S.J.I.T.N Vol.2 (2014)

Available at: www.sabauni.net
Journal home page: www.sjitn.sabauni.net

S.J.I.T.N
Saba Journal of Information Technology and Networking

Available at: www.sabauni.net
Journal home page: www.sjitn.sabauni.net

S.J.I.T.N Vol.2 (2014)

Available at: www.sabauni.net
Journal home page: www.sjitn.sabauni.net

S.J.I.T.N
Saba Journal of Information Technology and Networking

Contents

S.J.I.T.N Vol. 2 (2014)

Available at: www.sabauni.net
Journal home page: www.sjitn.sabauni.net

S.J.I.T.N
Saba Journal of Information Technology and Networking

Review

A REVIEW OF THE FACTORS AFFECTING THE SUCCESS /FAILURE OF E-GOVERNMENT PROJECTS

Mohammed A. Al-Sharafi*

Yarmouk University, Faculty of Information Technology and Computer Science.

Article info

Article history :
Accepted April 27, 2014

Keywords:
E-Government
Success
Failure

Abstract

It is becoming increasingly difficult to ignore the important role of e-government. A lot of countries have the desire to implement e-government project. But the fate of most projects is the failure. There are many factors have an impact on the success or failure of e-government project. In this paper, these factors will be listed and classified into Organization, Technical, Social and Governing factors. In addition, they will be discussed. At the end of this paper, many recommendations have been listed and explained that may help in the success of e-government projects.

* Corresponding author: Mohammed A. Al-Sharafi
E-mail address: ma_shrafi@yahoo.com

Introduction

The past decade, governments at all levels have released the projects of Electronic Government (E-government). The objective of these projects is to offer an electronic service to the citizen, business, or other arm of government based on the type of the service.

E-government defined as a use of information technology (IT), such as internet, wide area network, and mobile technology to provide the public with convince access to the information and services [1]. Another definition of E-government as a network of computer system through these computer systems, citizen, business and other arm of government can access to many services and transaction online or through other electronic means [2].

The governments around the world use the E-government to achieve greater efficiency in the performance of government through raising the performance of services for investors and beneficiaries for all society efficiently, easily, and accurately.

E-government will make the activities of government more transparent by decreasing the corruption since each one will be dealt as others, no one will be recommended upon others. Furthermore, E-government will provide the information and service to anyone who need it in easy and faster way. Another benefit of E-government is the cost reduction and revenue growth. In addition, the E-government has many advantages such as, it can use criteria for measuring the service quality and the administrative efficiency, achieve a particular policy, and it will help in building the trust between the citizens and their governments. [3]

According to Fang, Z. [4], the progress of country's E-government can be measured by divide it into five categories as follows:

- Emerging web presence: the government has one or a few websites that offer static information to the users.
- Enhanced web presence: the number of websites increased and the type of information become a dynamic.
- Interactive web presence: in this category, there is exchange for information between the users and the government through downloading a forms and submit these forms online.
- Transactional web presence: in this category, the users can access to the services and prioritize them based on their needs.
- Fully integrated web presence: The complete integration of all online government services through a one-stop-shop portal.

The old fashioned model of ICT in government has been changed to the new model of ICT which has been extracted from the old fashioned model of ICT in government (Fig. 1). The new model is one of ICT transforming and supporting the outside work of governance by processing and communicating information and data. As shown in figure [3].

The e-government has been reflected between four relationships[3]:

1. Government-to-Citizen (G2C) Provide information and services to the citizen through online or any other electronic media.

2. Government-to-Business (G2B) Offer information and services to the business and industries.

3. Government-to-Government (G2G)

Exchange the information and services between the agencies in the government.

4. Government-to-Nonprofit (G2N) The government provides information and communication to non-profit organization.

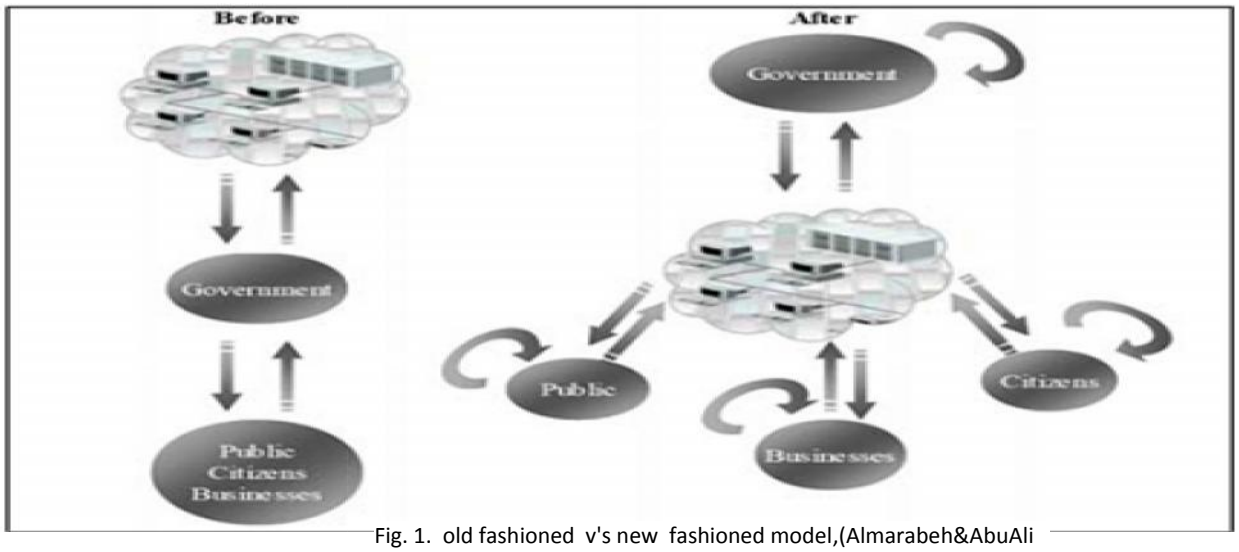

Fig. 1. old fashioned v's new fashioned model,(Almarabeh&AbuAli (2010). [3])

Most of E-government projects don't success, only 15% of E-government projects which designed and implemented in developing countries are successfully projects. While 50 % of the projects are partially successfully and 35% are fully failure [5].

In order to achieve E-government projects the desired objectives as well as providing the high quality service, many success factors must be taking into account. Besides that, there are many failure factors which we have to be aware of them. These factors will be discussed in this next section.

Literature review

There is a large volume of published studies describing the factors that can effect on the success or failure of an information system such as Supramaniam & Kuppusamy (2011). E-government project is one of information system projects. In this section, the factors will be divided into four categories: organization, technical, Social, and governing.

1.0 Organization Factors

1.1 Staff Skills

The first factor of organization factors is the staff skills. The staff must be trained very well if we want the e-government project to be succeed. The

lack of training and the qualified staff will make the moving to a new trend like e-government is so difficult [2,3].

Training staff will not be the only thing can be achieved. In addition, the human resources must be managed and restructured with take into account the e-government goals. Training the staff and motivate them is a critical for e-government success [3,7]. Within achieving e-government projects, there is a factor that we have to pay attention to it which is the high turnover of the employees from public sector to private sector since they will get a high salary from private sector more than public sector [3].

1.2 Education and Marketing:

Another factor that can effect on the success of e-government is awareness and marketing for

e-government project. The citizen must know about the services.

It will not be useful if people do not know about the services and how they can use it.

The idea of e-government and the benefits of it must be advertised to the citizens to explain the benefits that they will get when they use e-government system. The government itself should play the main role to achieve this task. The authors Mitrovic,Z. [8] approved that the awareness of services that offered by e-government project play a big role to make the citizens accept the new adaption of government services.

As a result of e-government projects, the transparency will be increased. Most of the citizens don't understand how government decisions are made. This lack of transparency will make the public are not involved in participation in government.

Furthermore, a lack of transparency can conceal official graft or favoritism. Better information management can be a helpful to make a framework and policy which in turn make sense of available data. These frameworks and policies can be used to derive a quick analysis enough to react to social and economic developments [2,3].In addition, when the staffs are trained very well, the information management will be better than before.

1.3 Change Resistance

Another factor that must be managed is a change resistance. The resistance may be from citizens or event from employees. The organization can overcome this resistance through training for an employee and awareness for citizens [9]. In the other hand, many researchers have been conducted that are related to acceptance technology. The authors Suki,N. & Ramayah, T. [11] found that interpersonal influence, usefulness, external influence, ease of use, facilitating conditions, compatibility, and attitude are very important determinants of user acceptance of the e-Government services.

Results indicate that the important determinants of user acceptance of the e-Government services are perceived, self-efficacy, subjective norms, perceived behavioral control, and intention to use e-Government services/system. Finally, implications and recommendations of these finding are discussed

2.0 Technical Factors

2.1 Infrastructure

Any country tries to implement e-government projects need to develop a basic infrastructure to make it support a new information communication technology. A lot of developing countries face this challenge even if they have the possessing the will. So, infrastructure development is a critical success factor for e-government project [3,12,13].

