RSs. Moreover, the research identifies the features of social media that can be used to enhance the efficiency and the effectiveness of RSs, identifies the ways to predict trends from social media and the ways of using the result of trend analysis to enhance the efficiency and the effectiveness of RSs. It classifies the collected evidence, reports the results of the classifications, and lists the features of social media that can be used to understand trends and the ways of using the trend analysis to enhance RSs.

Keywords: *Prediction, Evaluation, Recommender Systems, Social Media, Trend Analysis.*

1. INTRODUCTION

Recently, many web-applications [1] have been published in the World Wide Web to provide millions of items and services to millions of users. Recommendation systems (RSs) [2] are the techniques that have been used, by many web applications, to recommend items to users. These techniques are based on users, items and preferences of users on items i.e. rating, sharing files, watching movies, reading news and so forth. Because, items and users are increasing exponentially; the users of the web application faced by the problem of information overload and found difficulties to select a suitable subset from millions available items.

1.1 Recommendation System Categories

There are many techniques of recommendation systems [2] that can be divided into these categories:

1.1.1 Content-based rss

Content-based RSs provide a list of items to a user according to the descriptions of the items and the

user's profile. Users' profiles are created and updated automatically, with respect to the activities and interests of users on items. These techniques have been used in different domains e.g. on-line news sites. They use features of items to recommend a list of needed items to a user. In many RSs items are stored in a database table that constructed of fields, sometimes called attributes or columns. Items are listed in records and any record contains some descriptions about an item. These descriptions have been used by content-base RSs to identify recommended lists of similar items to users.

1.1.2 Collaborative filtering rss

The Collaborative filtering is widely used process in the last decades. This successful technique has been used in RSs to recommend items to a user with respect to his similar users' interests on that item or similar items. Users' interests or ratings are generated from their activities and interactions with the web applications that have been using RSs. Ratings of users on items can be explicit or implicit. Explicit ratings are provided by the

users' responses to queries given by the system. The main drawback is the need of users' responsibility, with users not responding to the query. Implicit ratings do not need the users' response; it's taken from users' navigation on the web by clicking on the links and choosing their interested items.

The collaborative filtering algorithm [2] has three main steps:

- First the technique calculates the rating of users on items, that used to compute the similarity between the active users or the items. The most popular methods used for similarity measuring are Pearson Correlation and Vector Distance.
- The second step is choosing the k nearest neighbors of the active user or the item.
- The last step predicts new items for the user and generates the recommendation list of items.

Collaborative Filtering Algorithms [2] can be either Memory-based or Model-based techniques.

Memory-based technique:

Memory-based technique [3] is based on the history of users' preferences on items like items they

choose, movies they watch, pictures they mark to like and so forth. History of user's preferences may be the activities of other users that he has agreed with them in the past. Memory-based technique uses the ratings of users on the items that stored in databases to generate recommendations. This approach can be used to deal with new items, to recommend to new users the list of items they might like, to find friends and formulate communities and to recommend items to the formulated communities.

Model-based technique:

Model-based technique uses a training dataset to train model; then it uses that model for recommendations. Well-known model-based techniques include clustering and machine learning.

1.1.3 Hybrid rss

Hybrid RSs uses a combination of two or more recommendation techniques to introduce new more efficient one e.g. Content-base CF technique. Robin Burke [4] lists the recommendation techniques in table 1.

Table 1: Recommendation Techniques [4]

Techniques	Background	Input	Process
Collaborative	Ratings of users on items.	Rating of users on items.	Identify similar users using their rating on items
Content-based	Descriptions of items	Ratings of users on items	classifications of items needed by users
Demographic	Demographic of users and their rating on items	Demographic information about users	Identify similar users by locations and items
Utility-based	Descriptions of items.	A utility function over items that rated by users	Apply the function and recommend items to users
Knowledge-based	Features of items and Knowledge about items that meet a user's needs.	Description of items needed by users.	Identify items to users.

