More than Two Decades of Research on Groupware: A Systematic Lexical Analysis

Loay A. Altamimi

Abstract—Collaborative technologies or software known as groupware are key enabling tools for communication, collaboration and co-ordination among individuals, work groups and businesses. Available reviews of the groupware literature are very few, and mostly neither systematic nor recent.

This paper is an effort to fill this gap, and to provide researchers, with a more up-to-date and wide systematic literature review. For this purpose, 1087 scholarly articles, published from 1990 to 2013, on the topic of groupware, were collected by the literature search. The study here adopted the systematic approach of lexical analysis for the analysis of those articles.

Keywords—Lexical Analysis, Literature review, Groupware, collaborative Software.

I. INTRODUCTION

IN general, information and communication technologies (ICTs) have an undeniable effect on the organizational processes and dynamics, particularly, with regard to collaboration, *cf.* for example, [1]. In this respect, collaborative technologies or software known as groupware are key enabling tools for communication, collaboration and co-ordination among individuals, work groups and businesses [2]. Groupware refers to applications that, integrate work on a single project by several concurrent users at separated workstations. These applications accentuate the multiple user environments, coordinating and orchestrating things, so that, users can "see" each other, avoiding the conflicts with each other [3]. Such technologies are designed to allow users to communicate more effectively, improve productivity at meetings, provide access to knowledge repositories, and/or manage projects [4]. The collaborative functionality of groupware is frequently the application that drives companies to extend their networks beyond a single site and outside the enterprise [5].

The 1990s saw the emergence of groupware [6]-[8], and the proliferation of various groupware and collaboration software tools [9]. Since then, and particularly, with the advent of the web, many types of these applications are currently available and being used in organizations around the world. In addition, over this period, groupware has been the focus of many research efforts, and there has been a growing body of literature on this subject, especially, in this context, in the management & organizational literature. However, available reviews of the groupware literature are very few, and mostly

neither systematic nor recent (these reviews are outlined later). This paper is an effort to fill this gap, and to provide researchers, with a more up-to-date and wide systematic literature review through employing the principle of lexical analysis. The lexical analysis presented herein, is the first phase for further analysis of the literature using the content analysis approach, by which, articles are to be codified and analyzed according to theoretical categories.

II. GENERAL BACKGROUND

The term groupware is a hybrid of the words group and software [10]. Besides the ones mentioned in the introduction, there are many other available definitions of groupware, e.g. *cf.* [11]. These technologies, are also referred to as "collaborative software" e.g. [11]-[13] or "collaboration technology" [14].

In the literature, there are several taxonomies and classifications of groupware applications. These are based upon different criteria, such as, for example, same/different time/space, kinds of interaction supported, the groups' size, the predictability or unpredictability of different times/places, strategic intent of the technology, or the kind of collaboration or data supported [15]. Also, *cf.* [14], [16], [17].

Additionally, a number of models attempted to define the functions to be provided by a groupware application to its users. One important model is the Co4 model of [18]. According to its authors, this model, distinguishes four basic functions of groupware:

✓ Support for conferences by means of conference management functions.
✓ Support for cooperation by mean of shared workspaces.
✓ Support for conversation by means of conversation channels.
✓ Support for coordination by means of coordination policies and coordination mechanisms.

Lastly, in this brief and general background, groupware may include many different types of applications [10]. However, it is not always easy to decide whether a specific tool qualify as groupware or not, and, there is sometimes some disagreement in this area [15]. Also, *cf.* [14]. In addition, in this context, it is important to draw a distinction between groupware and the newer technologies known as social software or Web 2.0. The groupware approach places people into groups defined organizationally or functionally, whereas, social software is based on supporting the desire of individuals to be pulled into groups to achieve their personal goals [19]. For more on the distinction between social software and groupware, see also, [20]-[22].