The need of appropriate infrastructure means that weak infrastructure such as, technology being used, skilled people and communication systems, will be the first obstacle in employing the E-government project [5]. That means, we have to drop the existing devices or upgrade them to Commensurate with new infrastructure .In addition, we have to fire the current employees and bring a qualified employees or train the existing employees and use them to operate the new e-government system. Suitable and up-to-date infrastructure is necessary for the development of E-Government so that the technologies can be applied and used positively [7]. But other researches overcome on the lack of infrastructure by delivering the services through center citizens are designed for this mission such as kiosks [9]. Adequate technological infrastructure must take into account which includes computerization system, telecom policies, ICT policies etc [10]. Using an off-the-shelf solution from manufacturing country for a developing country will produce a large design-reality.

2.2 Availability and Accessibility

The offered services must be available 24/7. In addition, the government must serve all members of society through making the services accessible to

them. According to Alomari, M., Sandhu, K. & Woods, P. [14]

Accessibility is defined as “the degree to which web information is accessible to all human beings and automatic tools” So; the online services will be designed with appropriate interfaces to suit all citizens such as blind and handicapped [3]. In addition, e-government system must support variety of languages especially when the country has many local languages [15].

According to Alomari, M., Sandhu, K. & Woods, P. [14], many website characteristics have been assumed to make the website accessible such as “The more user-friendly the search structure of the website is than the search procedure through the offline channel, the higher is the possibility of consumers’ information search through the internet”, and” The better is the design of the website than the artistic facet of an offline channel’s store display, the higher is the possibility of consumers’ information search through the internet” .

2.3 Computer-Self Efficacy

The technology acceptance model (TAM) suggests that perceived ease of use (PEOU) and perceived usefulness (PU) determine the attitude on the way to adoption of ICT [16]. If the citizens do not have the ability to use the technology to access useful information and services, the e-government project will fail. That is will lead to make the acceptance of the system not easy.

3.0 Social Factors

3.1 Trust

According to Alomari, M., Sandhu, K. & Woods, P. [14] "trust considered as prerequisite of e-government implementation" and consider “a central defining aspect of many economic and social interactions. To guaranty that e-government will be succeed, between government and citizens, agencies, across governments, within agencies, and with businesses trust must be built [3].

According to Alomari, M., Sandhu, K. & Woods, P. [14], trustworthiness can be perceived when three characteristics available: ability, Kindness, and integrity. Ability means to what extent a trustee can process “that group of skills, competencies and characteristics that enable a party to have influence within some specific domain”. Kindness means to what extent a trustee is believed “to want to do good to the trustor”. Integrity means to what extent a trustee adheres “to a set of principles that the trustor finds acceptable”.

The author Colesca, S. [17] found that there are factors affect positively on trust and also other factors affect negatively on the trust. The positive factors which directly enhanced the trust in e-government are :higher perception of technological and organizational trustworthiness, the quality and usefulness of e government services, the Internet experience and propensity to trust, the negative factors which have a negative influence over trust are: age and privacy concerns. Another research for Teo, T., SRIVASTAVA, S.& JIANG, L. [18] propose that quality insights of citizens toward a specific e-government Web site are affected by their trust in e-government Web sites. In their study, they found that, there are a set of key success factors play an important role in determining the level of trust. These keys are: information quality, system quality, and service quality perceptions.

There are many way to build trust between the e-government project and its citizens by: **first**, Map key internal and external partners and build a strategy to keep open lines of communications. **Second**, start with short-term projects that produce early results. This helps build trust and could help point to areas for larger scale ventures. Finally, strong leadership can help build confidence in e-government project [3].

3.2 User's Satisfaction

In addition to trust, the e-government projects must satisfy the users' satisfaction (citizens and business).

Some authors consider user satisfaction one of the most important factors to consider any system successful. According to Floropoulos, J., Spathis, C., Halvatzis, D. & Tsipouridou, M. [19] user satisfaction is "the sum of one's feelings and attitudes toward a variety of factors affecting the situation". Furthermore, according to Floropoulos, J., Spathis, C., Halvatzis, D. & Tsipouridou, M. [19] accessibility is one of the elements required to design efficient and effective websites.

3.3 Attitudes and Beliefs

Another factor is the Attitudes and Beliefs. If the citizens have a negative attitude against using the services offered by e-government, it will represent one of the main barriers for e-government adoption [14]. Many people may have a negative attitude towards electronic services and they would prefer to stay with traditional methods. I think it is related to the resistance of change that we discussed before. The responsible of e-government can overcome of this limitation by doing some advertisement, training and seminars. The altitude is not related to citizen only, it also related to the internal policies desire which must be available to make the e-government meet the goals that it built for.

3.4 Privacy

The government must guaranty that the personal information will not be misuse in any way. Governments must be responsible of protection the enormous amounts of personal information they hold. Governments collect data on their citizens every day during doing the transactions. Protecting the privacy of citizens' personal information stored on these databases while making effective use of the information contained in them is a vitally important issue [3].

The privacy can be improved through educate and train government staff about how is the importance of privacy, applications must be designed to integrate privacy protections. Following "fair information practices" to minimize the collection of personal information, and finally limit the access to personal information unless it is necessary to achieve the task.

3.5 Security

Security must be addressed although it will cost so much. Security must be addressed in the design phase. Information security management within any organization involves "some form of managing potential risk, vulnerabilities, and threats that face an information system [22].

Trust is an extremely important part of E-government projects. Without trust, citizens who may already be suspicious of using technology may avoid use of online services that ask for detailed personal information. From this point came the importance of security. When the citizens know that their personal information are secured and no one can access to them unless they have access grant, the trust will increase which will reflect on using e-government system.

Security can be improved through following some step such as: a senior official can be designated. He will be responsible for computer security, Keep assess your system from a while to another, run continuing training to employees on computer security. The authors Seo, D., Yi, W. & Lee,K. [20] propose another technique to increase the security. They propose the information security activities model. The outcome of their study will help in securing reliability and activating the use of e-government service

3.6 Digital Divide

The gap between individuals who have access to the Internet and those who do not; is called the digital divide. Those without access cannot study crucial computer skills, cannot access information that can

offer profitable opportunities, and cannot share in the benefits of E-government.

3.7 E-Literacy

E-Literacy focus on the group of people who are can't use information and communication technologies because they are not computer literate [3]. In the recent years, with the internet and digital revolution, the people have been divided into two parts: into the "information rich" and the "information poor. So, the e-government must solve the problem by make the access to government and its services equally between its citizens or by increasing the barriers to participation [3].

4.0 Governing Factors

4.1 Leadership

According to .Luk,S. [21], the leadership has four major of theories. These theories classified based on the variable type that they emphasize. These theories are: trait, behavioral, contingency, and integrative. The same authors have been mentioned that the strong leadership will make the process of e-government implementation achieved quickly.

According to Luk,S. [21], they claim that to improve the quality of service significantly, the leader of agencies has to work together across traditional boundaries. Another research for AL-Kaabi,R.[2] proposes that the leadership is one of the critical success factors of e-government projects. The leader can play an important role through solve the problem that may face the employees during the design of project or even after the project installed to the environment. The leaders can minimize risks, motivate the employee, solve problem and so on.

4.2 Law and Public Policy

The application of Information Technology and Communication (ICT) may meet legitimate or policy barriers. Legislatures must confirm that laws are keep up to date to identify electronic documents and transactions since it is one of the critical success factors of e-government projects [13].There are many ways can be used to keep the laws up to date by following these steps: ask with participants to evaluate how existing laws may obstruct the desired results, simplify laws and regulations to permit electronic filings with government agencies, and restructure processes by simplifying rules and procedures[3].

Recommendations

In the previous section, the most critical factors that impact on the success or failure of e-government projects have been discussed. In this section, some recommendations will be listed and discussed about how we can make the factors help us in designing e-government projects. Furthermore, many techniques and plans will be mentioned to help us in overcome of some limitation that might show during or even after e-government implementation.

Infrastructure Development

To overcome on the limitation that can be in infrastructure development especially for the developing country, many issues must be taken into account such as, the project that we want to develop must be compatible with the Infrastructure of telecommunication, public kiosks, schools, health center, and mobile centers can be used in case the density of telecommunication is low, the competition between the service providers must be open to accelerate the deployment of telecommunication Infrastructure. A new technology such as wireless can be brought to help in distribution of service and put the rules to organize this service. Framework can be established at the beginning to draw the road for the investment effort.

The trust factor can be one of the critical success factors if it has been built in right way. There are many ways that can help in building the trust such as: we can start with short-term e-government projects that produce early result, in addition, a

strong leadership can play a role in building the confidence in the projects.

The privacy can be improved through train the employees and educate them about how is the importance of privacy and how it can help in building a good relationship between e-government and citizens, applications must be designed to integrate privacy protections. Following <fair information practices> to minimize the collection of personal information, and finally limit the access to personal information unless it is necessary to achieve the task.

The E-Literacy factor can be a challenge for any country has the desire to implement e-government project especially for developing country. Besides, here are some techniques that can help to reduce the e-literacy impart by: make sure that the content of e-government system available in the local languages and the interfaces of that system are easy to use. The application of e-government has to support the picture or even speech in addition to written text. In e-government project must have a window to teach the people how to use the services. Finally, the e-government project should pay attention to different groups like immigrants, women, and elderly.

Any application of e-government project that we want to design must be designed according on our needs. In addition, the project must take into account the relevancy, affordability, and language compatibility. Implementing e-government project will help in encouraging the cooperation between the private sector and the government agencies in collection and utilization the data without misuses the personal information.