1.2 Social Media And Trend Analysis In Rss

Social media platforms [5] have been used by communities to interact and communicate with each others in different domains like entertainments, politics, sports and so forth. Recommender systems help users' interactions with each other's by recommending the shared items and the similar friends. However recommender systems suffer from the problem of sparsity, weakness of accuracy of similarity between users or items, lack of efficiency and effectiveness of applications. Therefore this research explores studies use social media features to enhance RSs.

Users interact with each other's by using web applications and they generate preferences on items; then the preferences used by recommender systems to predict items to users. However the opinions of users and items popularity are changing with the time. Therefore, the trend analysis and social media features provide great opportunity to enhance the RSs. This SLR identifies studies in the area to help the researchers to discover what have been done and what the future research challenges are. The rest of the SLR is organized as follows: Section 2 describes the methods and the techniques used to collect and classify the related studies. Section 3 reports the results of the classifications of the collected

evidence data. Section 4 discusses the result of the classification and gives the future work. Section 5 concludes the paper.

Table 2: Summary Of PICOC

Population	Recommender Systems
Intervention	Using social media and trend analysis in RS.
Comparison	Compare between : (1) The conventional RS. And (2) RSs those using social media and trend analysis.
Outcomes	(1) Features of social media used in RSs. (2) Ways of using Trend analysis in RSs.
Context	(1) Effectiveness of RSs. (2) Precision and recall of RSs.

2. THE REVIEW METHOD

This SLR is a way of identifying, assessing and interpreting all possible evidences in the field of recommendations systems using social media features and trend analysis. It aims to search for the relative data in all available databases and search engines, using all terms in the field and their synonyms. Also, it attempts to summarize all evidences in the area with contradicting to the traditional literature review which can only use some of the available ones.

2.1 RESEARCH QUESTIONS

Table (2) on page (3) shows the Population, Intervention, Comparison, Outcomes, and Context (PICOC) structure of our research questions. This SLR contains all studies that investigate using social media features and trend analysis of in recommendation systems. The main question aims to understand the RSs and the techniques that have been used to enhance the efficiency and the effectiveness, of applications, using social media features and the time factor. The main question as follows:

Main Question: How social media and trend analysis have been used to enhance RSs techniques?

Sub-question One: What evidences study using social media and trend analysis to enhance RSs?

Sub-question Two: Which features of social media have been used to improve the efficiency and effectiveness of RSs?

The sub-question Three: How has trend analysis

been used to enhance RSs?

2.2 Identification Of Relevant Literature

A search query sentence, to identify the best evidence, has been written using the relevant terms as follows:

1. The terms that have been generated from the review questions, based on Summary of PICOC.
2. The key words that have been generated from the area of recommender systems i.e. the article primary study subject.
3. The key words that have been generated from the related area i.e. trend analysis and social media.
4. The search has been conducted for the synonyms using the key words and the terms that collected from the articles.
5. After the collection of many papers which have been published recently and cited more, the search technique used the authors of the best papers using BibSonomy¹, PUMA² and other search engines, to collect more relevant studies.
6. The conjunction "AND, OR" have been used to write the query to link the terms that taken from the Population, Intervention, and Outcome.
7. The search string has been constructed as follows:
 - ((social media) or (social network) or (community))
 - ((trend prediction) or (trend analysis) or (temporal))
 - ((recommendation system) or (recommender system) or recommendation platform))

The query sentence:

((((Social media) or (social network) or (community)) or ((Trend prediction) or (trend analysis) or (temporal))) and ((Recommendation system) or (recommender system) or (recommendation platform)))

The most important issues in the process of the searching are:

1. To retrieve all possible relevant evidences
2. To retrieve less number of documents.

To satisfy these two issues, we concentrate on the

¹ <http://www.bibsonomy.org>

² <http://puma.uni-kassel.de>



constructed sentence as mentioned. However, these research techniques some time not effective. For this reason, the search also conducted by using terms like social media and trend analysis to retrieve more information in the specified area.

