Recommender Systems:
The Importance of Personalization in E-Business Environments

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ABSTRACT

Due to the rapid growth of the internet in conjunction with the information overload problem the use of recommender systems has started to become necessary for both e-businesses and customers. However there are other factors such as privacy and trust that make customers suspicious. This paper gives an overview of recommendation systems, the benefits that both the business and the customers have and an explanation of the challenges, which if faced can make the personalization process better for both parties. Moreover an outline of current studies is given along with an overview of Amazon's recommendations in order to clarify that the use of recommender systems is beneficial for an e-business in many ways and also for a valuable customer of such business.

Keywords: *E-Business, E-Commerce, Personalization, Recommender Systems, Social-Media, Website*

INTRODUCTION

The evolution of computers in combination with the rapid development of related networking infrastructures has brought e-commerce to a new level. The use of the Internet is moving forward and the need for e-commerce is becoming more wide and in different ways (Jannach et al., 2010). However as the information on the internet grows and the people who use these devices become larger there is a need to face the challenges that are tight related to these environments. The need to face the information overload is the most important nowadays and directs us to the use of recommendation technologies (Konstan & Riedl, 2012).

Recommender systems are concerned with the dynamic customization of data received over the World Wide Web and are based on user preferences (Ricci et al., 2011). The scope of the recommendations is to assist the user to decide what to buy, who to make friend to a social network or what news to read (Konstan & Riedl, 2012; Polatidis & Georgiadis, 2013, Prasad & Kumari 2012). Due to information overload on the internet, personalization systems are one of

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the most valuable tools nowadays. Additionally it should be noted that it is a very demanding process to design and develop such a system, since it combines knowledge and skills from different computer science fields (Konstan & Riedl, 2012; Ricci, 2011). Despite of that, a number of well-respected methods have been developed the past few years, with some of them being used in commercial environments. Moreover, in mobile devices the information access problem becomes even harder because of the difficulties found due to hardware limitations.

It is important to note that the algorithms applied to web based systems cannot be transferred directly to a mobile device, since there are different needs, characteristics and limitations. The needs are about location-based services found mainly in tourism and mobile financial services. Characteristics refer to the user interface, processing power, memory capabilities and limitations, which are about the network boundaries found in the Global System for Mobile Communications (GSM), Wi-Fi and the Global Positioning System (GPS). However the advantages are more important and include the ubiquity and the location-based service, which are crucial factors that mobile recommender systems are based (Ricci, 2011).

Furthermore the need for privacy has become a very important aspect of personalization techniques (Kobsa, 2007; Shyong et al., 2006; Benats et al., 2011; Jeckmans et al., 2013). It is vital for the system to use some private data in order to provide accurate recommendations. However it should be taken into consideration that privacy is a massive problem with negativity towards the use of recommenders in personalized environments (Jeckmans et al., 2013; Polatidis & Georgiadis, 2013). Most of the time simple users are not aware how e-commerce organizations use these data and they react in various destructive ways. We have reached a point that merchants want to improve their service and use unfair practices. However, there is a reconciliation point that could be reached if both parties are willing to work towards this road.

The research is aims to show that personalized systems can improve the user experience. However, in mobile environments attributes such as location and time should be embedded to such algorithms but on the other hand there are privacy concerns that have to be taken into consideration (Ricci, 2011).

Additionally, there are still open questions that need extensive research to be answered. These include further investigation on business related aspects of recommender system, including financial gains of e-businesses and limitation of search costs. In addition other e-commerce goals should be explored in mobile environments. These include the goals of mobile recommender systems and the expectations of the users such as implications associated with the location-based parameter and if this should be compulsory or enforced only when questioned. Also, it is not clear if there is a mobile domain or there are a number of e-commerce scenarios that are more suitable to mobile devices such as tourism, mobile banking and personalized advertising. However these questions are still open, because recommender systems are a relatively new field of study found in the literature and the lack of surveys and results is obvious (Konstan & Riedl, 2012).

THE IMPORTANCE OF RECOMMENDER SYSTEMS FOR E-BUSINESSES

Recommender systems are computer algorithms used widely in e-commerce to suggest items to a user. The recommendations are about what items to buy, news reading, social networking connections and what movies to rent among many others. Among the most popular websites that use recommender systems is Amazon.com, which provides a personalized web page to each individual user. Netflix is another example website that uses recommender systems to suggest movies and TV shows. Such systems in general suggest a list with top N items relevant to the user. The items are retrieved according to rules

set by the algorithm and suggest the topmost from the list, depending on the interface. Recommender systems were developed to make daily decisions simpler. These decisions are mostly about low cost environments such as book and movie suggestions, with their primary scope being to relief the user from long searches (Jannach et al., 2010; Ricci et al., 2011).

Although recommender systems are a relatively new field of study in the literature its techniques are widely adopted and solve well to a level the information overload problem (Oulasvirta et al., 2012). Recommender systems are usually found in electronic commerce environments. These environments have changed rapidly within the last few years due to the growth of the internet due to the fact that there is too much information to handle and the users are often frustrated. Recommender systems have emerged because of the two aforementioned factors. Moreover the constant growth of the wireless networks and the development of mobile devices and environments have brought new terms in our lives. E-commerce, M-commerce and recommender systems are some of these new terms and are introduced below.