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III. A Review of Groupware Literature Reviews

As aforementioned, to the best of our knowledge, available reviews of the groupware literature are very few, and mostly neither systematic nor recent. These reviews, outlined here briefly, include the following:

Reference [23] reviews 230 articles published by mid-1998 and examined processes and outcomes in computer-supported group decision-making. It is a concise overview of what has been studied and how: the systems, independent, intervening, adaptation, and dependent variables, manipulated or measured, and experimental procedures employed.

Reference [24] reviews the theories and methodologies in the then literature on groupware, and, they propose a research agenda for future work in this area. Reference [25] reviews 45 papers from the ACM CSCW conference (1990-1998), for the methods and techniques used for the evaluation of groupware systems.

Another review is [26] which emphasizes on the group decision-making related to the team-based structure of the wood procurement organization, and its relationships with customers.

Reference [16] presents a review of research in the area of creating collaborative application taxonomies. The authors analyze previous literature, and examine commercial products and research prototypes in the domain of collaborative computing.

Lastly, with regard to previous groupware literature reviews, the authors of [10], in their words, do not attempt a traditional review of the groupware literature, and focus instead, on the group dynamics underlying the development of effective groupware. The study discusses the status and limitations of groupware research; then it addresses challenges in supporting collaborative activities in distributed teams. The authors develop and elaborate a group dynamics model of groupware development. Finally, they discuss the area of distributed or distance learning, in which collaborative-support tools are extensively incorporated.

IV. Contribution of the Paper

A review of the groupware literature is a somewhat daunting task, given the nature of this very broad and diverse literature [10]. As indicated earlier and seen from the previous part, available reviews of the groupware literature are very few, and mostly neither systematic nor recent. This paper is the first phase of an effort to provide researchers, with a wide and more up-to-date literature review that covers scholarly articles published in the period since the emergence of groupware to the year 2013. It attempts to explore the evolution of literature, identify the main types of tools addressed and significant trends in dealing with groupware as well as the main publications in this area.

The study here adopted a systematic approach for the literature review. It employed the principle of lexical analysis, which enables the treatment of a large corpus of information through applying statistical analysis to determine the frequencies of certain words and expressions in a text. As to the second phase, (outlined briefly in the future work section), it will involve the use of the approach of content analysis, by which articles are codified and analyzed according to predefined categories identified from relevant studies. According to Weber, as cited in [27]; the content analysis approach, can be defined as, a method of codifying the content or text of a piece of writing into categories based on chosen criteria.

V. Literature Search & Analysis Method

A keyword search against two categories, the documents' title and abstract, was performed for scholarly literature on groupware, published in the period from 1990 – 2013.

The literature search aimed to be as comprehensive as possible. However, it was kept, as far as possible, focused on literature published in the areas of business and management. To this end, the search utilized *Business source premier*, *Emerald* and the subject area of Business, Management and Accounting in the database of *ScienceDirect*. The list of search keywords (Table I) was developed with making use of [16], [28], [29].

TABLE I
LIST OF KEYWORDS FOR LITERATURE SEARCH

Groupware	Collaborative Software
Audio Conference	Collaborative Document Editor
Collaborative Writing Systems	Video Conference
Decision Support Systems	Electronic Meeting systems
Document Management Systems	Newsgroups
Electronic Calendaring	Workflow Management Systems
Collaboratories	Project Management Systems
Knowledge Management Systems	Usenet

The variables identified in the literature, for the purpose of the lexical analysis were as follows, title, abstract, source and year. The use of lexical analysis enables the treatment of large bodies of information. The use of statistical procedures allows reducing the reading effort, taking advantage from the redundancy of the language. Another advantage is to use lexical entries to focus on some words or uses that would remain hidden by a classical reading. Statistics can thus help the reader curiosity and reinforce the discovery process. Lexical analysis changes the focus from the reading of the text to the reading of its lexical substitutes and thus speeds up the knowledge process [30], [31]. 'Lexical analysis offers a middle-ground between quantitative and qualitative analysis, being rapidly applicable to texts of all types, and giving a far more flexible interface between the tasks of data acquisition, analysis and interpretation. This approach is typified by the calculation of "word lexicons": lists of words and their corresponding frequencies in the corpus' [30].

