Techniques, benefits, and challenges of recommendation system in e-commerce: A literature review

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Abstract

The recommendation system (RS) is considered one of the most essential and influential tools in the advancement of e-commerce. The main aim of RS is to create significant suggestions and recommendations information, products, or objects for users' society that users could interest them. Therefore, many RSs are utilized for solving information overload problems in areas such as e-commerce. This paper aims to review and classify different methods, techniques of recommendation systems in e-commerce platforms. This paper also shows the benefits and challenges of RS in the e-commerce field.

Keywords
Recommendation system, clustering technique, e-commerce, literature review, content analysis.

1. Research background

1.1 The booming of e-commerce

Nowadays, many economists and experts believe that in recent years, the world has entered the information age after undergoing a revolution equivalent to the industrial revolution. (Shahriari et al., 2015). With the advent of e-Commerce, many people in the world can compete in global markets regardless of language and cultural barriers, and physical distance. In addition, to adapt to changing corporate contexts, transaction processes might be reengineered. (Raman, 2000). E-commerce is the necessity of international business, vice versa, international business boosts e-commerce (Zheng et al., 2009). This strong relationship demonstrates e-increasing commerce's significance in the global economy.

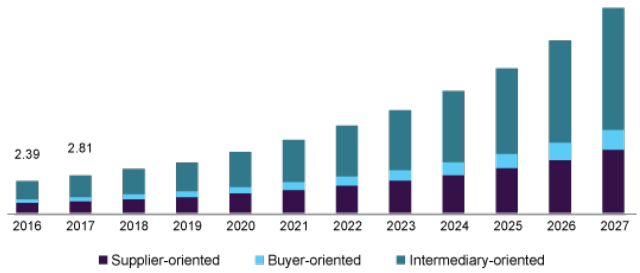

Figure 1: Asisa Pacific B2B e-commerce market size (Source: www.grandviewresearch.com)

According to Grand View Research, "the global B2B e-commerce market size was valued at USD 6.69 trillion in 2020 and is expected to grow at a compound annual growth rate (CAGR) of 17.5% from 2020 to 2027". The growing importance of faster browsing has led to the development in connectivity, thus leading to the growth in 4G and 5G technology (grandviewresearch.com, 2020). The COVID-19 crisis accelerated an expansion of e-commerce towards new firms, customers, and types of products (oecd.org, 2020). For example, consumers spent $861.12 billion online with U.S. retailers in 2020, up 44.0% from $598.02 billion in 2019, according to the latest digitalcommerce360.com (2021). Online spending represented 21.3% of total retail sales last year (2019), compared with 15.8% the previous year (digitalcommerce360.com, 2021).

1.2 Recommendation System

1.2.1 Definition

RS is a tool that helps users by offering services or goods that are likely to be of interest to them. (Najafabadi & Mahrin, 2016). The suggestions relate to various decision-making processes, such as what items to buy, what music

to listen to, or what online news to read. “Item” is the general term used to denote what the system recommends to users. An RS focuses typically on a specific type of item (e.g., Online movie, products in a website), and accordingly, its design, its graphical user interface, and the core recommendation technique used to generate the recommendations are all customized to provide valuable and practical suggestions for that specific type of item (Ricci et al., 2011). The RS is not a new idea. Karlgren, 1990 come up with the idea of a recommendation system, a "digital bookshelf". Over the next two decades, researchers at MIT and Bellcore continuously developed the technique (Shardanand & Maes, 1995). Despite many recommendation algorithms and techniques, there are two main methods: Content Filtering and Collaborative Filtering. Collaborative Filtering helps customers find what they like by finding users who are like them. In contrast, Content Filtering works by understanding the features and attributes of each product, powerful for content-rich products. Let's take an example to understand clearly:

- Collaborative Filtering (CF): Data analysts found that most of the consumers who buy apple and orange, they tend to buy grapes. From this information, the RS can group that customers into groups of people with similar interests. Therefore, the RS should recommend customers buying Apple and Orange buy Grapes.
- Content-based Filtering (CBF): This approach may use historical browsing information, such as the blog that the user has read and the characteristics of those blogs. Suppose users often read Laravel (a framework of PHP) articles or are likely to leave comments on software engineering blogs. In that case, Content filtering can use this history to identify and recommend similar content (articles write on Laravel or other software engineering blogs).

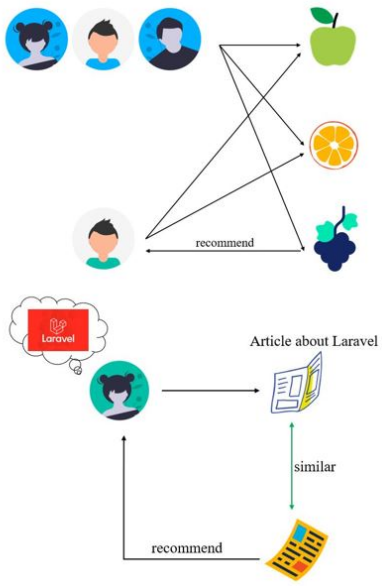

Figure 2: CF and CBF example

1.2.2 Algorithms and applications of recommendation system in e-commerce

RSs are used by e-commerce sites to suggest products to their customers and provide consumers with information to help them decide which products to purchase. The products can be recommended based on the top overall sellers on a site, on the demographics of the consumer, or an analysis of the consumer's prior buying activity as a predictor of future buying behavior. (Schafer et al., 2000). Researchers and managers recognize that recommender systems offer great opportunities and challenges for business, government, education, and other domains. Recent examples of successful recommendation systems in real-world applications have emerged (Lu et al., 2015). Most of the researchers have studied new approaches of recommender systems to solve these problems of CF and CBF, and to implement them into real-world situations. Specifically, by assessing the user's preferences and applying data mining techniques to recommender systems, it has proved successful in giving personalized information to the user (Deuk Hee Park et al., 2012).

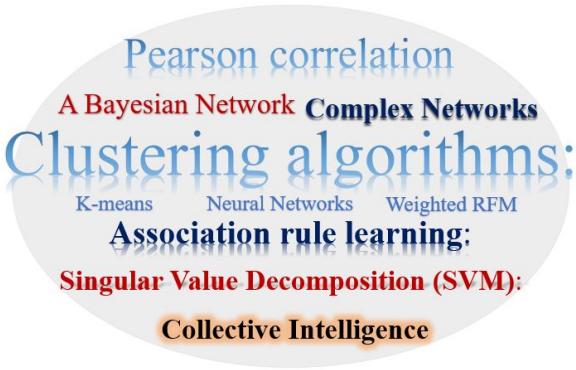

Figure 3: Algorithms used in RS

1.3 Related work

There have been a lot of literature review papers about RS as well as RS in e-commerce. These reviews generally categorize articles according to business type (Aminu Da'u & Naomie Salim, 2021; Deuk Hee Park et al., 2012), and data mining techniques (Aminu Da'u & Naomie Salim, 2021; Nabizadeh et al., 2013) as Cold-start, Data sparsity, Accuracy, Scalability in almost all areas. The authors Deuk Hee Park et al. (2012), Guan et al. (2016), and Nabizadeh et al. (2013) are interested in using algorithms and upgrading the classical algorithms to improve the problems encountered. A lot of research has been done on system modeling using various machine learning techniques, such as Neural Networks and Support Vector Machine (Guan et al., 2016).