There are many ways that the government can increase the degree of acceptance of e-government project through the following steps: make the citizens partners in development and applied the projects of e-government. Increase the number of services that can be offered in e-government. The questionnaires can be done to evaluate the services by the citizens. Expand on using the server from many of citizens to respond to the huge expected flow of citizen that they ask for the offered services.

Future Work

The factors that have been discussed are not related to specific country. They are studied in general. In future, we will study the e-government project in Yemen especially for application related to “Yemen Civil Service Modernization Project”. Questionnaire will be distributed over wide Yemen and it will involve the employees in Ministry of Civil Servant and the citizens who are benefiters of this service.

Conclusion

This review has given an account of the reasons of e-government failure. A lot of factors have been discussed and the role of each factor has been explained through this review.

Many of recommendations have been listed, many limitations can be overcome and that will lead to reduce the problems and challenges that will face the developers during e-government project implementation if we consider these recommendations

Table 1: Summarized by Author

	Governing Factors	Technical Factors	Social factors	Organizational Factors
1	Leadership	Infrastructure development	Trust	Staff skills
2	Law and Public Policy	Availability and Accessibility:	User's satisfaction	Education and marketing
3		Computer-self efficacy:	Attitudes and Beliefs	Change resistance
4			Privacy	
5			Security	
6			Digital Divide	
7			E-Literacy	

References

[1].ALin, F., Fofanah,S . & Liang, D. (2010).Assessing citizen adoption of e-Government initiatives in Gambia: A validation of the technology acceptance model in information systems success. Government Information Quarterly, Vol.28 (2), pp 271 - 279.

[2]. AL-Kaabi, R.(2010).Secure and Failure Factors of e-Government Projects Implementation in Developing Country: A study on the Implementation of Kingdom of Bahrain . World Academy of Science, Engineering and Technology.Vol.66. pp. 128-131.

[3]. Almarabeh , T. & AbuAli , A. (2010). A General Framework for E-Government: Definition Maturity Challenges, Opportunities and Success. European Journal of Scientific Research .Vol.39 (1), pp. 29-42.

[4]. Fang, Z. (2002). E-Government in Digital Era: Concept, Practice, and Development. International Journal of the Computer, the Internet and Management, Vol.1 (2). pp 1-22.

[5]. Abdelsalam, H., ElKadi, H. & Gamal, S. (2010, October). Setback and Remedy of Local e-Government Projects: A Case Study from Egypt. Poster session presented at the proceedings of the 4th International Conference on Theory and Practice of Electronic Governance, Beijing, China. ACM .

[6]. Supramaniam, M & Kuppusamy, M.(2011). Analysis of Critical Success Factors in Implementing Enterprise Resource Planning Systems in Malaysian Business Firms. The Electronic Journal on Information Systems in Developing Countries, Vol.46(5).pp 1-19

[7]. Sharifi ,M. & Manian,A. (2010). The study of the success indicators for pre- implementation activities of Iran's E-Government development projects. Government Information Quarterly.Vol.27.pp 63–69. ScienceDirect.

[8]. Mitrovic,Z.(2009). Awareness of e-Government Related Small Business Development Services in Cape Town. The Electronic Journal on Information Systems in Developing Countries.Vol.39 (4).pp 1-14.

[9]. Bhatnagar, S.(2004). E-Government: From Vision to Implementation: A Practical Guide with

Case Studies. Sage India Publications. ISBN:0-7619-3259-3.

[10]. Hossan ,G., Habib, M. & Kushchu, I. (2006). Success and Failure Factors for e-Government projects implementation in developing countries: A study on the perception of government officials of Bangladesh. Poster session presented at the proceedings of 2th European Conference on Mobile Government. Retrieved March 20,2011 from http://www.mgovernment.org/resurces/euromgvo2006/PDF/9_Chowdhury.pdf

[11].Suki, N. & Ramayah, T.(2010). User Acceptance of the E-Government Services in Malaysia: Structural Equation Modelling Approach . Interdisciplinary Journal of Information, Knowledge, and Management.Vol. 5(1).pp 395-413.

[12].Adhikari,G. (2008, December).e-Revenue Administration in Nepal. Poster session presented at the proceedings of the 2nd international conference on Theory and practice of electronic governance. Cairo, Egypt. ACM.

[13]. Mohammad, H., Almarabeh, T. & Abu Ali,A.(2009). E-government in Jordan. European Journal of Scientific Research.Vol.35(2).pp 188-197.

[14].Alomari, M., Sandhu,K. & Woods, P.(2010). Measuring Social Factors in E-government Adoption in the Hashemite Kingdom of Jordan. International Journal of Digital Society (IJDS), Vol 1(2).

[15].Bwalya, K. (2009). Factors Affecting Adoption of e-Government in Zambia. The Electronic Journal on Information Systems in Developing Countries.Vol.38(4).pp1-13.

[16]. Shareef, M. ,Kumar, V., Kumar, U. &Dwivedi,Y.(2011). e-Government Adoption Model (GAM): Differing service maturity levels. Government Information Quarterly,Vol.28(1).pp 17–35 , ScienceDirect.

[17].Colesca, S.(2009). Increasing E-Trust: A Solution to Minimize Risk in E Government Adoption. Journal of Applied Quantitative Methods.Vol.4(1).pp 31-44.

[18].Teo, T., SRIVASTAVA, S. & JIANG, L. (2009). Trust and Electronic Government Success: An Empirical Study. Journal of Management Information Systems. Vol. 25(3), pp. 99–131.

[19]. Floropoulos, J., Spathis, C., Halvatzis , D. & Tsipouridou, M.(2010). Measuring the success of the Greek Taxation Information System. International Journal of Information Management. Vol.30 (1), pp 47–56.

[20]. Seo ,D., Yi, W .& Lee,K.(2010, November). Information Security Activities Model per e-Government Service Promotion Stage. Poster session presented at the proceedings of the 12th International Conference on Information Integration and Web-based Applications & Services. Paris, France. ACM.

[21].Luk,S.(2009). The impact of leadership and stakeholders on the success/failure of e-government service: Using the case study of e-stamping service in Hong Kong. Government Information Quarterly, Vol.26 (4).pp594-604, ScienceDirect.

[22]. Schneider, R. (2010, October). A Comparison of Information Security Risk Analysis in the Context of e-Government to Criminological Threat Assessment Techniques. Poster session presented at the proceedings of Information Security Curriculum Development Conference. Kennesaw, GA, USA.ACM.

Available at: www.sabauni.net
Journal home page: www.sjitn.sabauni.net

S.J.I.T.N
Saba Journal of Information Technology and Networking

Recommendations Generating Using Multi Attribute Decision Making

Hael Al-bashiri* , Amer Al-badarnehand,Ismail Hmeidi

Jordan University of Science and Technology (JUST), Department of Computer Science

Article info

Article history :
Accepted March, 2014

Keywords:
Decision Making

Abstract

In the last few years, the amount of information that is available on the Internet to the users grows rapidly. Due to this, the searching process for information or certain items and decision-making in most cases became difficult and very complex. The recommendation system technique is very important to help users how to deal with information overload. In this paper, we present collaborative filtering and Multi Attribute Decision Making (MADM) method that increases the accuracy of the system. The (MADM) technique is implemented to generate the recommendations. This technique is based on all ratings of most similar users that lead to improve the accuracy of traditional collaborative filtering approach.

The experimental evaluation has shown that the proposed recommendation system outperforms the traditional system in terms of accuracy by (12-15) %.

* Corresponding author:Hael Al-bashiri
E-mail address:hailealbashiri@gmail.com

Introduction

In our daily life, we make our decisions in most cases based on recommendations of people, newspapers, or the Internet (e.g., book reviews, movie critics, restaurant rating). However, as the amount of information that is available on the Internet grows very fast, So searching and making decisions about information becomes difficult. We need new technologies to help Internet users to how deal with information overload.

Recommendation systems can assist Internet users how to deal with this problem. These systems provide what you need according to what you chose at a previous time. The main objective of the recommender systems is to provide tools that help users to control the information search and gather actions of other users.

The recommender systems have important application areas that focus on considerable recent academic and commercial interests. They are widely used by many commercials and nonprofit web sites to help users to choose items based on users' preferences. These systems assist to overcome the problem of increasing information overload by providing customers with suggestions or recommendations based on their likes (good ratings) and dislikes (bad ratings) relative to the other customers. Big purchasing websites like eBay [18] and Amazon [17] represent some of the businesses that have essential recommendations into their shopping experience. Recommendations have become an integral aspect of these e-commerce platforms and are used to personalize the shopping experience [3].

A recommender system is a computer-based system that gives advice on items, services, or information based on pre-collected data such as past users' activities. These items/services are not yet accessed or purchased and may be users' interests. Recommendation list is generated based on analyzing historical information of other users' interests.

Recommendation systems are implemented by creating profile of a target user and comparing it with closest users' profiles which are stored in the database. The recommendation systems can be generally classified as [4]:

Collaborative Filtering (CF): recommendation systems: propose items to a target user depending on information about similarities among other users' preferences .*Content-based recommendation systems*: items are recommended to a target user based on similarity between their content and content of items which user has rated in the past time. *Hybrid recommendation systems*: These systems combine between both collaborative and content-based approaches in order to improve system accuracy and performance by avoiding limitations of them [5].

In collaborative filtering instead of using the items content itself, the items ratings are used to generate recommendations. One of the well-known collaborative filtering techniques is the k-nearest-neighbor (KNN).KNN compare this preference history with a preference of other users in order to find the K most similar users. Similarity calculation is based on the rating of items [6].