2.3 Selection Of Studies

The search criteria aims to include all empirical studies that cover the area using trend analysis and social media features in RSs. It covers all possible studies in the past decade and includes the following:

1. Papers about using social media and trend analysis to enhance RSs.
2. Papers investigate social media features and how features have been used to enhance RSs.
3. Papers about trend prediction from social media.
4. Papers about using predicted trends to enhance RSs.
5. Papers about using trend analysis in social media.

2.4 Data Extraction And Study Quality Assessment

A form containing six questions and topics, to classify the collected data, has been designed. It has been used, by answering the question, to measure the quality of any evidence of the primary collected studies. The research used the questions proposed by Liz Spencer et al., [1, 6]. The topics that must be covered by the studies are:

1. Trend analysis in recommendation system.
2. Social media in recommendation system.
3. Trend analysis in social media.
4. Social media and Trend analysis in recommendation system.

Table (3) contains the six questions and topics that used for the classification and the statistic. The scores have been collected according to the answer of any question as follows:

1. If the study cited the score equals to 1, else the score Zero. For the current-year publication the scores is 4. In the past one year the score is 3, in past two year the score is 2, else the score is 1.
2. The aim of the study if it is clear (the score is 2), if it partially clear (the score is 1) else the score is zero.
3. This research covers the topics trend analysis, social media and RSs techniques. How- ever many studies cover more than one topic. Therefore the researcher classifies the studies with respect as

follows:

- Trend analysis in RSs, the score is 1.
 - Social media in RSs, the score is 1.
 - Trend analysis in social media, the score is 1.
 - Social media and Trend analysis in RSs, the score is 1.
4. The rest of the questions scored as follows, the Yes=2, partially=1 and No=0.
 5. The summation of the seven answers is the score that used for the classification. The classification is:
 - Relative if (the score ≥ 6).
 - Good if ($6 > \text{the score} \geq 8$).
 - Very good if ($8 > \text{the score} \geq 10$) and.
 - Excellent if (the score more than 10).
 6. The researcher read the collected studies and answers the seven questions for any evidence. To validate the assessment, reading and answering the questions done twice, separately, and compared; then the researcher review the different scores.

3 RESULTS

This section represents evidences classification. To do that, a table is created by the name "classification-table" to list all collected evidences, a folder is created by the name "used-references" to be used for saving all the pdf files, and a Bib Tex database is created by the name "SLRreferences" to store the citation information. During the process of searching the following steps have been done:

1. The search has been done with respect to the review method mentioned in section (2).
2. Any retrieved evidence has been renamed by the research title and has been saved in the "used-references" folder.
3. Then the researcher read the abstract and the introduction of the evidence to classify it.
4. After avoiding the duplicate a record, in the table "classification-table", has been created and filled by the evidence classification.
5. A Bib Tex format citation information has been entered in the "SLRreferences" database, using a unique serial citation id.

The process of evidences retrieval has been illustrated in figure (1) on page (8). The following section gives the answer of the main question of the SLR and the answers of other three sub-questions.

Table 3: The Quality Question

The Assessment topic or question	High scores
The article's citations and publication year	1+4
Were the study is clear and satisfies its aims?	2
Were the study contribution(s) adequately described?	2
Using social media and trend analysis in RSs. The score one for any of the following topics: Social media and trend analysis in RS. Social media in RSs. Trend prediction from social media. Trend analysis in RSs. Trend analysis in social media.	1
Were the goals of the analysis was well transferred?	2
Were the results reached? For example : The study can help us properly To use the results	2
The full total quality score of the study	14 scores

3.1 The Answer Of The Main Question

The main question: "How social media and trend analysis have been used to enhance RSs?"