(Aminu Da'u & Naomie Salim, 2021) supposed that many RS are utilized for solving information overload problems in areas such as e-commerce, entertainment, and social media. However, despite the several research works on learning-based RS, very few secondary studies were conducted in the field. So, they offer an overview of the deep learning-based RS's theoretical foundations. They gave complete and detailed models of deep learning. (Qi Zhang et al., 2016) presented a review on the deep learning-based RS models. They proposed a co-attention network incorporating textual and visual information to recommend hashtags for multimodal. Batmaz et al. (2019) also provided a comprehensive review of deep learning-based recommendation approaches to enlighten and guide newbie researchers interested in the subject. They analyzed compiled studies within four dimensions: (i) deep learning models utilized in recommender systems, (ii) remedies for the challenges of recommender systems, (iii) awareness and prevalence over recommendation domains, and (iv) the purposive properties.

According to Nabizadeh et al. (2013), at this time, finding the customers' requirements and tendencies became important as this problem changed into a big problem. Their article presents an overview of recommendation systems and illustrates the present generation of recommendation techniques that are usually categorized into the following three main classes: CF, CBF, and Hybrid Recommendation approach. These approaches have a variety of benefits and drawbacks, but the emphasis of this study was on the recommendation approaches and their flaws. However, this article does not list the papers that were written, only what they have in common. Deuk Hee Park et al. (2012) identified 210 research papers on recommender systems that were released between 2001 and 2010 to explain the trend in recommender systems research and to provide practitioners and researchers with insight and potential directions on recommender systems. Although this paper is quite old, this article classifies articles in detail according to industries in areas such as: Book, Document, Image, Movie, Music, etc. In those areas, they list data mining techniques.

An systematic literature review (SLR) was introduced by Champiri et al. (2015) to survey the scholar context-aware RS. This study was performed to define the contextual information and methods used in digital libraries for making recommendations from 2001 to 2013, as well as how researchers interpreted and used relevant contextual information. Portugal et al. (2018) examined the use of machine learning methods and their application domain for RS using an SLR process. This paper presents a systematic review of the literature that analyzes the use of machine learning algorithms in recommender systems and identifies new research opportunities (Portugal et al., 2018). Najafabadi & Mahrin (2016), using SLR, a tool for evidence-based software engineering, aggregate evidence on the state of CF science and practice, as well as implicit data (EBSE). Another study that we found to be very interesting in online learning. Online learning is becoming common in the sense of unregulated COVID-19 translation. This paper (Murad

et al., 2018) presents the result of SLR on RS topic as a preliminary toward a further study on designing a smart Learning Management System (LMS) for online learning which adopts Natural Language Processing techniques.
In this article, we will apply those and review more articles in recent years to see that the Recommendation system has a lot of solving techniques and algorithms, which are always used for businesses to understand more about customer behavior and intentions, especially the clustering algorithm. Besides, we are interested in finding papers using the machine learning algorithm that combined those algorithms to develop optimal Recommendation system for each field and situation.

1.4 Research questions

Understanding the importance of Recommendation System in e-commerce, this paper aims to investigate research papers to gain insights into Recommender System and Clustering Algorithms (especially K-means) in general and in the e-commerce business. To this end, we raised and researched answers for the following research questions:

- What are the different aspects in application of the Recommendation System in the e-commerce (types of data, methods, techniques, algorithms)?
- What are the benefits, difficulties, and challenges when applying RS in e-commerce, research gaps in this field, the outlook for future research?

2. Research methodology

2.1 Data collection

We collected high-quality papers that were peer-reviewed and published between 1996 and 2020 by means of structured keyword search and cross-referencing. The keywords applied to search for articles in the database of Google scholar were recommendation System (OR Recommender System OR Recommendation Engine) AND/OR Clustering (OR Cluster, Clustering technique) AND Ecommerce (OR Mobile commerce, electronic commerce, web/ online business, online shopping, online purchasing). We considered all articles (except for literature review papers) that investigated recommendation systems in e-commerce.
Within our research, methods of Recommendation system research are defined and classified. To this end, the units of analysis in our review relate to research papers that have new contributions to this research field, such as:

- Develop and/or implement a new model/ technique to combined methods or algorithms that help RS more effectively, reduce the cost to operate the system.
- Empirically investigate how organizations use RS to increase the number of customers and understand customer behavior.
- Explore benefits and challenges of RS in e-commerce.

After carrying out screening titles, abstracts, and conclusions to choose the appropriate papers to review, altogether, we selected and reviewed 70 papers.

2.2 Data analysis

The authors used the content analysis method in investigating the collected papers. The content analysis method was defined early by Berelson in 1952 and developed by Philipp Mayring in 2000 and 2008. In simple terms, content analysis is the analysis of what is being said, written or recorded (Parveen & Showkat, 2017). Researchers might make assumptions about the author, reader, and text they are evaluating by using content analysis to establish the intent, meaning, and influence of communication content (Krippendorff, 2018).

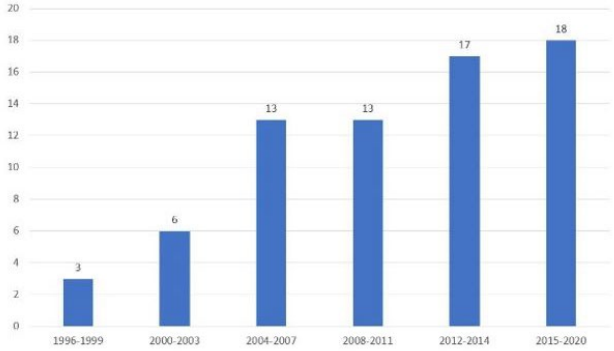

Figure 4: Distribution of reviewed papers by published year

3. Findings and discussions

3.1 Descriptive analysis of reviewed papers

Our review collected papers from journals (67%) and conference proceedings (33%). Our reviewed paper investigated the application of RS in different types of e-commerce business areas and specific products, including general online retailers, movies website, histories of customers' Web purchasing and browsing activities, demographic and psychographic information, transaction data, e-commerce in travel, cashback website, automobile, smartphones, and books. **Figure 4** shows the distribution by published year of reviewed papers. In line with the prevalent of e-commerce and customer analytics, the quantity of papers has increased over time. Research papers are selected from different Digital libraries. IEEE Xplore had more than 18% (13 out of 70 research papers) of the total number of research papers. Springer Link (12 out of 70 research papers, or 17.10%). We looked for a high-ranking reputable Journal to collect papers based on SJR. The SCImago Journal & Country Rank is a publicly available portal that includes the journals and country scientific indicators developed from the information contained in the Scopus® database (Elsevier B.V.).

Figure 5: Distribution of reviewed papers by ranking of journals/ proceedings

3.2 Dataset used in RS in e-commerce

This section will analyze the datasets that the reviewed papers used to study the recommendation system in e-commerce. From **Table 1** we can see that most of the articles we have been using transaction data. We define transaction data as data relating to a customer's purchase history and their basic information (age, gender, income, marital status, salary, etc). This definition is like the description of the transaction data type by Akter & Wamba (2016), in his big data analytics (BDA) paper: "Transaction or business activity data: Structured data from retail transactions, customer profiles, distribution frequency and volume, product consumption and service usage, nature, and frequency of customer complaints".