E-commerce or else known as electronic commerce, is the new way of doing business over the internet. It is concerned with the transactions made over the internet and involves different types of business conducted such as buying, selling, online banking, bill payments, job seeking and offering, new reading, social networking, travel services, auctions and real estate among many others. E-commerce has many benefits to both the organizations and customers. The most important benefits include making business at any time and from any possible place and financial gaining for both the business, which reduces the cost and the customer who buys cheaper. E-commerce systems employ recommender systems widely to improve sales (Ricci, 2011; Polatidis & Georgiadis, 2013).

M-commerce or else known as mobile commerce, is a new way of e-commerce done in a mobile device using a wireless network. A common example is using a smartphone or a tablet to access the internet over a Wi-Fi network. Types of commerce over mobile devices include mobile banking, content purchase, news reading, auctions and location-based services mainly used for tourism purposes (Ricci, 2011, Polatidis & Georgiadis, 2013). M-commerce technologies widely use recommender systems as well, but customized to its needs.

Furthermore, the use of recommender systems is essential for the service providers and not only the users (Polatidis & Georgiadis, 2013; Karimov & Brengman, 2011). The reasons that e-businesses use such systems are (Polatidis & Georgiadis, 2013):

1. **Increase Sales:** The most important reason for a commerce vendor to use a recommendation technology is to increase its sales and revenue. This is accomplished because the recommender usually suggests items that are relevant to the user, according to his history and preferences;
2. **Employ diversity of items:** A recommender system would usually suggest items from a large range that otherwise the user would be very difficult to find. Therefore the algorithm will suggest different items, increase the sales of items that otherwise would be challenging to sell and increase the total sales and profit;
3. **Increase user satisfaction:** The user is more satisfied by the overall service offered and it is likely to suggest it to others;
4. **Increase loyalty:** It is more likely for a user to revisit a site or reuse a mobile application if he is satisfied with the quality and treat.

According to Hinz (Hinz & Eckert, 2010) the two most important things for an e-business that uses recommender systems are:

1. Decreased search costs
2. Higher sales

Therefore it is clear at this stage that businesses that want to be innovative, increase their sales and be more trusted to the customer should be more personalized. In the internet era and with personal computers being everywhere the need for e-commerce and recommender technologies is essential. Likewise, smartphones and tablets use the same technologies in their respective environments with extra parameters taken into consideration. Such parameters include location, time and screen limitations. The information overload is so high nowadays, that recommender systems are necessary in almost every aspect of mobile devices. Furthermore, examples of recommendations include mobile commerce, news reading and finding related services, such as hotels or other tourism related information. Additionally, the personalization of the operating system itself has been taken into consideration (Davidson & Livshits 2012). Moreover mobile devices have progressed so fast that tend to become the primary source of access to social networks (Jabeur et al., 2013; Oulasvirta et al., 2012). Users who want instant access, from everywhere and not use a computer to do that, tend to use a mobile device such as a smartphone or tablet (Jabeur et al,. 2013; Oulasvirta et al,. 2012). The network communication facilities such as the cellular, Wi-Fi and GPS have aided towards this direction.

Studies by Karimov (Karimov & Brengman, 2011) recommender systems can bring gain to an e-business. However the same scholar found that only 1.4% of 210 top revenue websites used recommender systems, which is disappointing. To become more particular personalization gives the option to an electronic vendor to automatically interact with potential customers and offer them a variety of services, thus driving customer satisfaction higher (Riemer & Totz, 2001). However it should be noted that personalization and recommendation options vary between the type of products or services offered by the vendor.

Social media is a serious factor in e-businesses and that top websites try to develop a social presence by creating networks in networks such as Facebook and twitter. According to Karimov and Brengman (2011) Facebook is the most used social network for creating a presence followed by twitter. Although it might seem challenging, data from social networks should and can be integrated into recommender systems in order to improve recommendations, user satisfaction and trust to an e-business. It has been shown that when recommender systems are used then the customer trust towards an e-retailer is higher (Qiu & Benbasat, 2009; Wang & Benbasat 2007). Ochi et al. (2010) presented that recommendations have changed direction from user characteristics and history to social based recommendations; however we suggest that a hybrid algorithm that combines content-based, collaborative-based, knowledge-based and social media data and has the ability to change between, according to the current situation would be the most sufficient option.

Recommendation Algorithms

Below we give a description of collaborative, content and knowledge based algorithms. These are the most used algorithms nowadays in the field of recommender systems and the way that e-businesses gain value and trust.

In collaborative systems the basic idea is to find which users share the same interests with you in the past. The main idea of these systems is that the users, who had a taste similar to you, likely will have the same taste in the future. Pure collaborative techniques take a user-input matrix with ratings as the only input and generate a prediction value indicating similarities to other users (Jannach et al., 2010, Prasad & Kumari 2012).

Table 1 represents a ratings database for Alice and four other users.

A number of similarity methods exist such as the cosine-based similarity and the adjusted cosine similarity. Also the Pearson correlation based similarity has been widely used. Each method returns a number from-to, like-dislike value.