This paper is organized as follows. Introduction about the recommendation systems and problem space will be explained in section 2. Relevant recommendation approach and overview of collaborative recommendation systems will be discussed in section 3.The methodology and our approach will be presented in section 4. Experimental results are discussing in section 6. This paper will be concludes with section 7.

Problem Space

The essential problem in information filtering is calculating whether a certain item is likely to interest a user or not. The outcome of such a computation is either Boolean, yes or no, or a score that corresponds the scale to which a person may wish that item. Such a score helps to determine if an item can be suggested to a target user or not.

In this paper, we will explore the space of neighborhood-based and explain the MADM method that we have used.

Collaborative filtering using MADM method can be consisted of six steps.

1. Represent User-Item matrix.
2. Compute the similarities between all users and target user.
3. Select *n* users that have the highest similarity to create a neighborhood.
4. Construct Decision matrix using all neighbors' items (candidate items) with neighbors' ratings.
5. Apply TOPSIS method on decision matrix to normalize ratings and ranking all candidate items.
6. Chose a set of ranked items as recommendations.

Overview Of Collaborative Recommendation Systems

Many researchers in recommendation system area focused on rating constructions. Specifically, the estimate ratings for an item, which is unrated from user, based on past rating of the target user and other similarity users' rating. Many techniques are developed to predict ratings for items that cannot be accessed or purchased from user. And recommend set of them to target user according to the highest predicted rating, which is the most common and preferred approaches.

Collaborative recommendation systems recommend items to target user depending on the similarity between the current user preferences and other similar users. The collaborative filtering solves most of the problems that are found in the content-based approach. The recommendation of a collaborative filtering system depends on the similarity of users' preferences rather than similarity of items' content [13]. Close users are grouped together using some methods, such as k-nearest neighborhood [14]. The collaborative filtering approach suggests a set of items, which are liked to other items that the user's group prefers.

However, this approach has some shortcomings: it is difficult to give a good recommendation to users who have evolving preferences or strange tastes. The second problem appears when the information is not sufficient to find similarities between users' preferences. Another problem is if a new user or item entered into database can lead into a weak recommendation [9], this is known as cold star problem.

There are a lot of researches that can be classified as collaborative filtering system such as the system in [13]. Many collaborative recommendation systems have been developed and proposed in the literature. Some of these systems use correlation-based model. Some other algorithms employ a Bayesian network model [8][19], while others use association rules [10, 11].

User-Based Recommendation: Estimated predictions in this approach are divided into two steps. The first, computes the similarities among the target user and all other users using the Pearson Correlation Coefficient [12, 7, and 8].

$$W(u,v) = \frac{\sum_{a\in I}(R_{u,i}-R'_u)(R_{v,i}-R'_v)}{\sqrt{\sum_{a\in I}(R_{u,i}-R'_u)^2 \sum_{a\in I}(R_{v,i}-R'_v)^2}} \quad 1$$

Where *I* denoted to all items that rated by both *v* compared users and *u* target user, *R(u,a)* is the voting rated by user u on item *i*. and R'_u is the average rating for user *u*.

Then, in the second step *k* closest users to user *u* are taken in order to calculate the prediction rating for target user *u* on item *i* using equation 2. This formula shows how a prediction *P(u,i)* is computed. Where *P(u,i)*represents the predicted view for target user u about item *i*. *R(v,i)*represents the rating of item *i* by user *v*. R'_v is the average rating for user *v*.

$$P_{u,i} = R'_u + \frac{\sum_{i=1}^{k}(R_{v,i}-R'_v)W(u,v)}{\sum_{i=1}^{k}W(u,v)} \quad 2$$

Item-based KNN: the computing item-item similarities are used to calculate predictions [15]. The equation 3 is used to compute similarities between two items:

$$w(i,j)\frac{\sum_{u\in U}(R_{u,i}-R'_u)(R_{u,j}-R'_u)}{\sqrt{\sum_{u\in U}(R_{u,i}-R'_u)^2 \sum_{u\in U}(R_{u,j}-R'_u)^2}} \quad 3$$

Where, *U* represents all users who have rated both *i* and *j* items. Then apply the equation 4 to generate the prediction *P(u,i)*. This approach can use threshold for *k* similar items in here rather than all.

$$P_{u,i} = \frac{\sum_{j=1\ to\ K}\left(w(i,j)*(R_{u,j})\right)}{\sum_{j=1\ to K}(|w(i,j)|)} \quad 4$$

Where *k*=1,2,..*l* and *l* represent all items which are taken from the neighborhood.

Methodology

We apply MADM to recommend a set of movies that are important for the active user. The main steps of our work are:

- *Data Pre-processing:* is the important step in the data mining process in order to prepare data for another processing task to make data more easily and effectively processed. Data's gathering methods are often loosely controlled, resulting in out-of-range values, missing values, etc. This leads to produce misleading results after performed an analysis on dataset. Thus, the quality of data is important before running an analysis.
- *Representation Data Matrix*: The users and items can be set as a collection of numerical ratings into a user-item matrix.
- *Neighborhood Formation*: This step is the most important in the recommendation process. Neighborhood formation required computing the similarity between target user and other users within the user-item matrix. Similarity will be utilized to produce a recommendation for a target user.

  Neighborhood formation is performed in follows steps:

  i. Compare the similarity between all users with the target user within the user-item matrix.
  ii. Take K users that have the highest similarity to create a neighborhood.
- *Recommendation Generation:* In our system we employ multi attribute decision making approach in order to provide recommendations to the target user. MADM method describes any type of measurements that use a set of criteria to rank a set of alternatives. The output of MADM method is a set of alternative ranked that helps the user to whichever of these options is better than other.

The technique that is used in solving decision-making problems in our work is TOPSIS method (Technique for Order Preference by Similarity to the Ideal Solution) [2].

The TOPSIS technique is composed of the following steps:

Step 1: Construct normalized decision matrix R.

In this step, we transform various attribute dimensions into non-dimensional attributes, which allows comparisons across criteria. The normalized value of the decision matrix can be any linear-scale transformation to make value of rating between zero and one.

Normalizing score ratings is as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum x_{ij}^2}} \qquad 5$$

Where i=1… m and j= 1… n.

Step 2: Build the weighted normalized decision matrix.

We construct the weighted normalized decision matrix by multiplying each column of the normalized decision matrix by its related weight. The weight is determined directly using ranking method. In this method, the criteria are simply ranked in perceived order of importance by decision-makers: $c_1 > c_2 > c_3 > \dots > c_i$. The weights are non-negative.

The elements of weighted normalized decision matrix are computed using equation 6.

$$v_{ij} = w_j * r_{ij} \qquad 6$$

Step 3: Determine the positive ideal solution A* and negative ideal solutions A'.

- Positive ideal solution:

$A^* = \{ v_1^*, \dots, v_n^* \}$, where $v_j^* = \{ \max(v_{ij}) \text{ if } j \in J; \min(v_{ij}) \text{ if } j \in J' \}$.

- Negative ideal solution:

$A' = \{ v_1', \dots, v_n' \}$, where $v' = \{ \min(v_{ij}) \text{ if } j \in J ; \max(v_{ij}) \text{ if } j \in J' \}$.

Step 4: Calculate the separation measures from the positive and the negative ideal solutions.

The separation measure from positive ideal solutions is:

$$S_i^* = \left[\Sigma(v_j^* - v_{ij})^2\right]^{1/2} \qquad 7$$

Where i=1… m.

Similarly, the separation measure from the negative ideal alternative is:

$$S'_i = \left[\Sigma(v_j' - v_{ij})^2\right]^{\frac{1}{2}} \qquad 8$$

Where i=1… m.

Step 5: Calculate the relative closeness to the ideal solution C_i^*.

$$S'_i = \left[\Sigma(v_j' - v_{ij})^2\right]^{\frac{1}{2}} \qquad 9$$

Where $0 < C_i^* < 1$.

Step 6: Rank the alternative based on C_i^*,

Datasets

In our experiments the Movie Lens dataset that contains 100,000 movie ratings from 943 users on 1682 movies is used. The releasing time spans from 1922 to 1998 and the user's rating scale ranges from one star (in the worst case) and five stars (in the best case). Each movie has been rated at least once, and each user has rated at least twenty movies.

Users and items are numbered consecutively from one. The density of this version is around 6%. Here, the density is calculated as the fraction of ratings over the possible number of ratings[16].

In this work, we used three splitting data cases:

- First case: divided data into 80% training data and 20% testing data.
- Second case: divided data into 90% training data and 10% test data.
- Third case: we take ten items from each user as a test.

Experimental Results

In our experiments, recommended items are classified as interest to the target user or not

Fig. 1 shows AME value for each of the previous splitting cases. In Figure 1, we note that the AME values in the first and second cases are relatively closed, but the AME value in the third case is worst one due to that interest. User interest items are the items that rated by this user.

To evaluate the system, we used the recall measurement. If all the recommended items do not exist in the test set then the recall value is 0.0, which indicates that the accuracy of the system is very weak, if system finds all users' interests then the value of recall is 1.0, which indicates that the system has a great accuracy.

Our evaluation strategy based on comparing our recommendation system that applies the MADM approach to generate recommendations for a target user to a traditional recommendation system that uses predicted approach to generate recommendations.