The lexical analysis adhered to the following guidelines throughout:

- The two variables **(Title, Abstract) are combined in a single variable (Tit&AbstCombined)**, in order to examine the title and abstract of each article simultaneously.

- The set of search keywords was developed into a dictionary (a dictionary is a list of terms which describes a certain theme), in which each keyword is grouped with its different variations and synonyms found in the corpus and is represented in the form (#keyword), where (keyword) is the name assigned to the group, (e.g. #groupware =Collaborative software, #Conferencing = Audio conference = Audio conferencing = Video conference = Video conferencing). That means that, a group (#keyword) is counted only once, if any of the variations and synonyms belonging to it, is repeated, and/or if found together, in the same article. This is done so that, frequencies are based on observations rather than on occurrences. In other words, **frequencies herein represent the number of articles referring to a certain group or (#keyword)**.

- The frequency of (#keyword) is ignored if it is zero.

VI. RESULTS

A. Evolution of Literature (Year of Publication)

After removing all duplicates, the total number of articles collected was 1087 articles. Fig. 1 shows that, overall, the number of studies dealing with groupware fluctuated and varied among the years 1990-2013. However, one may distinguish two periods here—the first period, covers almost the first half of the 90s – precisely, the first six years -, and, the second period, which, goes from the year 1997 up to the end of our period of analysis.

In the first period, which marked, as above indicated, the emergence of groupware, the number of articles published in each year, although not very many, yet, it indicates clearly that, these technologies elicited some early academic interest. Meanwhile, by and large, comparing to the first period, the number of articles in each of the years from the year 1997 up to 2013 (excluding, inexplicably, the year 2007), shows an evident increase, which, in turn, suggests that; studying groupware in the second period has gained and attracted more attention in the literature. This, could be because, the Web became popular in the mid- 1990s [32], [33] and since then, many types of web-based groupware applications have become available and used in organizations around the world. Indeed, Web based groupware solutions that support the creation of communities of practice or ad hoc collaboration have become an essential part of computer supported collaborative work [34].
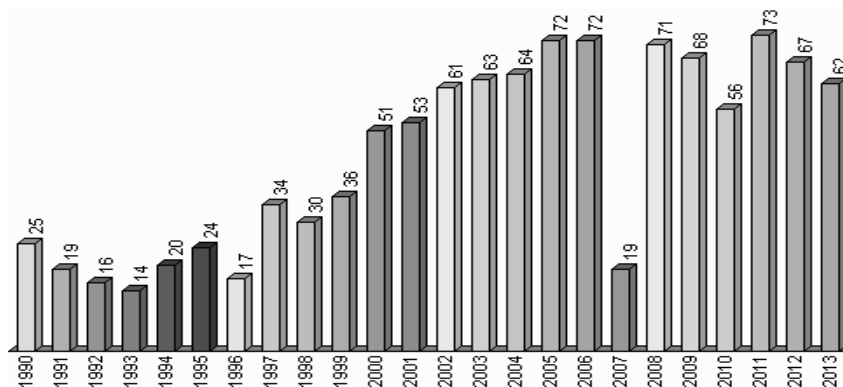

Fig. 1 Number of articles per year

B. Frequencies of Groupware Tools in the Literature

The results show that, various groupware tools were addressed in the academic research in varying degrees. It should be noted, however, that 245 articles of the total 1087 (22.5%) referred to # groupware in general, and did not include, any reference to any specific tool.

The frequencies indicate that, much of the attention in the literature was given to #decision support systems. This, in fact, goes in line with [35], who noted that, such systems are the focus of most of the research addressing groupware.

Decision support systems gained importance as a study area during starting days of distributed computing [36]. With the ever-increasing competitive and changing business environment, such systems have developed to accommodate the uncertainty [37], and, they are vital for effective decision making of a manager in an organization, which in turn are responsible for the survival and growth of the organization [38].