Content based recommenders are somewhat simpler to implement, since they are based on metadata of the actual data. This metadata

Table 1. A ratings database (source: Recommender Systems - An Introduction)

Users	Item1	Item2	Item3	Item4	Item5
Alice	5	3	4	4	Null
User1	3	1	2	3	3
User2	4	3	4	3	5
User3	3	3	1	5	4
User4	1	5	5	2	1

can be some technical description of an item, the genre of a movie, the title, type, author or other defined set of keywords. This is done by maintaining a list of attributes and searching within the list. Content based recommendation is a durable technique and the database is constantly updated with user preferences (Jannach et al., 2010, Prasad & Kumari 2012). Moreover content based is used in systems like news filtering and information retrieval. Furthermore systems like that, are used when there are not enough ratings to perform a collaborative based approach

In practice most systems are based in collaborative filtering methods, a technique which is based on other user ratings only. On the other hand, content based approaches use metadata information, such as movie categories or keywords. The main benefit of these methods is the low cost to acquire the data from the users. However there are many circumstances that these methods are not sufficient. Collaborative and content based methods usually perform well in low cost environments such as books and movies, where other users provide ratings and information more often. In other situations such as buying a personal computer or a digital camera a knowledge based algorithm shall be used.

As it is distinct by its name, knowledge based systems rely on data provided by the user and use them as constraints in order to provide recommendations.

Table 2 describes the characteristics of a dataset about digital cameras as found in the database of a system. The user can then add specific rules to the system in order to receive personalized recommendations.

Consider the following example described using logic rules:

Price < = 150 ^ Mega Pixels > = 10
^ Quality > = Medium

The system will list all cameras with their price being lesser than or equal to 150 and their mega pixels greater than or equal to 10 and their quality being at least medium. In this case camera4 will be listed since it is the only one satisfying the conditions.

Table 2. Example digital camera characteristics (source: Recommender Systems - An Introduction)

Name	Price	Mega Pixels	Zoom	Screen Size	Quality
Camera1	100	6	2x	2cm	Low
Camera2	119	8	2x	2.5cm	Medium
Camera3	200	12	4x	3cm	High
Camera4	150	10	3x	3cm	Medium
Camera5	140	8	4x	2.7cm	Medium

Finally social media recommenders instead, use data retrieved from social networks such as Facebook. However at the moment further research is necessary to make clear what data to use, how to use them and how to avoid spam data. We can say that in future possibly recommendation algorithms will be highly based on social data and that new entrepreneurs should consider investing in such systems. Furthermore making recommendations is becoming more and more popular nowadays and it is very important for an e-business to suggest the right products or services to each costumer (Machanavajjhala et al., 2010). If a business can succeed in doing that then the user would feel more satisfied and consume, thus making the retailer to gain financial.

E-BUSINESS BENEFITS

Studies have shown that customers value recommender systems and feel more comfortable when they visit a website that is personalized to their needs (ChoiceStream Personalization Survey, 2008). In simple words this means that they feel more trust towards the vendor and they are likely to visit again and make more purchases. In addition the benefits for an e-business that uses personalized systems are substantial when comparing to non-personalized websites. The benefits are mostly financial, since there are many studies that show that recommender systems are quite profitable for e-businesses (Wu et al., 2011; Cooperstein et al., 1999; Hinz & Eckert, 2010).

Recommender systems can decrease search costs for e-businesses by providing to the user the most appropriate products. According to Wu et al.(2011) recommenders can reduce transaction costs by targeting users and being more personalized. However according to the same survey there is still an open question if recommenders affect positively or negatively the sales of a business in online environments. However on the other hand a CNN (Mangalindan, 2012) article has gathered information that show the world's most influential e-business, Amazon, has used recommender systems and its overall sales have increased by 29% in 2011.

According to Wu et al. (2011) online stores usually have a larger variety of products and with the use of recommender systems can propose any relevant to each customer who might have shown an interest on anything related before and therefore the financial gain for the online business will be higher. According to the same scholar recommendations can be made in various stages within the selling process and if a customer decides to buy something and make one sale, this will decrease the supply costs. Additionally the search costs will be kept at a lower level. Fleder and Hosanager (2009) in their study have shown that recommender systems can increase the sale of new products to customers and have increased sales for the business.

Dias et al. (2008) have shown through a 21-month case study with real world data that the recommender systems not only increase the financial gains directly but they go far beyond that. In the same survey they support that there is evidence of the significance that personalization offers financially to e-businesses. Moreover they proved through their case study that there is both direct extra revenue with recommender systems, which relates with the purchase of a recommended item and indirect extra revenue which is related with the purchase of an item which is found in the same category of a recommended item. They have also proved that the indirect value remains constantly higher than the direct.

Privacy and Benefits

Chellapa and Sin study (2005) has shown that personalization is a very important factor for customers when visiting a website and they are likely to gain trust towards an e-business. Eventually they will make more purchases and therefore the financial gain for the vendor will be higher. On the other hand privacy surveys have shown that customers want to know how their data will be processed by the e-business (Kobsa & Teltzrow, 2005; Turow, 2003).