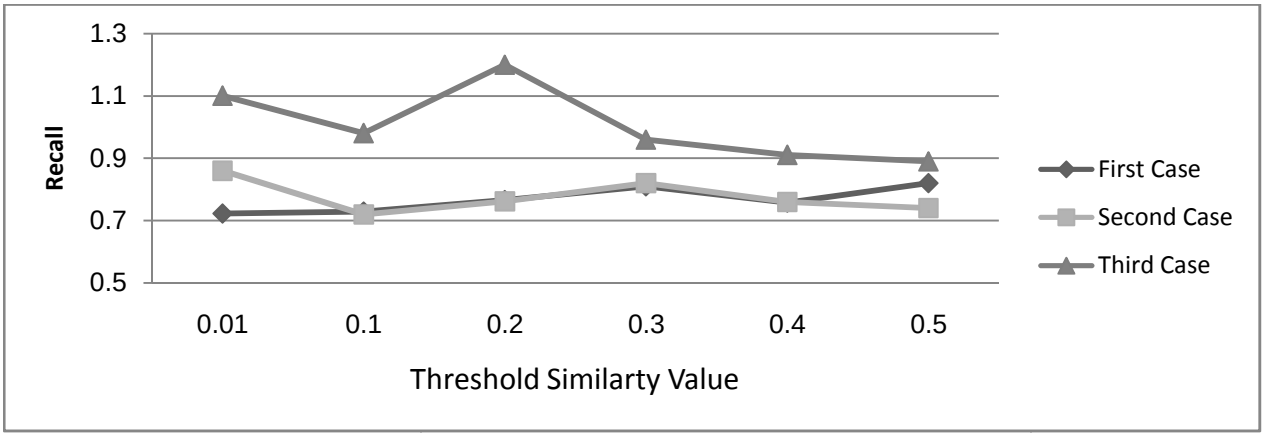

Fig. 1. AME for Different Splitting Dataset with Several Threshold Similarity Value.

the number of tested items for each user smaller than two previous cases. Also the AME value at threshold similarity value = .1 is better than AME value at threshold similarity value = .01, .2, .3, .4 and .5 in the all cases.

Thus, the Best Threshold Similarity Value (BTSV) is .1.

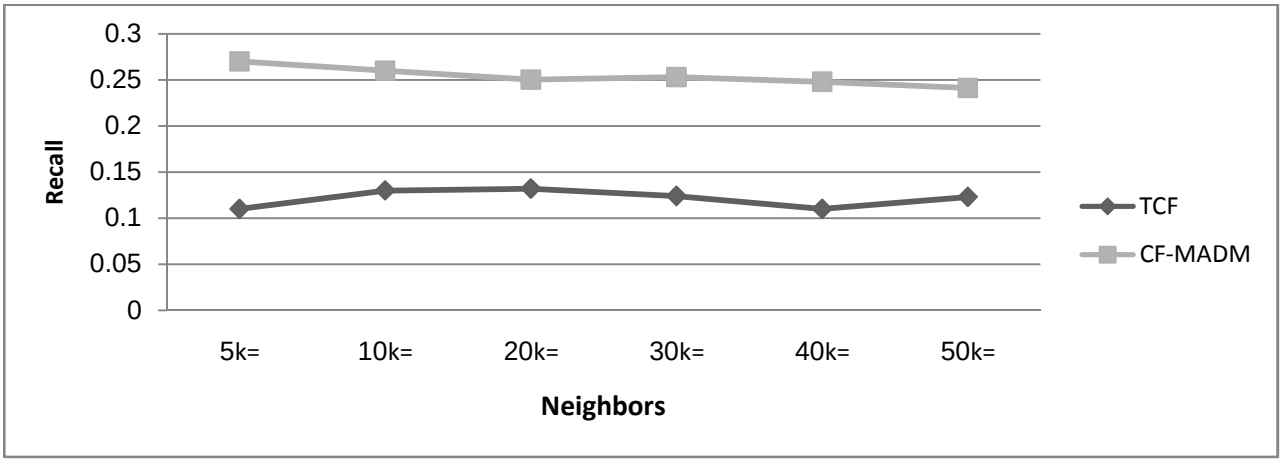

Fig. 2. Recall for CF-MADM and TCF.

Fig. 2 shows a comparison between the proposed method and traditional method in term of recall. Experiment conducted on the first case. The number of users is varied between 150, 100, and 50 randomly selected users. For each number of users we varied number of retrieved items between 50 and 100 retrieved items. After we done all the experiments we compute the recall average value for all cases and depicted it in the Fig. 2.

The results show that our approach performs better than the traditional one by approximately 12%. This improvement is due to that our approach is based on all ratings from most similar users for each candidate item. Unlike traditional approach that depends on prediction rate that used only the weight between target and similar

Fig. 3 shows a comparison between the first, second and third cases in term of recall. The number of users is 100, randomly selected users. For each number of users we varied number of retrieved items between 50 and 100 retrieved items. After we done all the experiments we compute the recall average value for all cases and depicted it in the Figure 3.The recall is affected by the number of items in testing data. Thus, you can note that the third case recall is better than the two previous cases recall due to that the number of tested items for each user is smaller than two previous cases user and ratings between them.

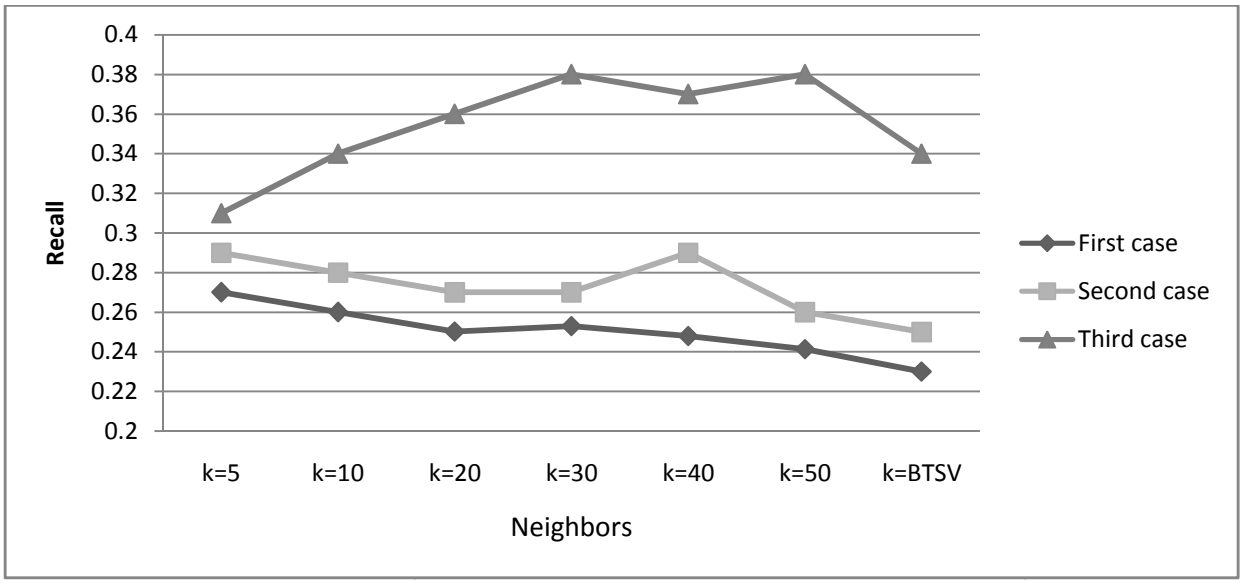

Fig. 3. Recall for First, Second and Third Cases.

Conclusions

This paper proposes a new generation method for collaborative filtering algorithm. Our new approach is based on all neighbors' ratings that lead to accuracy improvement. The experimental study shows that this approach has a better accuracy measurement (12%-15%) in generating recommendations using MADM method compared to generating recommendations using prediction method.

In the future work there are many possible directions, which include the following:

- Applying our experiments using different and larger dataset.
- Applying MADM method with other similarity methods and comparing between them.
- Applying MADM method with several similar methods to rank the most similar users.

References

[1]. Y. J. Lai, C. L. Hwang, Fuzzy multiple objective decision making methods and applications, New York: Springer-Verlag, 1994.

[2]. C. L. Hwang, K. Yoon, Multiple attributes decision making methods and applications, Springer: Berlin Heidelberg, 1981.

[3]. Sarwar, B. M., Karypis, G., Konstan, J. A., and Riedl, J. Application of Dimensionality Reduction in Recommender System–A Case Study. In Proceedings Of The AcmWebkdd 2000 Web Mining For E-Commerce Workshop, 2000b.

[4]. Vozalis, E, K Margaritis. Analysis of Recommender Systems' Algorithms. HERCMA. 2003; 732-745.

[5]. T. Y. Tang, P. Winoto, K. C. C. Chan. On the temporal analysis for improved hybrid recommendations. Web Intelligence, Proceedings. IEEE/WIC International Conference on, 2003.

[6]. Christakou, C., L. Lefakis, et al. A Movie Recommender System Based on Semi-supervised Clustering. omputational Intelligence for Modelling, Control and Automation, 2005 and International Conference on Intelligent Agents, Web Technologies and Internet Commerce, International Conference on.

[7]. P. Resnick, N. Iacovou, M. Suchak, P. Bergstrom, and J. Riedl. GroupLens: An open architecture for collaborative littering of netnews. In CSCW '94: Proceedings of the 1994 ACM Conference on Computer Supported Cooperative Work, 175-186, Chapel Hill, North Carolina, United States, 1994, ACM Press.