Table 1: Dataset using in papers

Dataset	References	Limitation
Transaction data	- (Anna Gatzioura and Miquel Sànchez-Marrè, 2014), (Gong, 2010), (Keonsoo Lee and Seungmin Rho, 2012), (Karzan Wakil et al., 2019), (Vahid Mohseni Roudposhti et al., 2018), (Dhrubasish Sarkar, 2012), (Sung-Shun Weng and Mei-Ju Liu, 2004), (Hsiao-Fan Wang and Cheng-Ting Wu, 20120), (Yulin Deng and Qianying Gao, 2018), (Zofija Tupikovskaja-Omovie and David Tyler, 2020), (Victor N. Zakharov and Stanislav A. Philippov, 2017), (Roung-Shiunn Wu and Po-Hsuan Chou, 2011), (Hye-Jeong Chun and June Wei, 20040), (HuangSubhash K.Shinde and Uday Kulkarni, 2012), (Duen-Ren Liu and Ya-Yueh Shih, 2005), (Chi-myung Kwon and Seong-yeon Kim, 2007), (Balabanovic and Shoham, 1997), (Panniello et al., 2009Shih and Liu, 2008), (Bai et al., 2020), (Anitha and Patil, 2019), (Kim and Ahn, 2008), (Ibrahim et al., 2011), (Dhaliwal et al., 2017), (Kim and Yang, 2005),	- The data with the number of observations is restricted due to many legal and privacy reasons. A vast amount of data is required to develop the best recommendation system for e-commerce sites with various categories. In addition, the data set's scope is constrained (usually in a specific area, with shopping characteristics). - Computation of some algorithms, such as SVD, will be rather costly. This only applies to movie and notebook suggestions. Bias may be introduced through the experimental design. The individuals rated the recommended items just after the preference elicitation processes, which could lead to an overestimation of the correctness of the recommendations.

	(Atchariyachanvanich and Sonehara, 2008), (Hosseini et al., 2010), (Cho et al., 2014).	- The sample is only skewed toward users who have accounts with private banks, resulting in an equal representation of public and private sector bank respondents.
Click-stream data	(Amit Kumar Jaiswal et al., 2020), (Dixit and Gupta, 2020), (Ding, 2018)	An algorithm usually applies only to a certain data type. There are efficiency differences when applying to numeric and non-numeric data.
Natural language analysis	(Michael Steinbach et al., 2000), (Roung-Shiunn Wu and Po-Hsuan Chou, 2011)	Customer actions through comments can be misleading at times, as a single sentence can convey a lot of information.
Hardware data	(Duen-Ren Liu and Ya-Yueh Shih, 2004)	Insufficient to identify similarities in user interests.

3.3 Techniques/ Algorithms used in Recommendation system

Depending on different fields which use the Recommendation system, there are various techniques/ algorithms. **Table 2** will show a detail of the techniques/algorithms used in the Recommendation system which we have collected. Sometimes the authors will combine different techniques / algorithms to create new frameworks that apply to specific areas.

Table 2: Techniques/ Algorithms used in the Recommendation system

Techniques/ Algorithms		Study	Main findings
Clustering Methods	K-means	Michael Steinbach et al., 2000	The results indicate that the bisecting Kmeans technique is better than the standard K-means approach and as good or better than the hierarchical approaches.
		Kim and Ahn, 2008	Suggests a new clustering algorithm, GA K-means. From the standpoint of intraclass inertia, they found that GA K-means could result in better segmentation than other conventional clustering algorithms such as simple K-means and SOM in a real-world case for market segmentation in electronic commerce.
		Yulin Deng and Qianying Gao, 2018	The improved SAPK +K-means algorithm has a low error rate in the clusters obtained from the two data sets. On customer segmentation of e-commerce websites, the SAPK+ K-means algorithm has a better clustering impact.
		Ibrahim et al., 2011	The K-Means clustering-based technique has a considerable impact on the security factor on confidence in mobile commerce websites. This study demonstrates that building a K-means-based model is feasible, adaptive to classifying consumer trust, and beneficial in calculating its degrees.
		Oyelade, O. J et al., 2010	The Euclidean distance as a measure of similarity distance was compared to the predictive capacity of the clustering algorithm using a basic methodology.
		Dhaliwal et al., 2017	Demonstrates how the established two-stage clustering process based on SOM and Kmeans solves the shortcomings of these techniques. Their proposed algorithm not only overcomes SOM and K-means' inherent limitations, but also expands their capabilities by incorporating a fuzzy user distribution.
		Anitha and Patil, 2019	Customer segmentation is examined, and clusters are assessed using Silhouette Analysis for the K-Means clustering algorithm with varying numbers of clusters. The Sales Recency, Sales Frequency, and Sales Monetary may all be examined using the Silhouette Score, and an optimal solution can be discovered.
	Neural Networks	Amit Kumar Jaiswal et al., 2020	Identify the interactive features that can forecast patterns in the movement of the user's mouse across the screen among clusters. This is demonstrated that mouse cursor locations, as well as other attributes like state and timestamps, may be used to strengthen the top ranks of the search results list, as nervous users are more likely to explore the upper portion of the screen.
	Clustering Methods in general	Dr. Mahmoud M. Abd Ellatif, 2007	Suggested an integrated strategy for evaluating the influence of ECRM on customer satisfaction in e-commerce websites, as well as examining the gap between expected and real value that customers assess on quality products on e-commerce websites

		Chih-Lun Liao and Shie-Jue Lee, 2016	A self-constructing clustering algorithm was used to minimize the dimensionality associated with the number of products.
		Gong, 2010	They were able to increase the efficacy of test case prioritization by using a recommender method as they prioritized test cases.
		Choochart Haruechaiyasak et al., 2005	To overcome these two difficulties, a new dynamic recommender system framework was presented. IHAC reduced averaged recommendation time per user by five times, although the Mean Absolute Error (MAE) remained comparable to conventional HAC approaches and a system that did not use any clustering algorithm.
		Ricardo Ferraz Tomaz et al., 2003	Mobile agents are suggested by the ICS architecture. The mobile agent model appears to be adequate for ICS applications.
		Mahadevan, 2011	Examine several clustering approaches that aid in the dynamic maintenance of client profiles.
Combining/ Comparing Methods	Combining/ Hybrid recommendation algorithms	Balabanovic and Shoham, 1997 (Combining Content-Based and Collaborative)	The Fab architecture provides additional benefits, which are enabled by the exploitation of overlaps between users' interests for purposes other than collaborative selection. The architecture of the adapting population of collection agents takes advantage of these overlaps to dynamically converge on topics of interest, allowing for both automated community identification and substantial resource savings as the number of users and documents grows.
		Nenava and Choudhary, 2013 (Inovative K-means Clustering (IKMC), Association rules)	The most common use of found navigation patterns is to reorganize web sites/pages in order to improve them. Customers are recommended products by electronic commerce suppliers using recommender systems.
		Duen-Ren Liu and Ya-Yueh Shih, 2005 (Analytic hierarchy process (AHP), Association rules)	They created a new recommendation method that combines AHP, clustering, and association rule-based methods. Because RFM weights change depending on product and industry parameters, using AHP to evaluate the relative relevance of RFM variables was critical.
		Dixit and Gupta, 2020 (K-means, Association rules)	On the basis of these preferences, users are clustered, and the neighborhood creation work is completed using a collaborative filtering technique based on a user-item category matrix.
	Comparing Pre-filtering and Post-filtering	Markus Zanker and Markus Jessenitschnig, 2008 (Collaborating Filtering Techniques, Association rules, Hybrid recommendation algorithms)	Emphasized precise client needs as a source of customized feedback from users. The project was inspired by the need to personalize the experience of anonymous and first-time travelers.
		Panniello et al., 2009 (Pre-filtering and Post-filtering)	Show that when we want to create less obvious recommendations, the post-filtering strategy performs better than the pre-filtering approach, and that the contextual post-filtering RS performs better than the un-contextual RS.
		Breese et al., 2013 (Correlation coefficients, Vector-based similarity calculations, Bayesian methods)	The results of a large number of studies on the prediction performance of statistical algorithms for collaborative filtering or recommender systems are presented in this study. The results show that Bayesian networks with decision trees at each node and correlation methods outperform Bayesian clustering and vector similarity methods under a variety of conditions.
Others	Collective intelligence	Keonsoo Lee and Seungmin Rho, 2012	Proposing a way for proposing things to a user who is new to the service and whose preferences are unknown due to a lack of purchase history. The proposed method considers the behavior history of existing users with similar profiles to analogize the new user's desire.
	Factor analysis	Karzan Wakil et al., 2019	The findings of this study revealed that including a customer's history into an ecommerce website's recommender system can greatly assist recommender systems in recommending appropriate items that meet the user's wants. Customer activity background can be influenced by factors such as user profile, expert views, neighbors, loyalty, and clickstreams, according to the findings of this report.
		Vahid Mohseni Roudposhti et al., 2018	The most relevant theory for establishing a theoretical foundation for customer intention to purchase in recommender systems was recommended as the TAM theory. The research approach accurately predicts the customer's intention to purchase the advice.
	Singular Value Decomposition (SVD)	Badrul M. Sarwar et al., 2000	Shows that Singular Value Decomposition (SVD) may be such a technology in some cases. In the case of an exceptionally sparse e-commerce dataset, the SVD-based solution consistently performed worse than conventional collaborative filtering.