Trust and Benefits

A very important factor in the process of creating trust between an e-business and a customer is positive experiences. A study by Pavlou (2003) has shown that experience plays a vital role for trust in websites. In addition the design and operation of a website plays its role in creating trust. For a website to increase trust errors should be eliminated, process orders properly and make it usable (Bart et al., 2005). Fogg (2003) states in his paper that the presence of contact information, links from believable websites and links to other relevant information, along with quick responses are important reasons from an e-business perspective towards its customers.

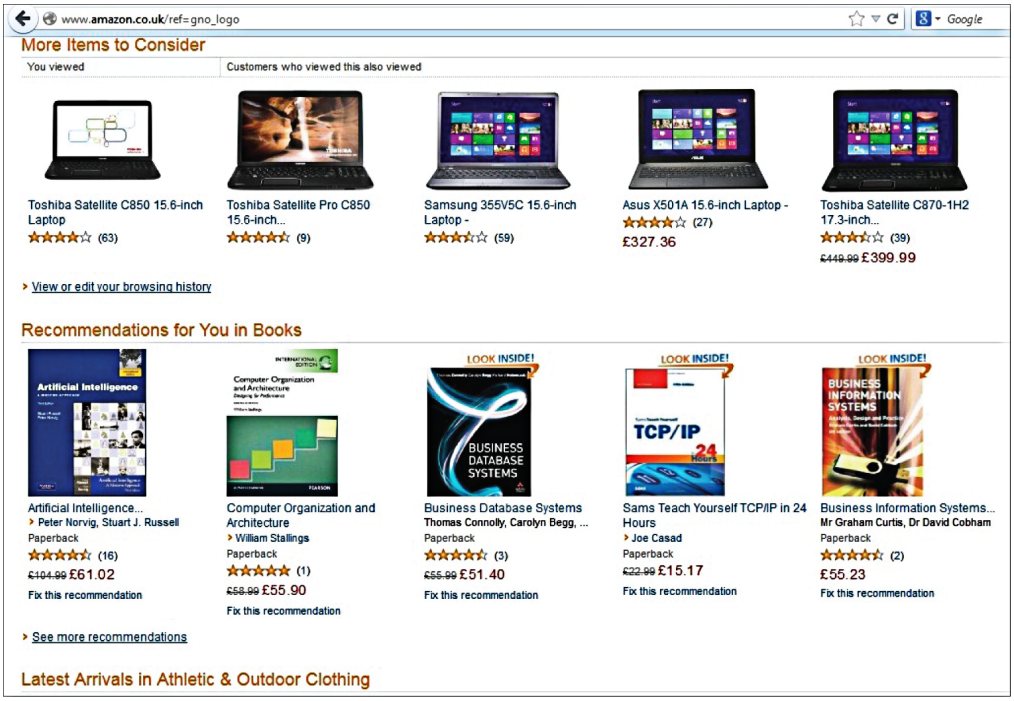
Other factors include the overall reputation of the website (Schoenbachler & Gordon, 2002) and the presence of a privacy statement and seal (Kobsa, 2007). Turow's (2003) study has shown that financial rewards towards customers can increase their trust and their intention to pass more private information to the website. Trust is a very important aspect for an e-business to increase financial gains and it should be taken seriously. Kobsa (2007) suggests that privacy laws should be taken into consideration and that privacy, which is vital for trust, can be personalized.

The Amazon Case

It has been mentioned earlier in the literature that Amazon is one of the top e-retailers that has been using recommender systems successfully to increase its financial gains. Amazon has increased its sales by 29% in 2011 (Mangalindan, 2012). Although this is the case, Amazon plays with the psychology of the user by providing with different type of recommendations at various stages of the buying process.

As shown in Figure 1, personalized recommendations appeared after a user has signed in successfully to Amazon and as it is obvious that it provides customer recommendations for the user according to his previous buying

Figure 1. Amazon's recommendations initial page (source: http://www.amazon.co.uk)



and search history. At the right hand side, there general recommendations regarding discount and bestselling items. All these different types of recommendations are based on user personality and psychology and are trying to irritate the user optically in order to click.

Figure 2 shows that the user is irritated optically again. After he has made a buying choice two different types of recommendations appear. Frequently bought together and what other customer have bought.

There is absolutely nothing bad with this technique, which is quite similar with what is happening in actual retail stores. Every vendor, including e-businesses, has the right to take advantage of every possible option and opportunity in a free market to satisfy the customer and increase sales by minimizing costs. Amazon has proven that recommender systems are valuable to an e-business and that other factors apart from algorithm development play a crucial role.

RESEARCH METHODOLOGY

An important aspect in research that helps to understand the aspects is the examination of the relevant published literature. The use of a research methodology also helps other researchers to understand the insight parts of our research (Park et al., 2011).

Recommender systems are an important field in research and a number of online databases were searched to provide an adequate level of literature review. Google Scholar, Science direct, DBLP, IEEE xplore digital library and the ACM digital library were searched comprehensively for current and published works that included conference papers, Journal papers and books. However as researchers in a serious field we continued with extensive search for other published works that included results published in websites. For the aforementioned the Google and Yahoo search engines were used.