The literature shows also a degree of interest in other groupware tools. Among them, #knowledge management systems were the most frequent. Citing a number of authors, [39] indicates that, "given the rising importance in considering knowledge as a key organizational asset, interest in knowledge management systems (KMSs) is increasing at a rapid pace".

The other groupware tools were less popular and less frequent in the literature. These included consecutively, #workflow management systems, #conferencing, #newsgroup, #project management systems and #document management systems. The least frequent tools were #collaboratories and #electronic calendaring (each cited in only 2 articles) and #collaborative document editors and #collaborative writing systems (each cited in only 1 article). All the results are shown in Fig. 2.

Additionally, to give a general feel of trends over time, in addressing groupware tools; a correspondence analysis was applied to (Tools **X** Year) cross-table and displayed here graphically, as a "factor map", so that, trends become intuitive and easy to identify (Fig. 3).

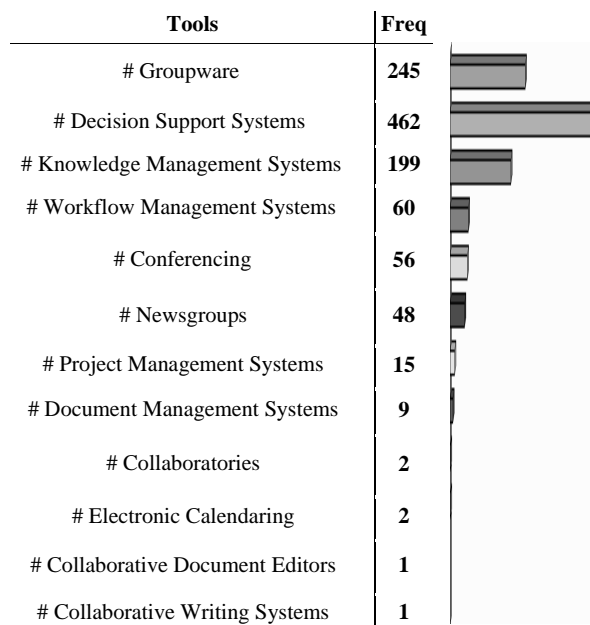| Tools	Freq
# Groupware	245
# Decision Support Systems	462
# Knowledge Management Systems	199
# Workflow Management Systems	60
# Conferencing	56
# Newsgroups	48
# Project Management Systems	15
# Document Management Systems	9
# Collaboratories	2
# Electronic Calendaring	2
# Collaborative Document Editors	1
# Collaborative Writing Systems	1

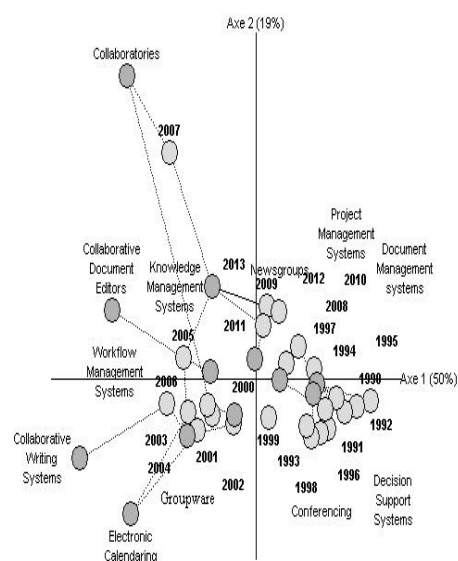Fig. 2 Frequency of groupware tools in the literature