[8]. Billsus D, Pazzani MJ. Learning collaborative information filters. Proceeding of the 15th International Conference on Machine Learning, Madison, Wisconsin, 1998.

[9]. Zan Huang, Hsinchun Chen, Daniel D. Zeng. Applying Associative Retrieval Techniques to Alleviate the Sparsity Problem in Collaborative Filtering. ACM Transaction on Information Systems (TOIS). 2004; 22(1): 54-88.

[10]. Chamgchien S, Lu T. Mining association rules procedures to support on-line recommendation by customers and products fragmentation. Expert systems with applications. 2001: 20, 325-335.

[11]. Liu D, Shih Y. Integrating AHP and data mining for procedures recommendation based on customer lifetime value. Information and management. 2005; 42, 387-400.

[12]. J. Herlocker, J. Konstan, A. Borchers, J. Riedl. An algorithmic framework for performing collaborative lettering. In Proceedings of the 1999 Conference on Research and Development in Information Retrieval (SIGIR-99). 1999.

[13]. M. Balabanovic, Y. Shoham. Fab. Content-based, collaborative recommendation. Communications of the ACM. 997; 40(3):66–72.

[14]. Teng SH. Yao FF. K-nearest neighbor clustering and percolation theory. In Workshop on Algorithms and Computation. Hong-Kong 1993; 192-211.

[15]. B. Sarwar, G. Karypis, J. Konstan, and J. Riedl. Item-based collaborative filtering recommendation algorithms. In WWW '01: Proceedings of the 10th International Conference on World Wide Web, 285-295, Hong Kong, 2001, ACM Press.

[16]. Collaborative recommendation system [accessed 2012 May]. Available from URL http://www.grouplens.org/.

[17]. Recommendation system [accessed 2012 June]. Available from URLhttp://www.amazon.com/.

[18]. Recommendation system [accessed 2012 June]. Available from URLhttp://www.ebay.com/.

[19]. Breese JS, Heckerman D, Kadie C. Empirical analysis of predictive algorithms for collaborative filtering. Proceeding of 14th Conference on Uncertainty in Artificial Intelligence; 1998 July; Madison, WI.

Available at: www.sabauni.net
Journal home page: www.sjitn.sabauni.net

AUTOMATIZATION OF UNIVERSITY TIMETABLING PROBLEMS

Ivanchenko, A., Abuhania ,A. *

South Russia State Technical University, (Novocherkassk Polytechnic Institute)

Article info

Article history:

Accepted March, 2014

Keywords:

Scheduling
Constraints
Curriculum

Abstract

This article is running a formalization of the basic elements of the problem of scheduling training sessions for universities. Analyzing "hard" and "soft" constraints.

We are developing computing Information model for scheduling problem of the university. Describing the table components, their structure and linked relations as well as describing the general scheme of solving the problem

* Corresponding author: Amer Abuhania.
E-mail address: am27er@gmail.com

Introduction

In operations research, real world problems are often solved by analyzing and modeling them so that they can be solved by some sort of mathematical program or heuristic. These problems can be anything. From an optimization of a plant, a schedule for a job shop, a transportation routing problem, or even a university timetable. The programs used to solve these problems can range from integer, mixed-integer, or constraint programming to simulation, and also heuristics such as tabu search and other local search techniques. In order to model a problem or put a problem into a language that a program can solve, the problem definition must be formulated . This step of formulating the problem called scheduling problems for the university . University course scheduling can be considered as an instance of what so called timetabling problem, which appears to be a tedious job in every academic institute once or twice a year. This problem involves the scheduling of classes, students, teachers and rooms at a fixed number of time slots, in a way that satisfies a set of hard constraints and minimize the cost of a set of soft constraints. This problem is considered to be of more complexity, and this implies that there is no

known polynomial time algorithm that can guarantee finding the best solution . Traditionally, the problem is solved manually by trial and hit method, where a valid solution is not guaranteed. Even if a valid solution is found, it is likely to miss far better solutions. These uncertainties have motivated scientific studies of the problem to develop automated solution techniques for it. In this work, the university scheduling problem will be handled; this includes the process of assigning a set of (classrooms and laboratories, research and manufacturing equipment, computer and projection equipment, teachers) into account a set of hard and soft constraints. An example of hard constraints: no person can be in more than one place at a time. Another example is that the total resources allocated to a timeslot must be less than or equal to the resources that are available in that timeslot.

Soft constraints, on the other hand, are advisable to plan a lecture at the beginning of the working day and not to alternate them with studies of other species.

In these circumstances, the current task is to improve the efficiency of the university through the development and implementation of methods, models and software for making rational scheduling of various processes [1,2,3].

Definition of the problem

In the base of mathematical model of the subject area "Schedule" the concept of "process" is the considered the most significant which is a set of interrelated resources and activities that are linked to a specific time interval.

Let’s perform the formalization of the concepts "resource", "time interval", "activity" and "schedule" within the subject area.

As a resource we consider the university classroom sets where j is a multi-index:

$j = (j_b, j_a, j_c, j_t)$ taking into account the audience belonging to an educational building, its number, its type (for example, lecture-room, computer lab, electronics lab, etc.) and its capacity (for example, the audience for 25, 50 or 100 people) [1].

For concept formalization of time interval, there are two approaches in the task of period for scheduling. At the first approach the "natural" period of the curriculum - a semester is taken as a period, at the second is one educational week or two in succession going weeks (first and second, etc.). The second approach ("a week's time-table") is simpler in realization, more clear to the participants of educational process(teachers and students) due to the rhythm of a week's time-table . The elementary temporal interval of sets according to folded tradition is called a "pair", and the totality of all temporal intervals in the span of time corresponding to the period of scheduling formation makes up the great number of $T = \{t_i\}$, that is used in the process of scheduling [1,2].

Applying to scheduling formation the concept activity is characterized by three objects, that we will name a teaching unit:

$$u_p = \{g_k, d_q, p_l\}$$

Where: g_k is a group of learners , d_q - the studied discipline and p_l is a teacher . The totality of all educational units of higher learning institution forms for the examined period of scheduling sets $U = \{u_p\}$.The above mentioned formalization of such concepts as a resource, a temporal interval and an activity allows to examine a time-table (schedule) as some unambiguous reflection of s from sets U . in a set (work is Cartesian) $T \times A$:

$$s: U \to T \times A \in S .$$

Constraints

Obviously, not every reflection from S can be considered as a time-table because of its possible physical realization that is determined by the set of "hard" constraints. In turn, the time-table quality serving as a criterion during the selection of the "best" time-table from the sets of possible is related to the degree of "soft" constraints satisfaction.

We consider the list of main "hard" limitations as follows:

1)The condition of audiences availability. It is assumed that every audience has the chart of availability forbidding its use in certain temporal intervals. It means that some columns of F matrix must be canceled beforehand (or filled by values "n/a"). As the limitation can be named static due to its implementation providing the decision of scheduling task and is resulted in the simple narrowing of decision area searching.

2) The condition of teachers availability assumes that a teacher can have the "chart of presence" meaning that in certain temporal intervals he is out of higher learning institution and cannot

participate in educational process. There is also a static limitation and its implementation is taken to priori placing of several values "n/a" in the lines of F matrix corresponding to the set of a teacher.

3) The condition of two educational units' compatibility $u_i \; and \; u_j$ meaning that in the set temporal interval (pair) every student and every teacher can participate only in one elementary process. The verification of this limitation is taken to the calculation of $u_i \cap u_j$ crossing if it is empty, then teaching units of $u_i \; and \; u_j$ are compatible. We should notice that this constraint is dynamic, as it needs to be checked up only in the process of decision making. However, for corresponding calculations reduction is boole of BU matrix can be formed beforehand.
4) The condition of educational units and audiences compatibility, that supposes the existence of possible audiences list for every teaching unit. The admission can be related both to the capacity of audience and it specialization (a stream lecture cannot be conducted in a laboratory, laboratory employment on mechanics cannot be conducted in chemical laboratory etc.). Static constraints and their implementation are also taken to a priori placing of several of values "n/a" in lines of F matrices.
5) The condition of "attainability": two audiences appointed in a time-table in contiguous temporal intervals can appear "unattainable" in relation to a teacher or students if distance between corresponding educational corps is great (dynamic constraint).

Along with "hard" constraints it is accepted to also examine "soft" constraints of R_m, that can be broken and on the whole the degree of violation of totality of such constraints can characterize the time-table "quality".

We consider some of "soft" constraints as follows:

1) The amount of the lessons during the day conducted by a teacher, must not exceed a set value W_p. The verification of this constraint can be executed effectively enough taking into account that indexes of p for u_p and i t_i are multi indexes (i.e. there is a teacher index of l in the index of p , and in the index i containing the number of the day of the week of d).
2) The amount of lessons during the day, on which a student must be present, must not exceed a set value W_s. The verification of this constraint is produced with the use of the above mentioned boole matrix of BG .
3) The lessons planned to a teacher on a concrete day must be located in contiguous temporal intervals (without " break ").

   Accordingly, the amount of such " break " can serve as the measure of time-table quality.

4) The lessons planned to students on a concrete day also must be located in contiguous temporal intervals (without " break "), and the amount of " break" influence on the estimation of time-table quality.
5) The absence of "transitions" is desirable between educational corps during the day both for teachers and students (accordingly, the amount of transitions serves as the measure of time-table quality).