The following keyword descriptors were used both on their own stand and combined:

- Recommender System/s
- Recommendation System/s
- Personalization
- Business value
- Privacy
- E-business
- Entrepreneurship
- Social Media

Each publication searched was from a high impact venue and was evaluated carefully in order to select the most appropriate for our research. Moreover in a field that is constantly evolving we included current published works and have included papers that make research

Figure 2. Amazon's further recommendations (source: http://www.amazon.co.uk)

contributions and case studies that employed metrics and provided real world results. Additionally it is important that the literature would fit the scope of the research and highlight the value of recommender systems in e-business environments.

The decision tree data mining technique was chosen due to its simplicity to help us make a decision if we would accept or reject a work. A decision tree is a tree where each node represents an attribute and a decision is made at each stage until the bottom leaf is reached (Kotsiantis 2011). To describe the process in a more formal way we give the rules used in our research methodology below.

At the top node we have the article found in an online database. If the article title is promising for further research proceed to the next stage or else reject. At the next leaf if the abstract of the article is promising then continue and read the article or else reject. At the next leaf if the article is of a satisfactory level then proceed to the next stage or else reject. At the final leaf, if the article is from a respectable source accept it or else reject. Then the process starts again for the next article.

ANALYSIS: CHALLENGES

Below we discuss challenging topics found in recommender systems literature. These areas are still under active research and serious future work is required (Shyong et al., 2012).

Privacy

Privacy is about ensuring that the user data will be kept private whatsoever. Privacy policies in conjunction with the knowledge level of the users about the subject guide them towards a negative behavior when they are being asked about to pass data in order to receive more personalized content (Shyong et al., 2012; Polatidis & Georgiadis 2013; Jeckmans et al., 2013).

In recommender systems the users are divided in three main categories, with regard to their judgments and choices (Shyong et al., 2012):

1. Users that will give any kind of information to a recommender system with return more personalized content;
2. Users that will give some information to a recommender system in order to get improved recommendations;
3. Users that will not give any kind of information to a recommender system because of privacy concerns.

The category that passes some information include general data such as gender, age, education. These data are given easier rather than more specific personal data (Jeckmans et al., 2013). However to improve recommendations we have to convince the users that their data will be safe and conduct research about privacy. This research can be done either in a lab using observation techniques, either directly or indirectly and by asking the users to answer questions about. Moreover the benefits of personalization should be made very clear to the user and provide them with a very clear, certified, privacy statement and seal. The users want to know how their data will be used.

Social Media Integration

The integration of social networks in mobile operating systems in conjunction with the growth and speed of internet has brought huge amounts of social networking data. It is one of the easiest ways to collect data from users that they are willingly given and can be very beneficial to e-commerce and businesses in general. However it is a challenging procedure to collect and separate the necessary data used for e-commerce purposes. Data from social networks shall be used to assist customers by making more accurate recommendations. Social media allow the exchange of information in different categories, each one having special characteristics. The most important categories are the following (Gundecha et al., 2012):

1. **Social Networks:** These are web-based networks of users that connect and interact

with each other through updates, online chat and multimedia sharing. Well-known examples include Facebook and twitter;

2. **Blogs:** These are websites that contain text and multimedia content that is arranged in a chronological order. These are usually maintained by a single user or a team of users. Famous examples include Blogger and Word Press;
3. **News reading:** Selection of articles or categories to read from online specified news websites;
4. **Online video sharing:** This includes the sharing of videos to services such as YouTube or Veoh;
5. **Online photo sharing:** This is photo sharing in services such as Flickr or Picasa;
6. **Auction sites:** Data from history purchases and search history at sites such as EBay.

A huge amount of data is created on each of these social media networks daily and this is a trend that is growing exponentially. As an indicative figure, let us mention that the number of Facebook and Twitter users increased by 112% and 347% respectively from January 2009 to January 2010 (Jabeur et al., 2013). However, it is a challenge to decide which data to use. Moreover there is a number of spammers that create more data than real users (Gundecha et al., 2012).

All social networks have application programming interfaces (APIs) that can be used to communicate with them. However it is a challenge to retrieve the data and respect privacy as well. Apart from information related to the user such as gender, age, background, relationship status, there is a number of dynamic contents that is constantly changing. These contents include mood, location, posts and posts made by other users on his personal page (Liu & Maes, 2004).

Enhanced Role-Based Access Control Model

An edge point that is directly related with privacy, which at the moment is the highest challenge in personalization environments, is Role-Based Access Control (RBAC). A role in an organization is a set of rules describing what actions a particular person can take within. Therefore it is clear that a novel role model is necessary to determine the access level and constraints. Even though a satisfying number of technologies exist, due to an always moving forward environment there are always new challenges (Ferraiolo et al., 2007).

Role-Based Access Control is the fundamental security model enforced nowadays. It is used in various ways to define the ways that users will have access to resources. Moreover, with the right modeling can be used to control app permissions as well.

The two most important aspects of access control are authorization and authentication (Ferraiolo et al., 2007). Authorization is if the user has the permission to perform certain operation and authentication is to identify if the user is the one who claims he is.