Fig. 3 Factor map of groupware tools / year

C. Characteristic Words in the Literature

A search excluding "stop words" (e.g. an, on, of, the…etc.), words containing a number and words of fewer than two letters, was performed on the variable (Tit&AbstCombined), for the most characteristic words in the articles in this review. The results illustrated in Fig. 4, give a general feel of trends in the literature. (Thresholds were set to show, terms with a

minimum frequency of 5 for the whole corpus, and, only the 10 most frequent words). Moreover, the "factor map" (Fig. 5) illustrates the correspondence analysis applied on the (Characteristic Words X Year) cross table, and, offers a graphic representation of the results, so that, trends in the groupware literature over the search period (1990-2013), can come to life and become intuitively interpreted. In some sense, and, to a certain extent, some of these results find resonance in [34] who, citing a number of authors, stated that, "research on groupware has focused on design aspects, task processes and the impact of technology use. In the last years, the focus has shifted to social emotional factors of group collaboration and how this affects groupware design".
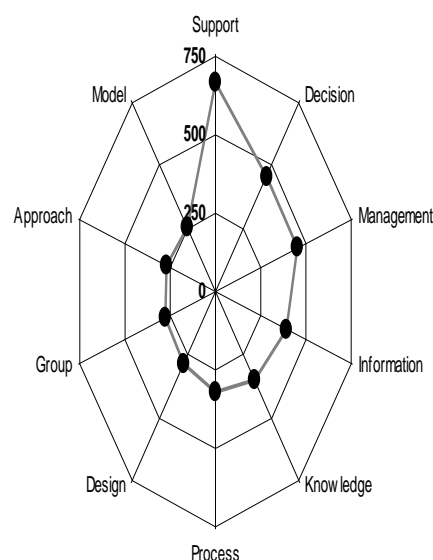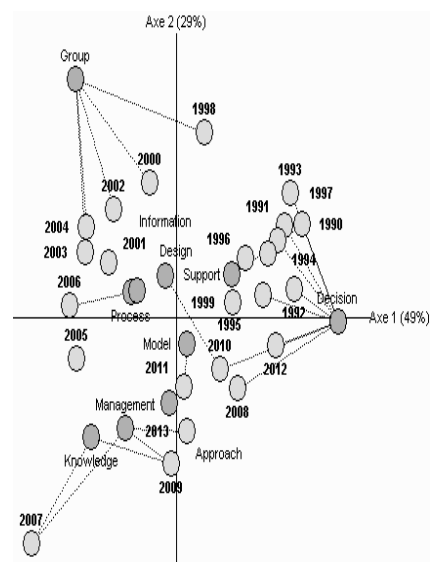

Fig. 4 Most characteristic words

Fig. 5 Factor map of most characteristic words / year

D. Top Publications

Lastly (and briefly), the results shown in Table II, concern the **5** top publications in terms of the number of articles published on the topic of groupware during the period 1990-2013.

TABLE II
TOP PUBLICATIONS ON GROUPWARE 1990-2013

Publication	No of Articles
Decision Support Systems	**62**
European Journal of Operational Research	**44**
Groupware: Design, Implementation, and Use	**32**
Group Decision and Negotiation	**29**
Journal of Management Information Systems	**28**

VII. CONCLUSION, LIMITATIONS & FUTURE WORK

The systematic literature analysis presented herein in this paper, employed the principle of lexical analysis, to produce statistical distribution of words and expressions key for the investigation in this work and enable the identification of the general trends in the literature. The paper provides an overview of, the status of the scholarly literature dealing with groupware technologies, and, its evolution since the emergence of these technologies. It also attempted to identify, the type of groupware tools addressed, and the degree to which they were addressed. Furthermore, the identification of the most characteristic words gives a general idea of the lines of research on groupware.

Overall, the results show that, there was some early academic interest in groupware technologies, with the beginning of their emergence. The results also suggest that, studying groupware has gained and attracted more attention in the literature after the Web became popular in the mid-1990s, and consequently, the prevalence of many types of web-based groupware applications in organizations around the world. On another front, the analysis showed varying degrees of interest, in the various groupware tools, and, it clearly indicated that, some types of these tools were under-addressed in the literature. This calls for more research in this area and offers several research opportunities to explore the different groupware tools' potentials and shortcomings in different situations, different people, and different needs. This is important for several reasons. Firstly, groupware applications can be used across a variety of different organizational levels and settings, *cf.* e.g. [40]. In addition, as [41], for instance put it, "the set of groupware tools used during a distributed development process is usually chosen by taking into account predetermined business politics, managers' personal preferences, or people in charge of the project. However, perhaps the chosen groupware tools are not the most appropriate for all the group members and it is possible that some of them would not be completely comfortable with them".