The SLR collects 43 studies varied from different topic of the main study. Moreover, 17 studies [5, 7, 3, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, and 21] describe using social media in RSs. And 19 studies [22, 23, 24, 25, 26, 27, 28, 29, 22, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39] cover the topic of using trend analysis to enhance RSs. Since the two mentioned topics improve the efficiency of RSs, the SLR contains 2 studies [40, 41] using social media and trend analysis in recommendation system. Also the research collects 5 studies [42, 42, 43, 44, 45, 46] to cover the ways of using trend analysis in social media. Section (3.2) on page (7) gives a classification of the evidence that cover the area of using social media and trend analysis in RSs. Section (3.3) on page (8) answers the question about using features of social media to enhance the efficiency and effectiveness of RSs. Section (3.4) on page (10) answers the question about using trend analysis in recommender systems.

3.2 The Sub-Answer One: Studies About Social Media And Trend Analysis In Rss

The question: "What evidences Studies using social media and trend analysis to enhance RSs?"

To answer this question a table has been created to help the classification of the related evidences. The table contains id No., publication year, title topic, evaluation, citation id and notes. All collected evidences listed and classified in the table. The classification is due the topics that

answer the questions mentioned in section (2.1).

The Topics covered in the research [5, 15, 21] are using social media in recommendation techniques, predicting the trends of social media, using trend analysis in recommendation system, and using social media features and trend analysis to enhance RSs. Table (4) is the summary of the collected data. It contains the topic, the evidences count, the citation No. of the references of the classifications i.e. excellence, very good, good and relative. After the collection of the references, they classified with respect the topics and questions mentioned in table (3) on page (7). The classifications start from excellent, very good, good and related. Figure (2) illustrates the classification steps. The search has been conducted to cover all possible data in recent years, covering all topics in the RSs area. Figure (3) gives the summary of the evidences per years for topics that answer the questions mentioned in section (2.1).

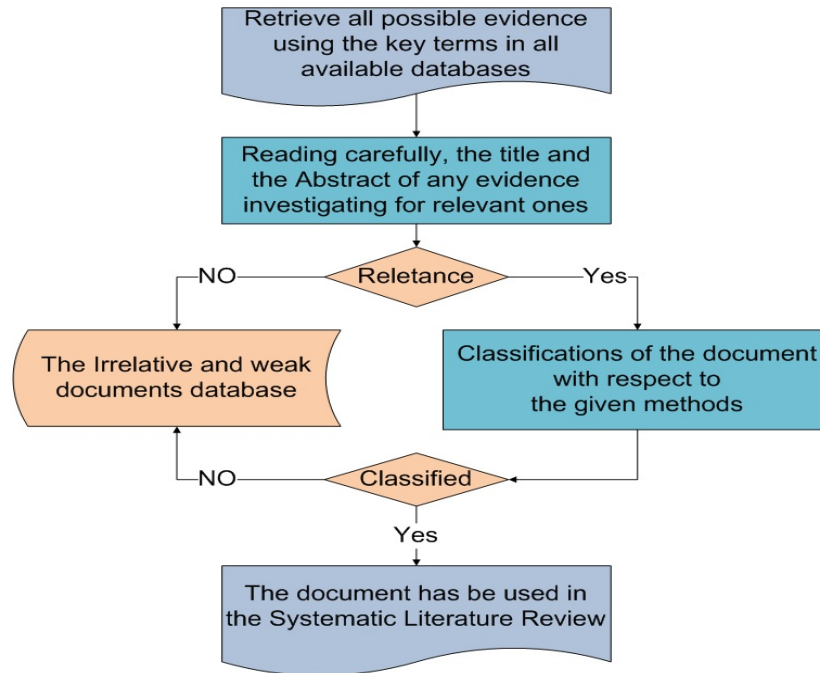


Figure 1: Evidences Collection Process

3.3 The Sub-Answer Two: Features Of Social Media

The sub question: "Which features of social media have been used to improve the efficiency and effectiveness of RSs?"