		Chi-myung Kwon and Seong-yeon Kim, 2007	This research investigates the efficiencies of the classical CF method and SVD-based recommender system for the purpose of producing useful recommendations to customers when large-scale customer-product purchase data are available.
	Weighted RFM (Recency, Frequency, Monetary)-based method.	Shih and Liu, 2008	The collaborative filltering method has been successfully used in a number of applications. This paper combines the CF approach with customer demands derived from commonly purchased goods in each sector to make recommendations.
	Logistic Regression	Ding, 2018	On the validation set, the model with XGBoost and feature engineering performs the best, while the Logistic Regression model does not generate a good prediction. They show that the features used to construct the model are unlikely to be linearly related to the target mark.
	Bayesian methods	Nachiketa Sahoo et al., 2012	The recommendations can be improved by using multiple component ratings.

3.4 Benefits of Recommendation system

Recommender systems have been successfully applied to enhance the quality of service for customers, and more importantly, to increase the sale of products and services in the e-commerce business (Choochart Haruechaiyasak et al., 2005). It was in this industry that recommendation systems became commonly used for the first time. E-commerce companies are ideal for producing reliable suggestions because they have millions of consumers and data on their online actions. Especially, the role of recommender systems is vital in terms of implementing personalized and intelligent services and has great significance in the development of smart e-commerce (Yin Zhang et al., 2019). The implementation of an e-commerce referral system raises the prospect of it focusing on both customer and supplier needs, assisting in the streamlining of business transaction processes and relationship management. In this section, we will cover some of the benefits of the recommendation system after reviewing all the above articles.

Table 3: Benefits of Recommendation system (RS)

Benefits of RS	Description	Related papers
Increased sales/conversion	There are few ways to increase sales without investing more in marketing. When you set up an automated recommendation system, you get recurring additional sales with no effort.	(Amit Kumar Jaiswal et al., 2020), (Dixit and Gupta, 2020), (Panniello et al., 2009), (Badrul M. Sarwar et al., 2000), (Chi-myung Kwon and Seong-yeon Kim, 2007), (Shih and Liu, 2008), (Roung-Shiunn Wu and Po-Hsuan Chou, 2011), (Hye-Jeong Chun and June Wei, 2004), (Huang Duen-Ren Liu and Ya-Yueh Shih, 2004), (Boge et al., 2001), (Huang, 2011), (Atchariyachanvanich and Sonehara, 2008), (Kuzelewska, 2014), (Khansa et al., 2012)
Increased user satisfaction	Since it eliminates their commitment, the shortest path to a transaction benefits both you and the customer. Recommendation systems allow you to shorten your customers' path to a transaction by recommending a better option to them, even before they search for it.	(Sung-Shun Weng and Mei-Ju Liu, 2004), (Anitha and Patil, 2019), (Amit Kumar Jaiswal et al., 2020), (Balabanovic and Shoham, 1997), (Duen-Ren Liu and Ya-Yueh Shih, 2005), (Markus Zanker and Markus Jessenitschnig, 2008), (Panniello et al., 2009), (Breese et al., 2013), (DingHsiao-Fan Wang and Cheng-Ting Wu, 2012), (Zofija Tupikovskaja-Omovie and David Tyler, 2020), (Abd Ellatif and Ramadan, 2010), (Huang, 2011), (Kuzelewska, 2014), (Cho et al., 2014), (Chawla and Joshi, 2017)
Increased customer loyalty	You will improve consumer familiarity with your brand and user experience by having them to spend more time on your website, raising their likelihood of making potential purchases from you.	(Ibrahim et al., 2011), (Yin Zhang et al., 2019), (Jinhua Sun and Yanqi Xie, 2010), (Bai et al., 2020), (Hosseini et al., 2010)
Reduced issues, enabling to solve the problem of cold start	Discounts or coupons are another cost-effective way to re-engage customers, and they can be combined with guidance to increase conversion rates.	(Yulin Deng and Qianying Gao, 2018), (Nenava and Choudhary, 2013), (Victor N. Zakharov and Stanislav A. Philippov, 2017), (Huang Subhash K. Shinde and Uday Kulkarni, 2012), (Kim and Yang, 2005), (Zain et al., 2014)
Increasing of efficiency, reducing costs on business process	Businesses are still looking for ways to improve productivity and cut costs. The recommendation method played a major role in this.	(Oyelade, O. J et al., 2010), (Dhaliwal et al., 2017), (Ricardo Ferraz Tomaz et al., 2003), (MahadevanBreese et al., 2013), (Xinrui Zhang and Hengshan Wang, 2005), (Billsus and PazzaniKhansa et al., 2012)

3.5. Challenges/ Problems in buiding RS

Although this innovative process of recommender systems exhibits high efficiency, there are several great challenges including data sparsity, predictable recommendations, cold start problem, incorporation of content, over specialization problem, hybrid data and scalability to enable humanized services for complex commerce environments and various user demands (Yin Zhang et al., 2019). Due to the lack of optimal knowledge, recommender systems struggle to extract item features and model user interests to suggest appropriate content to users. As a result, to provide a solid

foundation for smart e-commerce, it is important to establish an effective, objective, and reliable recommender system. Besides, web users usually suffer from the information overload problem due to the fact of significantly increasing and rapidly expanding growth in amount of information on the mobile web (Nenava & Choudhary, 2013). According to Kuzelewska (2014), we have a few problems with each of the methods in the recommendation system:

Table 4: Division, methods, and problems in recommender systems

Method	Used algorithms and ideas	Problems
Content-based	• Description of items • Clustering algorithms • Automatic methods of description extraction	• Cold-start problem • Poor scalability
Collaborative filtering	• Other users' past behaviour • The neighborhood of items. Clustering algorithms.	• Sparsity of archive matrix • Cold-start problem • Poor scalability

In the recommendation scheme, there are three problems that are arguably the most important and comprehensive:
Cold-start problem: This issue has to do with making suggestions for new users or new things (Lika et al., 2014). "In case of new users, the system does not have information about their preferences in order to make recommendations" (Lika et al., 2014). This means that user profiles (which are made up of ratings given to things) will be quite brief (Sobhanam & Mariappan, 2013).

Poor scalability: *Scalability*, which is "how quickly a recommender system can generate recommendations" (Ghazanfar & Prugel-Bennett, 2010). The inadequacy of this system to deal with rising users/items and deliver recommendations in a fair response time is one of the fundamental concerns with the in-memory CF technique (Singh, 2020). In general, When more people and things are added to the database, the entire rating database is searched in collaborative filtering, resulting in poor scalability (Kumar & Sharma, 2013).