Secondly, groupware systems are heterogeneous and each offers a unique set of benefits [42]. For instance, groupware tools have different representation modes (based on figures or diagrams, or based on spoken or written words) and different Interaction Modes (e.g. synchronous or asynchronous) [41]. And, thirdly, with the emergence of the "Web 2.0"; organizations and teams can now cook up a collaborative framework of tools from a plethora of tools available on the Cloud [43].

Admittedly, the approach of lexical analysis used for the literature review, presented in this paper, involves some limitations. These limitations come from the fact that, as indicated earlier, lexical analysis is limited to determining the frequencies of words and expressions in a certain text. Thus, in the future work, and in order to improve these limitations and to make the literature review deeper and richer; literature will be analyzed using the approach of content analysis, by which articles are codified and analyzed according to predefined categories identified from relevant studies.

Content analysis could serve as a convenient research method for studying research publications [44]. It is the process that most of the units of a document, such as the title, abstract and so on, be analyzed and comprehended [45].

Content analysis is a qualitative research method commonly used for systematically studying large amounts of communication content such as news, articles, books, videos, or blogs. The key characteristic is that, the analyzed content is categorized by researchers [44]. It is a process by which communication content is transformed, through the objective and systematic application of categorization rules, into data that can be summarized and compared [46].

REFERENCES

[1] K. Gareis & W. B. Korte, ICTS and the adaptability of work arrangements in the EU. The Xth European Conference on Information Systems (ECIS), Gdansk, Poland. (2002, June), 1101- 1112

[2] S. Ray & S. Das, Corporate reporting framework (CRF): benchmarking Tata motors against AB Volvo and exploring future challenges, decision, (2009), 36(1):101–129

[3] C. Bouras, E. Giannaka & T. Tsiatsos, E-collaboration concepts, systems, and applications: Information Science Reference. In M. Freire & M. Pereira (Eds.), Encyclopaedia of internet technologies and applications, Information science reference, (2008). (165-171), ISBN 978-1-59140-993-9 (hardcover) -- ISBN 978-1-722 59140-994-6 (eBook)

[4] B. McKnight & N. Bontis, E-improvisation: Collaborative Groupware Technology Expands the Reach and Effectiveness of Organizational Improvisation. Knowledge and Process Management, (2002), 9(4), 219-227

[5] T. Wedlund, Global Product Development Supported by Groupware. The Sixth Conference on Product Models, (2000, November), Collegium, Linköping

[6] S. Carter, Collaboration Tools for Crisis Action Planners: an Evaluation of Microsoft Office 2000. Army command and General Staff College, Fort Leavenworth, Kansas, school of advanced military studies, (1999).

[7] E. L. C. Law, A. V. Nguyen-Ngoc & S. Kuru, Mixed-method validation of pedagogical concepts for an intercultural online learning environment: a case study. In Proceedings of the 2007 international ACM conference on supporting group work, (2007, November), pp. 321-330

[8] A. Keary, S. Redfern & P. Walsh, Current Trends and Developments, Future Requirements, and Predictions for Computer Mediated

Communications and E-Collaboration. Chapter 11, p.213, In Jennex, M. E. (Ed.). (2013), Knowledge Discovery, Transfer, and Management in the Information Age. IGI Global

[9] S. Kaplan, Technology and Organization Development, in Practicing Organization Development A guide for Consultants, 2nd Ed, Rothwell W. J. & Sullivan, R. L. (Eds.), John Wiley & Sons, Inc. (2005). pp. 550-582

[10] J. E. Driskell & E. Salas, Groupware, group dynamics, and team performance, CA Bowers, E. Salas, & F. Jentsch (Eds), Creating High-Tech Teams: Practical Guidance on Work Performance and Technology. Washington, DC: American Psychological Association, (2006), (pp. 11-34)

[11] A. Lococo & D. C. Yen, Groupware: Computer supported collaboration. Telematics and informatics, (1998), 15(1), 85-101.