Social media (Nicole B. et. al [30] and Sheng Yu and Subhash Kak [42]) are web applications used by users and organizations to create exchange and publish contents e.g. text, audio and video. As an example of social media are (Twitter and Facebook). Twitter (Sitaram Asur and Bernardo A. Huberman [16]) is a web application that allows the users to read and send text messages known as tweets. It initiated in March 2006 by Jack Dorsey. It has two types of users registered and unregistered users. Facebook is an online social networking service founded in September 2006 by Mark Zuckerberg. Social media provides

a huge amount of information. Government agencies regularly rely on social media to engage with their customers for improved citizen services and cost savings. Social Media integrates technology, social interaction, and content creation to collaboratively connect online information. Through social media, people or groups can create, organize, edit, comment on, combine, and share content, in the process helping agencies better achieve their mission goals. In this SLR, 19 studies [5, 7, 3, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21],[40, 41] cover the area of using social media to enhance RSs. Table (5) lists the feature of social media, describing how it used in RSs and the methods of the evaluation then the effect of the features on the RSs.

Table 4: Evidences Classification Per Topics

Topic	Cnt	Excellent	V. good	Good	Relevance
SM in RS	17	[5, 15, 21]	[19, 7, 14]	[18]	
		[11, 10, 3, 8]	[17, 9, 13]	[16]	
			[12]	[20]	
TA in RS	19	[29, 47, 30]	[32, 38, 26]	[23, 24, 25]	[33, 34]
		[37, 36, 35] [28]	[22]	[27, 31, 39]	
SM and TA in RS	2	[40, 41]			
TA in SM	5	[42, 46]	[44]	[43]	[45]
All	43	18	12	10	3
Others	4		[1, 6, 2, 4]		



Table 5: Features Of Social Media In Recommendation System

Feature & References	Social Media	How it used	Evaluation	Efficiency
Publishing [5] interaction [13]	Intel-epciune.ro You Tube	In Content recommendation, using Users publishing and interaction with in social network to calculate the similarity between users Then recommend items to a user. Using sharing Behavior as Implicit Feedback for Collaborative Filtering	Comparing Top-N popular and Item-based algorithms	It improve the efficiency
Tagging [21, 19]	Delicious, CiteULike, BibSonomy	In Collaborative and, Content-based Filtering, extending the nearest neighbor and Pearson Correlation algorithms by adding information about tagging behavior to enhance recommendation.	Comparing CF approach with Collaborative -Content-based Filtering	It improve the efficiency
semantic [20]	WordNet	Semantics of content-base profile were used to Group users, then the recommendation calculated within the group.	Compare using Mean Absolute Error method	It improve the efficiency
Like [13]		In Collaborative Filtering, like and unlike counted to calculate the similarity between users.	Comparing precision and recall	It improve the efficiency
$Recall = \frac{(The\ number\ of\ true\ predicted\ successful\ interactions)}{(The\ number\ of\ all\ interactions)}$ $Precision = \frac{(The\ number\ of\ true\ predicted\ successful\ interactions)}{(The\ number\ of\ predicted\ successful\ interactions)}$				
Rating [3, 19]	Facebook	In collaborative filtering, The ratings of users were used to clustering users to groups, to construct a social community. Then the similarity of users calculated within The group. To be used for prediction and recommendations	Comparing precision and recall	It improve the efficiency
Tweets [16]	Twitter	In knowledge recommendation, a knowledge extracted from chatter has been used and a linear regression model is constructed for predicting box-office revenues of movies in advance of their release	Precision and Recall	It improve the efficiency
$Recall = \frac{(Relevant\ Venues\ recommended)}{(Relevant\ venues)}$ $Precision = \frac{(Relevant\ venues\ recommended)}{(Venues\ recommended)}$				
interaction [17]	Online dating web site	In interaction-Based Collaborative Filtering, Methods voting added to normal rating to be used for similarity then recommendation.	Precision and Recall	Successful sometimes unsuccessful
relationships [18]	wikis	In tag-based recommendations , relationship information among people, tags, and items, are collected and aggregated across different sources and used for recommendation.	Compare item rating results across the different recommender techniques	It Successful to improve efficient

3.4 The sub-answer three: Using trend analysis in RS

The sub question: "How the trend analysis has been used to enhance RSs?"