Sparsity: The "sparsity" challenge is one of the most well-known issues in recommender systems (Sharifi et al., 2014). This problem stems from the fact that each user or object in a large data set has very little knowledge about them. To compensate for the scarcity, users' ratings in dense areas are first estimated, and these estimates are then utilized to estimate other ratings in sparse areas (Z. Zhang, 2014).

4. Conclusion

This literature review used keyword search and cross-references to collect units of analysis and the method of content analysis to review gathered research papers from 1996 to 2020. This paper provided an overview of different fields, techniques used in the Recommendation system, benefits, and challenges when using the Recommendation system in e-commerce. We collected most articles related to clustering algorithms and combinations of machine learning algorithms. The results found that the application of these algorithms significantly improves the accuracy, partially solving the problems that the recommendation system encounters. Through research papers, we have drawn a number of benefits of the suggestion system: Increased sales/conversion, user satisfaction, customer loyalty; Reduced issues, enabling to solve the problem of cold start; Increasing of efficiency and reducing costs on business process. Besides, the suggestion system still has many challenges that need to be improved, such as the Cold-start problem, poor scalability, sparsity. There are several limitations of this paper, including the number of reviewed papers and the level of quantitative content analysis. Therefore, future research can deploy qualitative approaches or combine qualitative and quantitative approaches to gain the best insights into this field of research.

References

Adomavicius, G., & Tuzhilin, A. (2001). Using data mining methods to build customer profiles. *Computer*, *34*(2), 74–82. https://doi.org/10.1109/2.901170

Akter, S., & Wamba, S. F. (2016). Big data analytics in E-commerce: A systematic review and agenda for future research. *Electronic Markets*, *26*(2), 173–194. https://doi.org/10.1007/s12525-016-0219-0

Aminu Da'u, & Naomie Salim. (2021). *Recommendation system based on deep learning methods: A systematic review and new directions | SpringerLink*. https://link.springer.com/article/10.1007%2Fs10462-019-09744-1

Amit Kumar Jaiswal, Prayag Tiwari, & M. Shamim Hossain. (2020). Predicting users' behavior using mouse movement information: An information foraging theory perspective. *Springer-Verlag London Ltd., Part of Springer Nature 2020*.

Anitha, P., & Patil, M. M. (2019). RFM model for customer purchase behavior using K-Means algorithm. *Journal of King Saud University - Computer and Information Sciences*. https://doi.org/10.1016/j.jksuci.2019.12.011

Atchariyachanvanich, K., & Sonehara, N. (2008). Cluster Analysis of E-Commerce Customer Profiles Based on Trust Perception. *2008 International Symposium on Applications and the Internet*, 429–432. https://doi.org/10.1109/SAINT.2008.75

Badrul M. Sarwar, George Karypis, Joseph A. Konstan, & John T. Riedl. (2000). *Application of Dimensionality Reduction in Recommender System—A Case Study*.

Bai, Y., Jia, S., Wang, S., & Tan, B. (2020). Customer Loyalty Improves the Effectiveness of Recommender Systems Based on Complex Network. *Information*, *11*(3), 171. https://doi.org/10.3390/info11030171

Balabanovic, M., & Shoham, Y. (1997). Combining Content-Based and Collaborative Recommendation. *Communications of the ACM*, *40*, 66–72.

Batmaz, Z., Yurekli, A., Bilge, A., & Kaleli, C. (2019). A review on deep learning for recommender systems: Challenges and remedies. *Artificial Intelligence Review*, *52*(1), 1–37. https://doi.org/10.1007/s10462-018-9654-y

Billsus, D., & Pazzani, M. J. (n.d.). *Learning Collaborative Information Filters*. 5.

Breese, J. S., Heckerman, D., & Kadie, C. (2013). *Empirical Analysis of Predictive Algorithms for Collaborative Filtering*. https://arxiv.org/abs/1301.7363v1

Champiri, Z. D., Shahamiri, S. R., & Salim, S. S. B. (2015). A systematic review of scholar context-aware recommender systems. *Expert Systems with Applications*, *42*(3), 1743–1758. https://doi.org/10.1016/j.eswa.2014.09.017

Chawla, D., & Joshi, H. (2017). Consumer perspectives about mobile banking adoption in India – a cluster analysis. *International Journal of Bank Marketing*, *35*(4), 616–636. https://doi.org/10.1108/IJBM-03-2016-0037

Chih-Lun Liao, & Shie-Jue Lee. (2016). *A Clustering Based Approach to Improving the Efficiency of Collaborative Filtering Recommendation*. Electronic Commerce Research and Applications.

Chi-myung Kwon, & Seong-yeon Kim. (2007). *Simulation Study on E-commerce Recommender System Based on a Customer-Product Purchase-Matrix*. Springer-Verlag Berlin Heidelberg.

Cho, Y. S., Moon, S. C., Jeong, S., Oh, I.-B., & Ryu, K. H. (2014). Clustering Method Using Weighted Preference Based on RFM Score for Personalized Recommendation System in u-Commerce. In Y.-S. Jeong, Y.-H. Park, C.-H. (Robert) Hsu, & J. J. (Jong H. Park (Eds.), *Ubiquitous Information Technologies and Applications* (pp. 131–140). Springer. https://doi.org/10.1007/978-3-642-41671-2_18

Choochart Haruechaiyasak, Chatchawal Tipnoe, Sarawoot Kongyoung, Chaianun Damrongrat, & Niran Angkawattanawit. (2005). A dynamic framework for maintaining customer profiles in E-commerce recommender systems. *Research Gate*.

Chun, H. (Ed.). (n.d.). *Development of Interface Feature- Based M-Ticket Framework for Air Travel Industry*.

Deng, Y., & Gao, Q. (2020). A study on e-commerce customer segmentation management based on improved K-means algorithm. *Information Systems and E-Business Management*, *18*(4), 497–510. https://doi.org/10.1007/s10257-018-0381-3

Deuk Hee Park, Hyea Kyeong Kim, Il Young Choi, & Jae Kyeong Kim. (2012). A literature review and classification of recommender systems research. *Expert Systems with Applicatons*, *39*, 10059–10072.

Dhaliwal, S., Van, N. N., Dhaliwal, M., Rokne, J., Alhajj, R., & Özyer, T. (2017). Integrating SOM and fuzzy k-means clustering for customer classification in personalized recommendation system for non-text based transactional data. *2017 8th International Conference on Information Technology (ICIT)*, 901–908. https://doi.org/10.1109/ICITECH.2017.8079966

digitalcommerce360.com. (2021, February 15). *Ecommerce trends amid coronavirus pandemic in charts*. Digital Commerce 360. https://www.digitalcommerce360.com/2021/02/15/ecommerce-during-coronavirus-pandemic-in-charts/

Ding, Y. (n.d.). *Post-Click Conversion Rate Predictive Model on E-commerce Recommender System*. Retrieved January 7, 2021, from https://core.ac.uk/reader/210609030

Dixit, V. S., & Gupta, S. (2020). Personalized Recommender Agent for E-Commerce Products Based on Data Mining Techniques. In S. M. Thampi, L. Trajkovic, S. Mitra, P. Nagabhushan, J. Mukhopadhyay, J. M. Corchado, S. Berretti, & D. Mishra (Eds.), *Intelligent Systems, Technologies and Applications* (pp. 77–90). Springer. https://doi.org/10.1007/978-981-13-6095-4_6

Dr.Mahmoud M. Abd Ellatif. (2007). *A Cluster Technique to Evaluate Effect of ECRM on Customers' Satisfaction of E- commerce websites*.