[12] M. Mazurek, T. Galeta & V. Galzina, Open source document management system in preparation of EU grants applications. In 4th International Scientific and Expert Conference TEAM 2012, (2012)

[13] P. Nemutanzhela, Functionalities of Groupware and Group Decision Support Systems. International Journal of Computer Science and Management Research, (2013), Vol 2 Issue 3

[14] C. Ellis & J. Wainer, 10 Groupware and Computer Supported Cooperative Work. Multiagent Systems: a modern approach to distributed artificial intelligence, (1999), 425.

[15] C. Franklyn, Computer Supported Cooperative Work (CSCW): Some Comments, Journal of Language, Culture and Communication (JLCC) February, (2010), Volume 1 No.7 & 8, 20-28

[16] G. Bafoutsou & G. Mentzas, Review and Functional Classification of Collaborative Systems, International Journal of Information Management, (2002), 22, 281-305.

[17] J. Grudin & S. Poltrock, Taxonomy and theory in computer supported cooperative work. In S. W. J. Kozlowski (Ed.), The oxford handbook of organizational psychology, (2012), (pp. 1323-1348). New York: Oxford University Press.

[18] G. H . Ter Hofte, H. J.van der Lugt & M. A. Houtsma, Co 4, a comprehensive model for groupware functionality. In Telematics in a multimedia envir onment: Proceedings of Euromedia, (1996), (Vol. 96, pp. 19-21).

[19] D. T. Green, J. M. Pearson, Social software and cyber networks: Ties that bind or weak associations within the political organization?. Proceedings of the 38th Hawaii International Conference on Sys-tem Sciences (HICSS), (2005, Jan), 117b - 117b

[20] M. Koch, CSCW and Enterprise 2.0–towards an integrated perspective. 2008, 21th Bled eConference, eCollaboration: Overcoming Boundaries through Multi-Channel Interaction.

[21] M. Steinhüser, S. Smolnik, U. Hoppe, Measuring the Success of Social Software Adoption in the Firm: Empirical Evidence and Model Design. Interna-tional Journal of Social and Organiza-tional Dynamics in IT (IJSODIT), 2012, 2(2), 34-47.

[22] G. Lugano, Social Computing: A Classification of Existing Paradigms. In Privacy, Security, Risk and Trust (PASSAT), 2012 International Conference on and 2012 International Confernece on Social Computing (SocialCom), (2012, September), (pp. 377-382). IEEE.

[23] J. Fjermestad & S. R. Hiltz, An assessment of group support systems experimental research: methodology and results. Journal of Management Information Systems, (1998), 15(3), 7-149.

[24] T. J. B. Kline & J. McGrath, A review of the groupware literature: Theories, methodologies, and a research agenda. Canadian Psychology, (1999), 40, 265-271.

[25] D. Pinelle & C. Gutwin, A review of groupware evaluations. In Enabling Technologies: Infrastructure for Collaborative Enterprises, 2000.(WET ICE 2000). Proeedings. IEEE 9th International Workshops on (2000), (pp. 86-91). IEEE.

[26] T. Palander, M. Toivonen & S. Laukkanen, GroupWare and group decision support systems for wood procurement organisation. Silva Fennica, 2002, 36(2): 585–600.

[27] J. Guthrie & I. Abeysekera, Content analysis of social, environmental reporting: what is new?. Journal of Human Resource Costing & Accounting, (2006), 10(2), 114-126

[28] S. Terzis, P. Nixon, V. Wade, S. Dobson & J. Fuller, The future of enterprise groupware applications. Enterprise Information Systems, (2000), .99-106

[29] J. Rama & J. Bishop, Survey and Comparison of CSCW Groupware Applications. In J. Bishop and D. Kourie (Eds.), Research for A Changing World, Proceedings of South African Institute of Computer Scientists and Information Technologists (SAICSIT), Somerset West, South Africa: Edition 1st. (2006, October), 198–205

[30] J. Moscarola, R. Bolden, From the data mine to the knowledge mill: Applying the principles of lexical analysis to the data mining and knowledge discovery process. Paper presented at The Second European Symposium on Principles of Data Mining and Knowledge Discovery, (1998, September), Nantes, France.