RSs based on users, items and users' preferences for items. However, users opinions and items popularity are changing according to events' time. This SLR investigates, through 21 studies [22, 23, 24, 26, 27, 28, 29, 30, 25, 31, 32, 33, 34, 35, 37, 38, 36, 47, 39] [40, 41], ways of trends prediction and ways of using trend

analysis to enhance the efficiency and effectiveness of RSs. Table 6 gives data that can be used for trend analysis, features extracted from that data, ways of using the features in RSs, how the ways evaluated and the effect of using trend analysis in RSs.

Also in the SLR 5 evidences [42, 43, 44, 45, 46] study the trend in social media. All these studies try to solve the problems by considering the time factor. But, this area needs more studies. table6: Trend analysis in recommendation system

Table 6: Trend Analysis In Recommendation System

Source of trend analysis	What Trend	How Trend Extracted	Evaluation method	Effect on RSs
RS use	RS updated at	RS predict any	Time-Averaged	Successful
Source of trend analysis	What Trend	How Trend Extracted	Evaluation method	Effect on RSs
Rating by users within time t [27]	every m = 7 days	ratings that will be input before time (t + m)	for kNN Algorithm	to improve efficiency
RS collect events by year, month, week, day, [36]	RS aggregate events in (year, month, week, day, hour)	RS spot trends over time	It compares several groups of records	Successful to improve efficiency
RS use location and time stamp [31]	RS cluster users Per year and month	RS use TF-IDF and a function Base on time	compare precision and recall	It increases RS efficiency
Users' rating and time stamp [29]	CF invest the state of old items and new sails	The matrix of users' purchase time and items' lunch time is used to weight the rating	compare between Conventional CF and the new technique	improve RS efficiency
CF use [26] preferences of users on items and time stamp	adaptive CF temporal	Update the parameters to provide greater temporal	compare between CF and adaptive CF	It solve problems of updating the parameters periodically

4 DISCUSSIONS

4.1 Recommendation Techniques

Recommendation systems (RSs) [2] are the techniques that have been used, by many web applications, to recommend items to users. These techniques are based on users, items and preferences of users on items i.e. rating, sharing files, watching movies, reading news and so forth. While, the users of these web applications are increasing exponentially parallel to the extended number of items; they faced by the problem of information overload, and found difficulty to select small set of items from millions of available items. RSs have been used to solve these problems. However, there are many time variation aspects about users' opinions and popularity of items.

This research investigates ways of using social media and trend analysis to enhance the efficiency of RSs.

4.2 Using Social Media In Recommendation Techniques

Social media [30] provide great opportunity for users to interact with each others. Government agencies regularly rely on social media to engage with their customers for improved citizen services and cost savings. Through social media, people or groups can create, organize, edit, comment on, combine, and share content. These processes help agencies better achieve their mission goals.

4.3 Using Time Factor In Recommendation Techniques

Social media provides a huge amount of information that can be mined to predict trends. Trend analysis and social media features can be used to enhance the efficiency and the

effectiveness of recommendation systems. This SLR investigates ways that can be used to predict the trend from social media datasets. As mentioned in section (3.4), many researchers study trend analysis in recommender systems. But the area needs more investigation and studies.