Duen-Ren Liu, & Ya-Yueh Shih. (2005). Integrating AHP and data mining for product recommendation based on customer lifetime value. *Information & Management*, *42*, 387–400.

Ellatif, A., & Mohamed, D. M. (2007). *A Cluster Technique to Evaluate Effect of ECRM on Customers' Satisfaction of E-Commerce Websites* (SSRN Scholarly Paper ID 1128802). Social Science Research Network. https://doi.org/10.2139/ssrn.1128802

Ester, M., Kriegel, H.-P., Sander, J., & Xu, X. (1996, January 1). *A Density-Based Algorithm for Discovering Clusters in Large Spatial Databases with Noise*. KDD. https://openreview.net/forum?id=BJWbENb_bB

Gatzioura, A., & Sànchez-Marrè, M. (2015). A Case-Based Recommendation Approach for Market Basket Data. *IEEE Intelligent Systems*, *30*(1), 20–27. https://doi.org/10.1109/MIS.2014.57

George, G., & Lal, A. M. (2019). Review of ontology-based recommender systems in e-learning. *Computers & Education*, *142*, 103642. https://doi.org/10.1016/j.compedu.2019.103642

Ghazanfar, M. A., & Prugel-Bennett, A. (2010). A Scalable, Accurate Hybrid Recommender System. *2010 Third International Conference on Knowledge Discovery and Data Mining*, 94–98. https://doi.org/10.1109/WKDD.2010.117

Gong, S. (2010). A Collaborative Filtering Recommendation Algorithm Based on User Clustering and Item Clustering. *Journal of Software*, *5*(7), 745–752. https://doi.org/10.4304/jsw.5.7.745-752

grandviewresearch.com. (2020). *E-commerce Market Share, Growth & Trends Report, 2020-2027*. https://www.grandviewresearch.com/industry-analysis/e-commerce-market

Guan, C., Qin, S., Ling, W., & Ding, G. (2016). Apparel recommendation system evolution: An empirical review. *International Journal of Clothing Science and Technology*, *28*(6), 854–879. https://doi.org/10.1108/IJCST-09-2015-0100

Haruechaiyasak, C., Tipnoe, C., Kongyoung, S., Damrongrat, C., & Angkawattanawit, N. (2005). A dynamic framework for maintaining customer profiles in e-commerce recommender systems. *2005 IEEE International Conference on E-Technology, e-Commerce and e-Service*, 768–771. https://doi.org/10.1109/EEE.2005.8

Hosseini, S. M. S., Maleki, A., & Gholamian, M. R. (2010). Cluster analysis using data mining approach to develop CRM methodology to assess the customer loyalty. *Expert Systems with Applications*, *37*(7), 5259–5264. https://doi.org/10.1016/j.eswa.2009.12.070

Huang, S. (2011). Designing utility-based recommender systems for e-commerce: Evaluation of preference-elicitation methods. *Electronic Commerce Research and Applications*, *10*(4), 398–407. https://doi.org/10.1016/j.elerap.2010.11.003

Huang, Z., Chung, W., & Chen, H. (2004). A graph model for E-commerce recommender systems. *Journal of the American Society for Information Science and Technology*, *55*(3), 259–274. https://doi.org/10.1002/asi.10372

Ibrahim, O., Nilashi, M., Bagherifard, K., Hashemi, N., Janahmadi, N., & Barisami, M. (2011). *Application of AHP and K-Means Clustering for Ranking and Classifying Customer Trust in M-commerce*. Undefined. /paper/Application-of-AHP-and-K-Means-Clustering-for-and-Ibrahim-Nilashi/7a7c0eb13c9e2ebbc2fd29a5aabd438cf29055cb

Jaiswal, A. K., Tiwari, P., & Hossain, M. S. (2020). Predicting users' behavior using mouse movement information: An information foraging theory perspective. *Neural Computing and Applications*. https://doi.org/10.1007/s00521-020-05306-7

Karlgren, J. (1990). *An algebra for recommendations: Using reader data as a basis for measuring document proximity*. Department of Computer and Systems Sciences, Stockholm University. http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-187752

Karzan Wakil, Fatemeh Alyari, Mahdi Ghasvari, Zahra Lesani, & Lila Rajabion. (2019). A new model for assessing the role of customer behavior history, product classification, and prices on the success of the recommender systems in e-commerce. *Emerald Insight*.

Keonsoo Lee, & Seungmin Rho. (n.d.). A Method of Generating Customer's Profile without History for Providing Recommendation to New Customers in E-Commerce. *Springer Science+Business Media Dordrecht*, 2012.

Khansa, L., Zobel, C. W., & Goicochea, G. (2012). Creating a Taxonomy for Mobile Commerce Innovations Using Social Network and Cluster Analyses. *International Journal of Electronic Commerce*, *16*(4), 19–52. https://doi.org/10.2753/JEC1086-4415160402

Kim, K., & Ahn, H. (2008). A recommender system using GA K-means clustering in an online shopping market. *Expert Systems with Applications*, *34*(2), 1200–1209. https://doi.org/10.1016/j.eswa.2006.12.025

Kim, T.-H., & Yang, S.-B. (2005). An Effective Recommendation Algorithm for Clustering-Based Recommender Systems. In S. Zhang & R. Jarvis (Eds.), *AI 2005: Advances in Artificial Intelligence* (pp. 1150–1153). Springer. https://doi.org/10.1007/11589990_159

Kourouthanassis, P., & Giaglis, G. (2012). Introduction to the Special Issue Mobile Commerce: The Past, Present, and Future of Mobile Commerce Research. *International Journal of Electronic Commerce*, *16*, 5–18. https://doi.org/10.2753/JEC1086-4415160401

Krippendorff, K. (2018). *Content Analysis: An Introduction to Its Methodology*. SAGE Publications.

Kumar, A., & Sharma, A. (2013). Alleviating Sparsity and Scalability Issues in Collaborative Filtering Based Recommender Systems. In S. C. Satapathy, S. K. Udgata, & B. N. Biswal (Eds.), *Proceedings of the International Conference on Frontiers of Intelligent Computing: Theory and Applications (FICTA)* (pp. 103–112). Springer. https://doi.org/10.1007/978-3-642-35314-7_13

Kuzelewska, U. (2014). Clustering Algorithms in Hybrid Recommender System on MovieLens Data. *Studies in Logic, Grammar and Rhetoric*, *37*(1), 125–139. https://doi.org/10.2478/slgr-2014-0021

Kwon, C., & Kim, S. (2007). Simulation Study on E-commerce Recommender System Based on a Customer-Product Purchase-Matrix. In J.-W. Park, T.-G. Kim, & Y.-B. Kim (Eds.), *AsiaSim 2007* (pp. 327–336). Springer. https://doi.org/10.1007/978-3-540-77600-0_35

Lee, K., & Rho, S. (2012). A Method of Generating Customer's Profile without History for Providing Recommendation to New Customers in E-Commerce. In J. J. (Jong H. Park, V. C. M. Leung, C.-L. Wang, & T. Shon (Eds.), *Future Information Technology, Application, and Service* (pp. 83–88). Springer Netherlands. https://doi.org/10.1007/978-94-007-5064-7_12

Liao, C.-L., & Lee, S.-J. (2016). A clustering based approach to improving the efficiency of collaborative filtering recommendation. *Electronic Commerce Research and Applications*, *18*, 1–9. https://doi.org/10.1016/j.elerap.2016.05.001

Lika, B., Kolomvatsos, K., & Hadjiefthymiades, S. (2014). Facing the cold start problem in recommender systems. *Expert Systems with Applications*, *41*(4, Part 2), 2065–2073. https://doi.org/10.1016/j.eswa.2013.09.005