[31] J. Moscarola, Contribution of Qualitative Methods to Research in Work and Organizational Psychology: Sphinx Lexica and MCA, (2002, June), Communication to ISSWOV 2002, VARSAW.

[32] N. D. Ziv, New media as catalysts for change in the transformation of the book publishing industry. International Journal on Media Management, (2002), 4(2), 66-74.

[33] P. A. Frisch, Popular Web-based reference sources for United States history. Journal of library administration, (2005), 43(3-4), 65-74

[34] A. Bachmann & B. Funk, YouCallo–Tapping the Knowledge of Social Groupware Systems. Richter, A., Bullinger, A. C., Koch, M., & Stocker, A. (2010). In Soziotechnische Integration? Bottom Up? Simplicity? Was sind die Erfolgstreiber von Enterprise 2.0?. Interaktive Kulturen, 397.Mensch & Computer 2010, (2010), 11.

[35] G. Hertel, S. Geister & U. Konradt, Managing virtual teams: A review of current empirical research. Human Resource Management Review, (2005), 15(1), 69-95.

[36] N. ,Anwar & A. Imran, "Significance of Decision Support Systems.", International Journal of Current Engineering and Technology, (2014), Vol.4, No.4 (p. 2741- 27413)

[37] J.You, Revolution of Forecasts-Based Accounting and Its Relation to Decision Support System, In Proceedings of the 2013 Fourth International Conference on System Science, Engineering Design and Manufacturing Informatization (icsem 2013), (2013, October), (pp. 93-96), IEEE Computer Society

[38] D. P. Goyal, A. Bhatia & O. P. Goyal, Success and hindrance factors in the development of decision support systems in banking sector in India: an empirical analysis. International Journal of Indian Culture and Business Management, (2010), 3(3), 349-361.

[39] R. Z. Kuo & G. G. Lee, KMS adoption: the effects of information quality. Management Decision, (2009), 47(10), 1633-1651

[40] E. Martínez-Caro & J. G. Cegarra-Navarro. "The impact of e-business on capital productivity: An analysis of the UK telecommunications sector." International Journal of Operations & Production Management 30.5 (2010): 488-507

[41] G. N. Aranda, V. Aurora, C. Alejandra & P. Mario, "Choosing Groupware Tools and Elicitation Techniques According to Stakeholders' features." In Enterprise Information Systems VII, pp. 69-76, Springer Netherlands, 2006

[42] R. Iqbal, J. Anne & G. Richard, "A collaborative platform for heterogeneous CSCW systems: Case study of academic applications." InIntelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, 2003. Proceedings of the Second IEEE International Workshop on, pp. 462-467. IEEE, 2003.

[43] M. Lavallee, P. N. Robillard & S. Paul, Distributed Cognition in Software Engineering. In eKNOW 2013, The Fifth International Conference on Information, Process, and Knowledge Management, (2013, February), (pp. 57-62)

[44] J. M. Favre, , D. Gasevic, R. Lämmel, & E. Pek, Empirical language analysis in software linguistics. In Software Language Engineering, (2011), (pp. 316-326), Springer Berlin Heidelberg

[45] C. Zhang, H. Wang, Y. Liu, D. Wu, Y. Liao & B. Wang, Automatic Keyword Extraction from Documents Using Conditional Random Fields. Journal of Computational Information Systems, (2008), 4, 3, 1169-1180

[46] B. M. Jones & S. Cox, 'Learnsafe'learning Organisations for Nuclear Safety, In Organizational Learning and Knowledge 5th International Conference proceedings, (2001)