An abundant challenge is the proposal of new modified RBAC model, which is essential at this point. This new model should be able to maximize the level of privacy of a mobile recommender system. The difficult part is to define the constraints that the new model should cover in terms of users, operations and permissions of both users and applications. Other important characteristics could be the least privilege technique and group access control relationships. In least privilege, the user should be able to perform only the operations required and not any other either at an above or at below level whatsoever. In group access, a user of a group could have additional permissions that other users in the same group do not. Furthermore a number of crucial operations could be performed only if two users at the same time are logged in to perform the operation.

Other less important factors that play a vital role is the confidence towards a website and app in the case of a mobile device, any positive previous experience from a vendor, the design and reputation of a particular website or mobile app. Last it should be noted that earlier research has shown that the average user would disclose information very easily

in exchange for money or gifts (Paireekreng & Wong, 2010). Some technical solutions that could partially solve the problem include the use of pseudonymous users and profiles, including subcategories, client-side personalization and distribution techniques (Ricci et al., 2011; Davidson et al., 2012). Finally the use of an external privacy tool in the form of an app can be used to control privacy.

DISCUSSION

Although recommender systems can be found in many web based systems and mobile environments nowadays, there is a number of factors that users of mobile platforms in particular take into consideration and avoid their use. These factors are tight integrated to privacy. Additionally, a new trend in the Internet era is social networking and its derivatives with huge amounts of data exchanged every day. These data should be used in recommender systems to improve personalization. A final important point is the development of new Role-Based Access Control (RBAC) model that will improve privacy ambiguities found in mobile app permissions and user access to data.

Moreover it worth noticing that although recommenders are becoming all and more popular every day and the main research direction is towards developing new algorithms and not much research towards the value of such systems in e-businesses. We have seen in the literature that recommender systems play a vital role in electronic environments and all new entrepreneurs should consider using them. Additionally studies have shown that the revenue generated from recommender systems is high and that most of it comes from indirect recommendations. This is happening due to the introduction of customers to previously unknown categories.

The current situation in e-commerce lacks communication between the consumer and an employer of owner of the business. This is holding back customers from purchasing (Lowry et al., 2010), although we feel that a website can be more personalized and tailored to each individual user needs to feel this gap. Our research clearly shows that recommender systems offer value in e-businesses and assist customers in various ways. We expect these systems to evolve and provide a more mature user experience, decrease business costs and become more privacy aware. In addition it should be noted that supporting technologies constantly evolve and that it is very difficult to know how the future will be. A noticeable example is the technology that recommender systems used a few years ago with the use of basic algorithms to the use of social-media based recommenders nowadays (Ochi et al., 2010). We strongly believe that social-media data will be used in more recommender systems in the future due to their nature and the information that can provide. Although careful selection of the data used must be carried to avoid useless data and avoid spammers.

It should be also noted that an e-business has extra financial cost to provide a personalization service. However business owners and new entrepreneurs should realize that if they are willing to pay the costs they will gain more customers, become more innovative and competitive in a free market and increase their overall financial gains. Our opinion is that online shopping will evolve further with the use of recommender systems and social-media in the future. Furthermore there are implications related with ethics that need to be further researched in order to get a more clear view.

At the same time there are technologies that are constantly evolving and that can be used to enchase the user experience. We expect that in the future technologies such as second life, which is a virtual environment, will continue to grow and every new business should consider investing in such technologies. In such virtual environments real money transaction can take place and can include recommendations as well.

CONCLUSION

Due to the constant growth of the internet and the information overload problem the use of recommender systems has become necessary. Moreover recommenders have attracted both people from academia and industry. In this paper we have analyzed the importance of such systems, with respect to e-businesses, and the types of recommendation algorithms used. Furthermore we have proceeded with an analysis of benefits that e-businesses have and include decreased search costs, direct and indirect financial gain.

A research methodology section has been written to help the reader understand better the insight parts of our research and the way we approached the searching relevant published literature. An analysis of the challenges part follows, which gives a detailed explanation of the challenges found in recommenders such as privacy, security and the importance of social media data.

It should be also noted that the managerial implications are very important in our case, due to the fact that we approach recommender systems from an entrepreneurship and e-business managerial view. The findings of our study have shown that the presence of implications does exist and should be examined by managers to improve their business. Firstly a priority that should not be underestimated is the financial gain offered from direct and indirect recommendations. This is a crucial factor that has to be considered from managers and has been analyzed in the literature. Also managers should be aware that customers feel more comfortable when a website is personalized to their needs and they are more likely to make a purchase. Additionally the privacy factor must be considered from a managerial view as well, since the user needs to be aware of what is happening with his personal data. Finally the most important priority of managers should be to clearly articulate the importance of recommender systems and personalization to their respective businesses by providing results of such systems used elsewhere and how they could benefit from their use.

FUTURE WORK

We believe that psychological factors are of a great importance in recommender systems research both in algorithm research and as a business strategy. A part of our future research will concentrate on the visual stimulation of people when use website that provide recommendations and how they react to them. Other human factors that are crucial and will be taken into consideration include the user personality and explanations that can use as persuasive techniques.