Liu, D.-R., & Shih, Y.-Y. (2005a). Integrating AHP and data mining for product recommendation based on customer lifetime value. *Information & Management*, *42*(3), 387–400. https://doi.org/10.1016/j.im.2004.01.008

Liu, D.-R., & Shih, Y.-Y. (2005b). Hybrid approaches to product recommendation based on customer lifetime value and purchase preferences. *Journal of Systems and Software*, *77*(2), 181–191. https://doi.org/10.1016/j.jss.2004.08.031

Lu, J., Wu, D., Mao, M., Wang, W., & Zhang, G. (2015). Recommender system application developments: A survey. *Decision Support Systems*, *74*, 12–32. https://doi.org/10.1016/j.dss.2015.03.008

Mahadevan, D. (n.d.). *A Study on Clustering Techniques in Recommender Systems*. Retrieved January 7, 2021, from /paper/A-Study-on-Clustering-Techniques-in-Recommender-Mahadevan/a97d7ee19a6e49d34c85bfef185ce2fcdb26799a

Markus Zanker, & Markus Jessenitschnig. (2008). Case-studies on exploiting explicit customer requirements in recommender systems. *Springer*, *19*, 133–166.

Michael Steinbach, George Karypis, & Vipin Kumar. (n.d.). *A Comparison of Document Clustering Techniques*.

Moital, M., Vaughan, R., & Edwards, J. (2009). Using involvement for segmenting the adoption of e-commerce in travel. *The Service Industries Journal*, *29*(5), 723–739. https://doi.org/10.1080/02642060902720253

Murad, D. F., Heryadi, Y., Wijanarko, B. D., Isa, S. M., & Budiharto, W. (2018). Recommendation System for Smart LMS Using Machine Learning: A Literature Review. *2018 International Conference on Computing, Engineering, and Design (ICCED)*, 113–118. https://doi.org/10.1109/ICCED.2018.00031

Nabizadeh, A. H., Rafsanjani, N., Salim, N., Rezaei Aghdam, A., & Fard, K. (2013). *Recommendation Systems: A review*.

Najafabadi, M. K., & Mahrin, M. N. (2016). A systematic literature review on the state of research and practice of collaborative filtering technique and implicit feedback. *Artificial Intelligence Review*, *45*(2), 167–201. https://doi.org/10.1007/s10462-015-9443-9

Nenava, S., & Choudhary, V. (2013). *Hybrid personalized recommendation approach for improving mobile e-commerce*. /paper/HYBRID-PERSONALIZED-RECOMMENDATION-APPROACH-FOR-Nenava-Choudhary/1320a632ea9a476e2eea821497eaca680c8a5e04

oecd.org. (2020). *E-commerce in the time of COVID-19*. OECD. https://www.oecd.org/coronavirus/policy-responses/e-commerce-in-the-time-of-covid-19-3a2b78e8/#section-d1e109

Oyelade, O. J, Oladipupo, O. O, & Obagbuwa, I. C. (2010). *Application of k-Means Clustering algorithm for prediction of Students' Academic Performance*. International Journal of Computer Science and Information Security, Vol. 7, No 1, 2010.

Oyelade, O. J., Oladipupo, O. O., & Obagbuwa, I. C. (2010). Application of k Means Clustering algorithm for prediction of Students Academic Performance. *ArXiv:1002.2425 [Cs]*. http://arxiv.org/abs/1002.2425

Panniello, U., Gorgoglione, M., & Palmisano, C. (2009). Comparing Pre-filtering and Post-filtering Approach in a Collaborative Contextual Recommender System: An Application to E-Commerce. In T. Di Noia & F. Buccafurri (Eds.), *E-Commerce and Web Technologies* (pp. 348–359). Springer. https://doi.org/10.1007/978-3-642-03964-5_32

Parveen, H., & Showkat, N. (2017). *Content Analysis* (p. 8).

Portugal, I., Alencar, P., & Cowan, D. (2018). The use of machine learning algorithms in recommender systems: A systematic review. *Expert Systems with Applications*, *97*, 205–227. https://doi.org/10.1016/j.eswa.2017.12.020

Qi Zhang, Jiawen Wang, Haoran Huang, Xuanjing Huang, & Yeyun Gong. (2016). *Hashtag Recommendation for Multimodal Microblog Using Co-Attention Network*.

Qilong Ba, Xiaoyong Li, & Zhongying Bai. (2013). Clustering collaborative filtering recommendation system based on SVD algorithm. *2013 IEEE 4th International Conference on Software Engineering and Service Science*, 963–967. https://doi.org/10.1109/ICSESS.2013.6615466

Raman, S. (2000). E-commerce and globalization yesterday, today, and tomorrow. *Proceedings of the 2000 IEEE Engineering Management Society. EMS - 2000 (Cat. No.00CH37139)*, 249–254. https://doi.org/10.1109/EMS.2000.872510

Ricardo Ferraz Tomaz, Sofiane Labidi, & BernardoWanghon. (2003). *A Semantic Matching Method for Clustering Traders in B2B Systems*. IEEE.

Ricci, F., Rokach, L., & Shapira, B. (2011). Introduction to Recommender Systems Handbook. In F. Ricci, L. Rokach, B. Shapira, & P. B. Kantor (Eds.), *Recommender Systems Handbook* (pp. 1–35). Springer US. https://doi.org/10.1007/978-0-387-85820-3_1

Roudposhti, V., Nilashi, M., Mardani, A., Streimikiene, D., Samad, S., & Ibrahim, O. (2018). A new model for customer purchase intention in e-commerce recommendation agents. *Journal of International Studies*, *11*(4), 237–253. https://doi.org/10.14254/2071-8330.2018/11-4/17

Sahoo, N., Krishnan, R., Duncan, G., & Callan, J. (2011). Research Note—The Halo Effect in Multicomponent Ratings and Its Implications for Recommender Systems: The Case of Yahoo! Movies. *Information Systems Research*. https://pubsonline.informs.org/doi/abs/10.1287/isre.1100.0336

Sarkar, D. (2012). *A Noble Approach of Clustering the Users in M-Commerce for Providing Segmented Promotion of Goods & Services Using K-means Algorithm*.

Sarwar, B., Karypis, G., Konstan, J., & Riedl, J. (2000a). *Application of Dimensionality Reduction in Recommender System—A Case Study*. MINNESOTA UNIV MINNEAPOLIS DEPT OF COMPUTER SCIENCE. https://apps.dtic.mil/sti/citations/ADA439541

Sarwar, B., Karypis, G., Konstan, J., & Riedl, J. (2000b). Analysis of recommendation algorithms for e-commerce. *Proceedings of the 2nd ACM Conference on Electronic Commerce*, 158–167. https://doi.org/10.1145/352871.352887

Schafer, B., Konstan, J., & Riedl, J. (2000). *E-Commerce Recommendation Applications*. *5*. https://doi.org/10.1023/A:1009804230409

Schering, A.-C., Dueffer, M., Finger, A., & Bruder, I. (2009). A mobile tourist assistance and recommendation system based on complex networks. *Proceedings of the 1st ACM International Workshop on Complex Networks Meet Information & Knowledge Management*, 81–84. https://doi.org/10.1145/1651274.1651290

Shahriari, S., Mohammadreza, S., & Gheiji, S. (2015). E-commerce and it impactson global trend and market. *International Journal of Research - GRANTHAALAYAH*, *3*(4), 49–55. https://doi.org/10.29121/granthaalayah.v3.i4.2015.3022

Shardanand, U., & Maes, P. (1995). *Social Information Filtering: Algorithms for Automating "Word of Mouth."* 210–217.