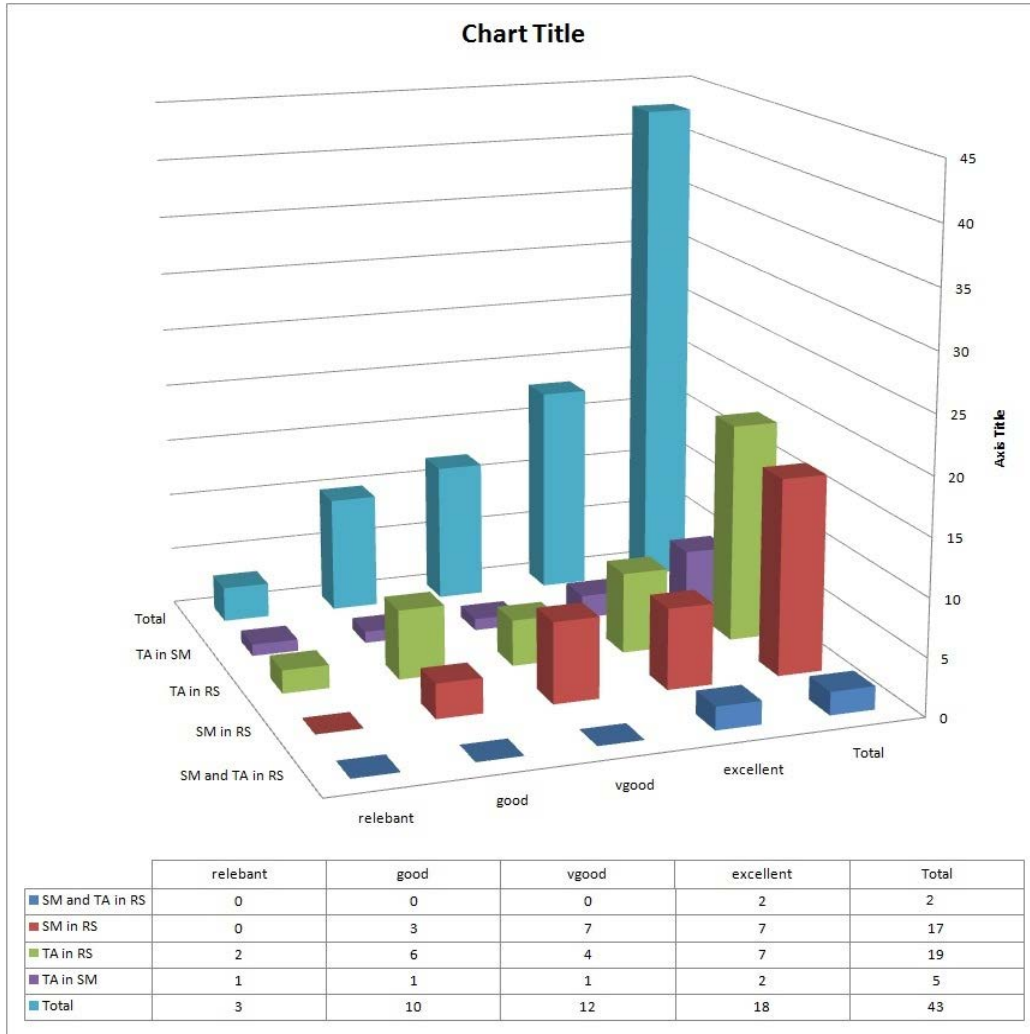


Figure 2: Evidences Classification

4.4 Future Work

The recommender systems became an essential issue these days, parallels to the evolution of social websites. The used techniques help a lot to recommend items to users. However there are a lot of drawbacks and problems need the researchers to concentrate on them and introduce more efficient and effective techniques. The following topics need more studies:

1. Using sociological theory to interpret predictors taking the changing of users' opinions and changing of products/services popularities with time in considerations.
2. Enhancing prediction by taking the time factor in consideration.
3. Modeling of predictions with social media and trend analysis.
4. Using semantic analysis system for social media to enhance RSs.