Business aspects of recommender systems will be researched as well, which will look at the entrepreneurship direction and will include aspects such as the use of innovative recommendation approaches, such as social media recommendations. Recommender systems are a multidisciplinary field that can be valuable in an e-business environment. Also an aspect that must be developed and researched further is how recommender systems can employ diversity to customers and not concentrate in more top selling items.

Our research has been focused on business to consumer environments (B2C). It would be very interesting to do further work and get results from business to business (B2B) and consumer to consumer (C2C) environments. The need for recommender presence in every field of e-commerce should be consider and it is clear nowadays that has a serious role to play. Furthermore it would be interesting to investigate how other related factors such as privacy and security play their role in recommendations and how users react.

Personalized privacy is something that has been proposed before due to differences between countries and laws (Kobsa, 2007). However based on our investigations technologies such

as role based access control (RBAC) and the trusted platform module (TPM) can be used to provide an excellent privacy level and not take into consideration local laws.

An important aspect of recommendations in e-business is the increase of case studies based on real data. It would be very interesting to see more research going on in that direction and also see the result of such research. In addition specific research should be based on the possibility of getting revenue from recommendations in environments apart from e-retailing. These environments include services recommendations in areas such as social networks, news reading and multimedia delivering. Besides that recommenders can be enriched with various media technologies to become more interactive and make the user feel more comfortable.

Finally it would be of great interest to see research results on new hybrid recommendation algorithms and how different parts of single and hybrid algorithms can be combined to solve problems at different recommendation levels. Further research at this level can lead to optimal recommendation results and be beneficial for both the consumer and the e-business.

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REFERENCES

Benats, G., Bandara, A., Yu, Y., Colin, J.-N., & Nuseibeh, B. (2011). PrimAndroid: Privacy policy modelling and analysis for Android applications. In *Proceedings of the IEEE International Symposium on Policies for Distributed Systems and Networks (POLICY 2011)* (pp. 129-132). Washington, DC: IEEE.

Chellappa, R. K., & Sin, R. G. (2005). Personalization versus privacy: An empirical examination of the online consumer's dilemma. *Information Technology Management*, *6*(2-3), 181–202. doi:10.1007/s10799-005-5879-y

ChoiceStream personalization survey: Consumer trends and perceptions, (2008). Retrieved October 21, 2013, from http://www.choicestream.com/pdf/ChoiceStream_ 2008_Personalization_Survey.pdf

Cooperstain, D., Delhagen, K., Aber, A., & Levin, K. (1999). *Making net shoppers loyal*. Cambridge, MA: Forrester Research.

Davidson, D., & Livshits, B. (2012). *MoRePriv: Mobile OS support for application personalization and privacy*. Redmond, WA: TechReport, Microsoft Research.

Ferraiolo, D. F., Kuhn, D. R., & Chandramouli, R. (2003). *Role-based access control*. Norwood, MA: Artech House.

Fleder, D. M., & Hosanagar, K. (2009). Blockbuster culture's next rise or fall: The impact of recommender systems on sales diversity. *Management Science*, *55*(5), 697–712. doi:10.1287/mnsc.1080.0974

Fogg, B. J. (2003). *Persuasive technology: Using computers to change what we think and do*. Morgan Kaufmann.

Gundecha, P., & Liu, H. (2012). Mining social media: A brief introduction. *Tutorials in operations research.*

Hinz, O., & Eckert, J. (2010). The impact of search and recommendation systems on sales in electronic commerce. *Business & Information Systems Engineering*, *2*(2), 67–77. doi:10.1007/s12599-010-0092-x

Jabeur, N., Zeadally, S., & Sayed, B. (2013). Mobile social networking applications. *Communications of the ACM*, *56*(3), 71–79. doi:10.1145/2428556.2428573

Jannach, D., Zanker, M., Felfernig, A., & Friedrich, G. (2010). *Recommender systems: An introduction*. Cambridge University Press. doi:10.1017/CBO9780511763113

Jeckmans, A., Beye, M., Erkin, Z., Hartel, P., Lagendijk, R., & Tang, Q. (2013). Privacy in recommender systems. In *Social media retrieval. Computer communications and networks* (pp. 263–281). London, UK: Springer Verlag. doi:10.1007/978-1-4471-4555-4_12

Karimov, F. P., & Brengman, M. (2011). Adoption of social media by online retailers: Assessment of current practices and future directions. *International Journal of E-Entrepreneurship and Innovation*, *2*(1), 26–45. doi:10.4018/jeei.2011010103

Kobsa, A. (2007). Privacy-enhanced web personalization. *The Adaptive Web, LNCS*, *4321*, 628–670. doi:10.1007/978-3-540-72079-9_21

Kobsa, A., & Teltzrow, M. (2005). Contextualized communication of privacy practices and personalization benefits: Impacts on users' data sharing and purchase behavior. In D. Martin & A. Serjantov, (Eds.), *Proceedings of the 4th International Workshop Privacy Enhancing Technologies (PET 2004)*, Toronto, Canada.