Sharifi, Z., Rezghi, M., & Nasiri, M. (2014). A new algorithm for solving data sparsity problem based-on Non negative matrix factorization in recommender systems. *2014 4th International Conference on Computer and Knowledge Engineering (ICCKE)*, 56–61. https://doi.org/10.1109/ICCKE.2014.6993356

Shih, Y.-Y., & Liu, D.-R. (2008). Product recommendation approaches: Collaborative filtering via customer lifetime value and customer demands. *Expert Systems with Applications*, *35*(1), 350–360. https://doi.org/10.1016/j.eswa.2007.07.055

Shinde, S. K., & Kulkarni, U. (2012). Hybrid personalized recommender system using centering-bunching based clustering algorithm. *Expert Systems with Applications*, *39*(1), 1381–1387. https://doi.org/10.1016/j.eswa.2011.08.020

Singh, M. (2020). Scalability and sparsity issues in recommender datasets: A survey. *Knowledge and Information Systems*, *62*(1), 1–43. https://doi.org/10.1007/s10115-018-1254-2

Sivapalan, S., Sadeghian, A., Rahnama, H., & Madni, A. M. (2014). Recommender systems in e-commerce. *2014 World Automation Congress (WAC)*, 179–184. https://doi.org/10.1109/WAC.2014.6935763

Sobhanam, H., & Mariappan, A. K. (2013). Addressing cold start problem in recommender systems using association rules and clustering technique. *2013 International Conference on Computer Communication and Informatics*, 1–5. https://doi.org/10.1109/ICCCI.2013.6466121

Steinbach, M., Karypis, G., & Kumar, V. (2000). A Comparison of Document Clustering Techniques. *Proceedings of the International KDD Workshop on Text Mining*.

Sun, J., & Xie, Y. (2009). A Web Data Mining Framework for E-Commerce Recommender Systems. *2009 International Conference on Computational Intelligence and Software Engineering*, 1–4. https://doi.org/10.1109/CISE.2009.5363548

Sung-Shun Weng & Mei-Ju Liu. (2004). Personalized product recommendation in e-commerce. *IEEE International Conference on E-Technology, e-Commerce and e-Service, 2004. EEE '04. 2004*, 413–420. https://doi.org/10.1109/EEE.2004.1287340

Tarus, J. K., Niu, Z., & Mustafa, G. (2018). Knowledge-based recommendation: A review of ontology-based recommender systems for e-learning. *Artificial Intelligence Review*, *50*(1), 21–48. https://doi.org/10.1007/s10462-017-9539-5

Tomaz, R. F., Labidi, S., & Wanghon, B. (2003). A semantic matching method for clustering traders in B2B systems. *Proceedings of the IEEE/LEOS 3rd International Conference on Numerical Simulation of Semiconductor Optoelectronic Devices (IEEE Cat. No.03EX726)*, 144–153. https://doi.org/10.1109/LAWEB.2003.1250292

Tupikovskaja-Omovie, Z., & Tyler, D. (2020). Clustering consumers' shopping journeys: Eye tracking fashion m-retail. *Journal of Fashion Marketing and Management: An International Journal*, *24*(3), 381–398. https://doi.org/10.1108/JFMM-09-2019-0195

Vahid Mohseni Roudposhti, Mehrbakhsh Nilashi, Abbas Mardani, Dalia Streimikiene, Sarminah Samad, & Othman Ibrahim. (2018). A new model for customer purchase intention in e-commerce recommendation agents. *Journal of International Studies*, *11*(4), 237–253.

Wakil, K., Alyari, F., Ghasvari, M., Lesani, Z., & Rajabion, L. (2019). A new model for assessing the role of customer behavior history, product classification, and prices on the success of the recommender systems in e-commerce. *Kybernetes*, *49*(5), 1325–1346. https://doi.org/10.1108/K-03-2019-0199

Wang, H.-F., & Wu, C.-T. (2012). A strategy-oriented operation module for recommender systems in E-commerce. *Computers & Operations Research*, *39*(8), 1837–1849. https://doi.org/10.1016/j.cor.2010.03.011

Wayne Xin Zhao, Yanwei Guo, Yulan He, Han Jiang, Yuexin Wu, & Xiaoming Li. (n.d.). We know what you want to buy | Proceedings of the 20th ACM SIGKDD international conference on Knowledge discovery and data mining. *Association for Computing Machinery*. Retrieved January 7, 2021, from https://dl.acm.org/doi/abs/10.1145/2623330.2623351

Wei, K., Huang, J., & Fu, S. (2007). A Survey of E-Commerce Recommender Systems. *2007 International Conference on Service Systems and Service Management*, 1–5. https://doi.org/10.1109/ICSSSM.2007.4280214

Wu, R.-S., & Chou, P.-H. (2011). Customer segmentation of multiple category data in e-commerce using a soft-clustering approach. *Electronic Commerce Research and Applications*, *10*(3), 331–341. https://doi.org/10.1016/j.elerap.2010.11.002

Yin Zhang, Haider Abbas, & Yi Sun. (2019). *Smart e-commerce integration with recommender systems*. Institute of Applied Informatics at University of Leipzig 2019.

Yulin Deng, & Qianying Gao. (2018). *A study on e-commerce customer segmentation management based on improved K-means algorithm*. Springer Nature.

Zain, T., Aslam, M., Imran, M. R., & Martinez-Enriquez, A. M. (2014). Cloud service recommender system using clustering. *2014 11th International Conference on Electrical Engineering, Computing Science and Automatic Control (CCE)*, 1–6. https://doi.org/10.1109/ICEEE.2014.6978334

Zakharov, V. N., & Philippov, S. A. (2017). Clustering of Goods and User Profiles for Personalizing in E-commerce Recommender Systems Based on Real Implicit Data. In L. Kalinichenko, S. O. Kuznetsov, & Y. Manolopoulos (Eds.), *Data Analytics and Management in Data Intensive Domains* (pp. 178–191). Springer International Publishing. https://doi.org/10.1007/978-3-319-57135-5_13

Zanker, M., & Jessenitschnig, M. (2009). Case-studies on exploiting explicit customer requirements in recommender systems. *User Modeling and User-Adapted Interaction*, *19*(1), 133–166. https://doi.org/10.1007/s11257-008-9048-y

Zenebe, A., Ozok, A., & Norcio, A. F. (2021). *Personalized recommender systems in e-commerce and m-commerce: A comparative study*.

Zhang, H., Chai, J., Wang, Y., An, M., Li, B., & Shen, Q. (2015). Application of clustering algorithm on TV programmes preference grouping of subscribers. *2015 IEEE International Conference on Computer and Communications (ICCC)*, 40–44. https://doi.org/10.1109/CompComm.2015.7387537

Zhang, X., & Wang, H. (2015). Study on Recommender Systems for Business-To-Business Electronic Commerce. *Communications of the IIMA*, *5*(4). https://scholarworks.lib.csusb.edu/ciima/vol5/iss4/8

Zhang, Y., Abbas, H., & Sun, Y. (2019). Smart e-commerce integration with recommender systems. *Electronic Markets*, *29*(2), 219–220. https://doi.org/10.1007/s12525-019-00346-x

Zhang, Z. (2014). Sparsity, robustness, and diversification of Recommender Systems. *Undefined*. /paper/Sparsity%2C-robustness%2C-and-diversification-of-Zhang/f2a36f06c026acfaf4980444940ffb3d0d24168e

Zheng, Q., Han, Y., Li, S., Dong, J., Yan, L., & Qin, J. (2009). E-commerce Case Analysis. In Q. Zheng (Ed.), *Introduction to E-commerce* (pp. 458–517). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-49645-8_13

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