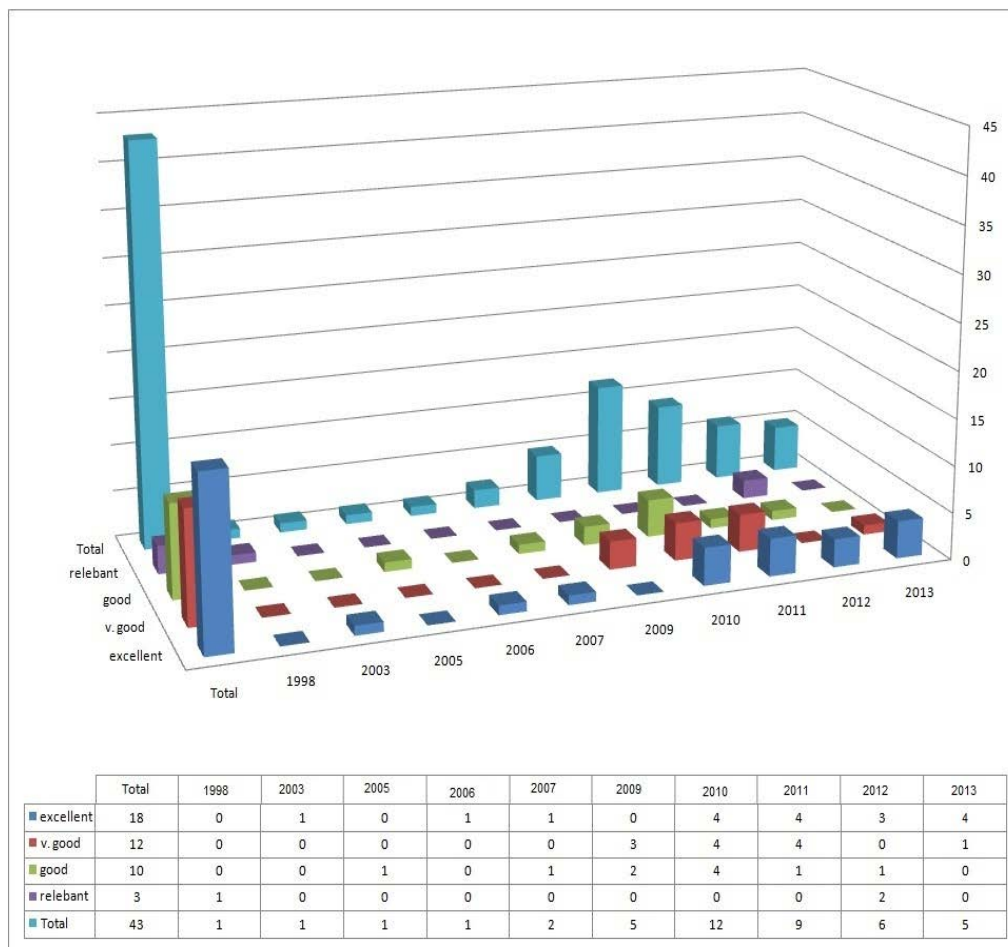


Figure 3: Evidences Per Year

5 CONCLUSIONS

This SLR collected and classified evidence that covered the area of using trend analysis and social media features in Recommender Systems. The SLR collects 43 studies varied from different topic of the main study. Moreover, 17 studies describe using social media in RSs. And 19 studies are covering the topic of using trend analysis to enhance RSs. Since the two mentioned topics improve the efficiency of RSs, the SLR contains 2 studies using social media and trend analysis on recommendation systems. Also the research collects 5 studies to cover the ways of using trend analysis in social media. However, there are a lot of challenges facing the RSs e.g. lack of efficiency and effectiveness. Therefore, using the time factor and trend analysis will help solving these problems.

More studies about using social media to enhance the RSs applications are needed. Because the users' activities and items popularities are

changing with the time, more studies about using trend analysis in RSs are needed too. The expected applications needed to use social media features and trend analysis to enhance the RSs.

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