It is possible to suppose that the brought list of "soft" limitations is not exhaustive and can be broaden.

With the use of the formalization described above it is possible to offer the next chart of scheduling task decision:

1) The preparation of basic data: the forming of U, T and A sets. It is rather routine process, however because of large dimensions of these quantities and the presence of them some structural peculiarities in (that is expressed by the use of multi indexes), their realization must lean against the careful working of corresponding structures of data (informative model) and envisage the use of "friendly" interface users.

2) The forming of the initial state of sets S by the treatment of "hard" constraints array.

3) The generation of " null " approaching – a possible curriculum of $s \in S$ satisfying "hard" limitations and the estimation of its "quality" by the folding of vectorial criterion in which private criteria are the measures of the violation degree estimation of "soft" constraints.

4) The organization of iteration process improvement of current time-table by the use of some known methods of discrete optimization [1,2].

Computer Informative Model (CIM)

Taking into account the large volume of set of model parameters, the presence of difficult logical and quantitative dependences between them, and also the possibility of decision task receipt of acceptable quality and in reasonable terms only by means of a computer, a necessary step is the creation of computer informative task model of scheduling. Under the computer informative model (CIM) the set of sizes (data), containing all necessary information about the investigated objects and processes, and also relations (connections) between them, is implied, logically and physically organized as the database (DB) kept in the memory of a computer and being under a management of control system databases (CSDB).

The realization of this step will allow not only to provide the comfortable form of data grant to programmatic application realizing the surplus of possible variants of time-table and the searching among them the best one, but also creates an "informative platform" for the realization of necessary functions for the use of the data kept in the CIM different categories of users. In the most general view central part CIM can be presented by the figure no [1]:

We've done a short review of the known methods that is necessary as a subject sphere within the framework of the Time-table formation for Institutions of higher learning. Among the methods of decision of scheduling task, it is possible to distinguish the following methods: the method of annealing imitation, the algorithm of count coloration, the imitation programming, the linear programming, and the genetic algorithms in whole [1,2,3,4].

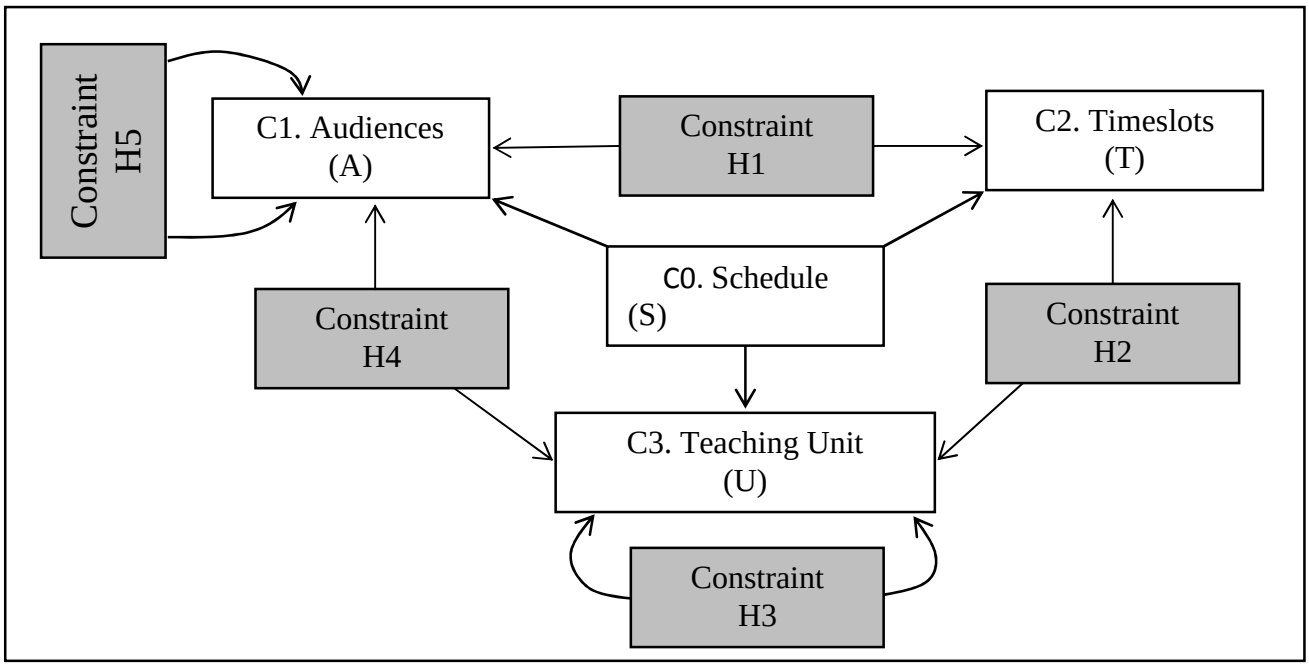

Fig. 1. Relations between the central table and the constraints

Conclusion and future work

In this research a new methodology for solving university course scheduling is proposed and implemented using real data set from the South Russia State Technical University. We have reduced the soft cost without affecting the hard cost by using multi-objective optimization.

As a future work, it would be a good idea to enhance the algorithm by trying other methods and evolutionary techniques. Also, to consider more soft constraints to better satisfy the willingness of the students and teachers, better.

References

[1]. Ivanchenko A.N., Abu hania A./ On the formulation scheduling problems for the university// News . institutions of higher learning. North - Caucasian region. Tech. Sciences - 2012. № 6. - C. 9-13

[2]. Zav'yaloA.M. Automation of task of drafting of educational time-table [electronic resource] / A.M.

Zav'yalov, A.B. Novikov // analysis of Systems in science and educatio: electron. Journal. - 2009. - № 1. - http://www.sanse.ru/archive/12(date of appeal : 30.04.2013).

[3].Oluwasefunmi T. A.A Genetic Algorithm Approach for a Real-World University Examination Timetabling Problem[electronic resource]/ Oluwasefunmi T. Arogundade, Adio T. Akinwale, Omotoyosi M. Aweda// International Journal of Computer Applications. – 2010. – Vol. 12, No.5, December 2010. – 4 p. – URL: http://www.ijcaonline.org/volume12/number5/pxc3872083.pdf(date of appeal: 02.07.2012).

[4] .RamirezE. R. Using genetic algorithms to solve high shool course time tabling problems : A Thesis Presented to the Faculty of SanDiego State University. In Partial Fulfillment of the Requirements for the Degree Master of Science in Computer Science [electronic resource]. - 2010. – 57 p. – URL: http://sdsudspace.calstate.edu/xmlui/bitstream/handle/10211.10/567/Ramirez_Eugene.pdf (date of appeal: 02.07.2012).

Available at: www.sabauni.net
Journal home page: www.sjitn.sabauni.net

Designing Algorithm For Resources Management Between Processes In Cluster Networks

Dr. Al-Khulaidi Abdualmajed Ahmed*

Saba University, Sana'a Republic of Yemen

Article info

Article history :
Accepted : 2013

Keywords:
Clustering
Task scheduler
Resource manager

ABSTRACT

The paper is concerned with the problem of optimizing the distribution of tasks executed in the cluster. To solve this problem, algorithm has been developed to perform management tasks. Verification of the proposed algorithms has been implemented for solving the transportation problem on a cluster network. The data obtained allow us to judge the effectiveness of implemented algorithms.

* Corresponding author: Dr. Abdualmajed A. Al-Khulaidi.
E-mail address: a.alkhulidi@sabauni.net

Introduction

In recent years, both abroad and our country have been working actively in association with the use of parallel processing technology. With the use of parallel processing technology, it may significantly increase the performance speed. Because supercomputers are expensive, only large companies and institutions can have such computing power [1,2,3]. The solution to this problem is the clustering of complete processing units together, therefore it is possible to create a system that make computing power comparable to a supercomputer and cost much less.

Algorithm Of Resource Management Between Processes

The job is an abstract entity consisting of a set of commands and options. The task presented to the user in the form of a script contains the resource requirements, job attributes and a set of commands to be executed. Once a script task is created, it can be used as many times as necessary and possible modification of it. The Job must be first put in the scheduler queue, then out of the queue. It will be passed to a node for execution. The job can be conventional (regular) and interactive. The usual task is queued and then we wait for its execution, the result will be recorded in a user-specified location. Interactive definition differs in the input and output streams that are redirected accordingly on the screen and keyboard respectively, Tasks of teams are entered from the keyboard itself. Each job may require running a lot of different resources such as processors, memory, time (and the usual CPU). You may also need storage space. With the help of a resource manager, we can set a limit for each resource. If the limit is not set for any resource, it is assumed to be infinity algorithm:

1. Algorithm is determined by the type of resources used by this task and the number and priority of the task.
2. Assignments are distributed by stages and arranged in order of priority.
3. Management Service are then sent to an executable script. Binding to an existing reservation is made by ASL, the reservation of resources at this point should already be done. Resources can be of the following species: the number of processors, memory, required software, virtual memory, time and so on…

Resource management in computing systems deals with the allocation of available system resources to the various tasks ready to be executed. This is a process that significantly affects the overall performance of the system. Typically, resource allocation algorithms take as input a list of tasks or processes that are ready to be executed at some particular time as provided by a system scheduler. The scheduler considers a task flow graph in order to resolve task dependencies. Traditionally, resource allocation in multiprocessor systems concentrates on the allocation of software tasks to each of the processor nodes (usually individual processors with local and memory), such that the overall performance of the system is maximized. This is a well-known problem with a large amount of research contributions towards efficient utilization of the massive hardware parallelism available in such systems using various exact and heuristic approaches. In a case of many core systems, important on-chip constraints such as limited buffer capacity for on-chip communication, on-chip network congestion, power density, and limited must be used.