Konstan, J., & Riedl, J. (2012). Recommender systems: From algorithms to user experience. *User Modeling and User-Adapted Interaction*, *22*(1-2), 101–123. doi:10.1007/s11257-011-9112-x

Kotsiantis, S. B. (2011). Decision trees: A recent overview. *Artificial Intelligence Review*, *39*(4), 261–283. doi:10.1007/s10462-011-9272-4

Liu, H., & Maes, P. (2004). *InterestMap: Harvesting social network profiles for recommendations*. Beyond Personalisation.

Lowry, P. B., Zhang, D., Zhou, L., & Fu, X. (2010). Effects of culture, social presence, and group composition on trust in technology-supported decision-making groups. *Information Systems Journal*, *20*(3), 297–315. doi:10.1111/j.1365-2575.2009.00334.x

Machanavajjhala, A., Korolova, A., & Sarma, A. D. (2010). *On the (im)possibility of preserving utility and privacy in personalized social recommendations*. ArXiv: 1004.5600v1 [cs.DS]. 30 April 2010. Retrieved October, 20, 2013, from http://http://arxiv.org/pdf/1004.5600v1.pdf

Mangalindan, J. P. (2012). *Amazon's recommendations secrets*. Retrieved October 21, 2013, from http://tech.fortune.cnn.com/2012/07/30/amazon-5/

Ochi, P., Rao, S., Takayama, L., & Nass, C. (2010). Predictors of user perceptions of web recommender systems: How the basis for generating experience and search product recommendations affects user responses. *International Journal of Human-Computer Studies*, *68*(8), 472–482. doi:10.1016/j.ijhcs.2009.10.005

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing*, *16*(1), 105–114. doi:10.1007/s00779-011-0412-2

Paireekreng, W., & Wong, K. (2010). Mobile content personalization using intelligent user profile approach. In *Proceedings of Third International Conference on Knowledge Discovery and Data Mining (WKDD 10)* (pp. 241-244). Washington, DC: IEEE.

Park, D. H., Kim, H. K., Choi, Y., & Kim, J. K. (2001). A review and classification of recommender systems research. In *Proceedings of the International Conference on Social Science and Humanity* (IPEDR vol.5, pp. 290-294) IACSIT Press Singapore.

Pavlou, P. A. (n.d.). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International Journal of Electronic Commerce 7*(3), 101-134.

Polatidis, N., & Georgiadis, C. K. (2013). Mobile recommender systems: An overview of technologies and challenges. In *IEEE Proceedings of the Second International Conference on Informatics and Applications (ICIA 2013)* (pp. 282-287). Washington, DC: IEEE.

Prasad, R., & Kumari, V. V. (2012). A catagorical review of recommender systems. [IJDPS]. *International Journal of Distributed and Parallel Systems*, *3*(5), 73–83. doi:10.5121/ijdps.2012.3507

Qiu, L., & Benbasat, I. (2009). Evaluating anthropomorphic product recommendation agents: A social relationship perspective to designing information systems. *Journal of Management Information Systems*, *25*(4), 145–182. doi:10.2753/MIS0742-1222250405

Ricci, F. (2011). Mobile recommender systems. *International Journal of Information Technology and Tourism*, *12*(3), 205–231. doi:10.3727/109830511X12978702284390

Ricci, F., Rokach, L., Shapira, B., & Kantor, P. (2011). *Recommender systems handbook*. Springer. doi:10.1007/978-0-387-85820-3

Riemer, K., & Totz, C. (2001). The many faces of personalization – An integrated economic overview of mass customization and personalization. In *Proceedings of the World Congress of Mass Customization and Personalization (MCPC 2001).*

Schoenbachler, D. D., & Gordon, G. L. (2002). Trust and customer willingness to provide information in database-driven relationship marketing. *Journal of Interactive Marketing*, *16*(3), 2–16. doi:10.1002/dir.10033

Shyong, K., Lam, T., Frankowski, D., & Riedl, J. (2006). Do you trust your recommendations? An exploration of security and privacy issues in recommender systems. In *Proceedings of the International Conference on Emerging Trends in Information and Communication Security (ETRICS)* (LNCS 3995, pp. 14-29).

Turow, J. (2003). *Americans and online privacy: The system is broke*. Aneenberg Public Policy Center, University of Pennnsylvania. Retrieved October 21, 2013, from http://www.securitymanagement.com/archive/library/Anneberg_privacy1003.pdf

Wang, L. C., Baker, J., Wagner, J. A., & Wakefield, K. (2007). Can a retail web site be social? *Journal of Marketing*, *71*(3), 143–157. doi:10.1509/jmkg.71.3.143

Wu, L.-L., Joung, Y.-J., & Chiang, T.-E. (2011). Recommendation systems and sales concentration: The moderating effects of consumers' product awareness and acceptance to recommendations. In *Proceedings of the HICSS* (pp. 1-10). Washington, DC: IEEE.

Yakov, B., Shankar, Y., Sultan, F., & Urban, G. L. (2005). Are the drivers and role of online trust the same for all web sites and consumers? A large-scale exploratory empirical study. *Journal of Marketing*, *69*(4), 133–152. doi:10.1509/jmkg.2005.69.4.133

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