In an effort to integrate the emerging challenges, I/O bandwidth necessitate the evolution of existing algorithms or even the development of new algorithms, In such dense systems, efficient workload distribution could benefit from real-time system information knowledge such as the status/utilization of each core and, additionally, the status of the interconnection network.

Interconnect-associated delays are an important factor in efficient decision-making and the problem is further more complicated while controlling Memory is related to traffic, such as cache misses and synchronization data is taken into consideration. Whilst dealing with a similar problem, research looks at general-purpose systems (CMPs) from a slightly different viewpoint , when compared to application-specific systems (MPSoCs). General purpose systems face runtime uncertainties where cache misses, data hazards, and unpredictable interconnect modeling can potentially alter the expected execution time of one task significantly. On the other hand, application-specific many core systems (typically heterogeneous MPSoCs) usually deal with predictable schedules and execution times. Consequently, MPSoC-related research mostly focuses on finding optimal, static, design time allocation, where the mapping of tasks to the cores can either take place as part of the compilation, or mapped prior to execution on the processor cores. However, as the number of cores increases, MPSoCs are expected to contain groups of cores, where all cores in a group are of the same type. Any core inside a group can potentially execute some task, shifting the task allocation process towards finding the best core that can execute one type of task among the cores in a group. As a result, allocation in future massively parallel CMPs and MPSoCs is expected to face similar issues and should not necessarily be treated independently.

Bidding Algorithms

This work uses the concept of bidding to decide how to allocate processes to the various cores of the system. Bidding algorithms have been widely used to solve several optimization problems as part of auction-based algorithms. Typically, for a specific number of items, there are n possible “bidders”, with each “bidder” placing a bid in an attempt to “buy” a number of items. Usually, the highest bidder claims one or more items, and bidding continues until there are no more items or no more bidders. Such algorithms can also be used in more complex scenarios, under various constraints. Bidding-based algorithms traditionally offer load balancing across distributed systems and networks, optimizing performance and utilization. In the proposed algorithms, cores actively decide based on their workload and utilization of their related communication resources (on-chip network) whether, and to what extent, to bid for (request) additional process (task) assignment. Each core (or group of cores), computes its bid independently and sends it, through the on-chip network, to the system level on-chip allocation engine. Transferring this decision to the cores is done with minimal overhead; it also improves flexibility and scalability of the system. Subsequently, the allocation engine decides where to assign the list of pending processes/tasks dispatched by the system scheduler, based on the placed bids.

In this work, we present two different simple bidding-based algorithms for performing on-chip resource allocation in a many core system, where processes are the “auctioned” items, and a processor core (or a group of cores) places its “bid” based on its status (or the status of each core in the group). since we are targeting hardware implementation of the algorithm where speed and simplicity are critical factors, We are aiming for a simple and fast bidding based solution, rather than an optimal one, Still, the obtained experimental results demonstrate significant performance improvement and highly balanced utilization among the various cores. The presented algorithms improve the system’s performance when compared to a standard (static) allocation mechanism such as round robin implemented in hardware. We use round robin as a hardware reference algorithm in evaluating our optimization algorithms, due to its simplicity to be implemented

(very low hardware overhead) as well as the lack of other existing comparable solely hardware-based solutions for the specific problem under consideration.

The first algorithm, Necessary Resorting (NRS), is simpler in terms of operations performed and, therefore, faster. At some time instance T, it starts by sorting the list of clusters C and the list of processes P . Then, it binds the highest bidder (cluster at the top of C) with the largest process (the one at the top of P), the second highest bidder with the second largest process, and so on. This scenario tends to distribute the various processes among the available clusters in such a way that clusters with smaller, already allocated, workload and/or smaller network traffic are allocated to larger processes. Hence, workload balancing is inherently achieved without being explicitly targeted.

The second algorithm, Dynamic Resorting (DRS), follows a similar rationale as the NRS algorithm with the exception that a cluster's bid is re-calculated every time a process is bound to the cluster and the list of available clusters in C is resorted in order to reflect the allocation. Hence the allocation is more dynamic in DRS than in NRS. In contrast to NRS that binds at least one process to each available cluster before considering binding additional processes to a cluster, the DRS algorithm can bind several processes to a cluster, and possibly none to others, based on the dynamically recomputed bids. Bidding, in this context, offers several inherent benefits. Bid computation is distributed inside the cores/clusters, eliminating unnecessary traffic. Also, if the clusters cannot respond due to network congestion or them being busy, their bid value is assumed to be zero and, hence, these clusters are excluded from the allocation during the busy intervals. The bidding process is scalable, since an increase in the bidders can easily be integrated by increasing the lists of bids and tasks as well as using more than one allocation units (each managing groups of clusters/cores). As the network size grows, network delay, a more important factor in large networks, is a linear component of the bid. Similarly, core simplicity and core clustering allow for hierarchical multilevel allocation engines, which can take into consideration more detailed intra-cluster conditions.

Application Of The Proposed Algorithm In A Cluster Package Mpi / Mpich And Checking It More Efficiently For Distribution To The Transportation Problem

The practical significance of the work lies in the fact that the algorithm of job control was used to expand the library mpich (for free licenses)
that is in the creation of the programming model cluster, which includes the implementation of the proposed algorithm. Using the library has been developed, parallel program is found to support program in the transportation problem based on the method of Vogel (penalty) for the cluster network.
Execution was carried out on 4 machines with dual-core Intel Core 2 Duo E6700 and 2 GB of RAM are given in Table 1. All times are in seconds.
Comparative system performance while running the example shown in Figure 1.
The abscissa in parentheses indicates the number of processes. The graph shows that there is a slight performance boost while running in an environment MPI / MPICH_NEW. However, when the number of processes from 20 to 40 increase in performance ,it becomes more significant (1.13 times faster when calculating the matrix of size 1000x1000).

Conclusions

Thus, the algorithm was tested in a distributed job to control problem on a cluster system MPI / MPICH and MPI / MPICH _NEW. Tests showed that the algorithm developed an efficient solution for the selected class of distribution problems.

Table 1.Results of computational experiments on the algorithm proposed management jobs in the cluster model of MPI / MPICH_NEW

Dimension of task	Number of processes	Run-time parallel algorithm for finding the support program (seconds)		Acceleration
		MPI/MPICH	MPI/MPICH_NEW	
50x50	20	0,005	0,005	–
70x70	20	0,009	0,009	–
100x100	20	0,020	0,019	1,05
150x150	20	0,031	0,029	1,06
500x500	20	1,020	0,935	1,07
500x500	40	1,005	0,920	1,09
1000x1000	40	2,501	2,209	1,13

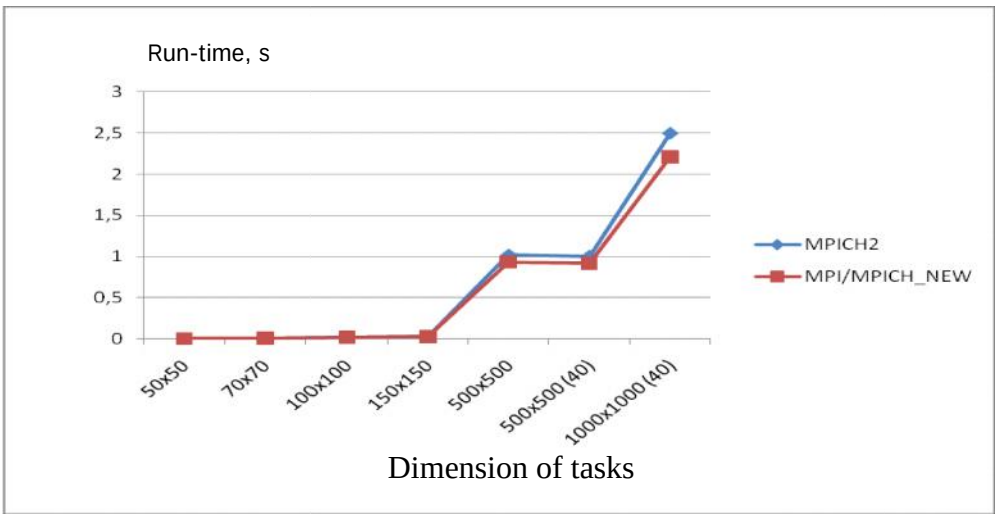

Fig. 1. Graph of execution time in MPI environment before and after application of the algorithm developed

References

[1]. AL-Khulaidi A. A. , Analysis of existing packages in the cluster networks, N.N. Sadovou, Journal Vestnik Don State Technical University, Russia 2010.T.10.

[2]. Foster I., Kesselman C., Tuecke S. “The Anatomy of the Grid: Enabling Scalable Virtual Organizations”. International Journal of High Performance Computing Applications, London.

[3]. Foster I., Kesselman C., J. Nick, Tuecke S. “The Physiology of the cluster: An Open Grid Services Architecture for Distributed Systems Integration”.
http://www.globus.org/research/papers/ogsa.pdf