Importance of Social E-factors for Grid based Infrastructure

S. K Kabanda, and M. O Adigun

Abstract— **Of recent, networked organization structures have become common practice in numerous industry sectors. They come together to pool their expertise to design, develop, maintain, and sustain resources that can be expensive. This increasing collaboration among organizations is related to business drivers, such as the need for increased flexibility, cost reduction and focus on core competencies or forming strategic alliances. Collaboration has become a key issue in networked organization, but has not been fully exploited in rural enterprises such as Small and Medium Enterprises (SMEs) where resource scarcity threatens their existence. We assimilate this problem to the very nature of collaborative approaches not meeting social and individual requirements of these SMEs. To this end, this paper aims at incorporating social e-factors in the development of an e-Commerce solution based on a grid computing platform, to enhance collaboration efforts during software development.**

***Index Terms*—Collaborative commerce, Enterprise, Grid computing, Societal requirements.**

I. INTRODUCTION

To survive and thrive in the internet economy, businesses are moving toward an e-business web model in which collaboration among members of the participating network of suppliers, distributors, service providers, and customers produces value for customers. Such Internet-enabled industry defines e-business as collaborative commerce, in which companies participating in the e-business web become virtual enterprises [1]. Virtual enterprises are characterized by rapid exchange of information within a virtual network of suppliers, customers and partners, working together to create value added processes [2], necessitating the establishment of appropriate inter-organizational systems to facilitate communication, co-ordination and collaboration among virtual markets [22].

Unfortunately, virtual markets benefits are mostly experienced by urban organizations. Rural businesses are still lagging behind because most are small and find it difficult to obtain the necessary resources needed to compete in the new digital economy. In addition, remoteness hinders many of them as they try to gain access to the capital, infrastructure, and technology needed to operate in today's global and instantaneous marketplace [3].

Research into inter-enterprise collaboration has advanced to Portal Technology for Collaborative E-Commerce solution, with some based on Grid computing technology. Grid computing is fast becoming the means to foster sharing of widely distributed, limited and scarce resources [4] for increased flexibility, cost reduction and focus on core competencies or forming strategic alliances [5].

Although collaborative commerce has risen as a key enabler for enterprises to secure resource advantage and to promote global competitiveness [6], the following challenges are still to be addressed: (i) strategic aspects to describe the drivers, contingencies, and strategies for inter-enterprise collaboration; (ii) sociological aspects which look at how individuals can benefit and their collaboration needs; (iii) technology, to describe how to make business transaction environments flexible enough not to hold back ; (iv) how to use collaborative support systems for quick and flexible configuration of business transaction environments, in order to achieve operational excellence; (v) and how collaborative support systems and business transaction environments be integrated into an open, generic, flexible infrastructure for business collaboration in the broadest sense [7].

To this end, this paper aims at proposing ways on how to go about creating a grid infrastructure in an African context. The paper incorporates social e-factors in the development of an e-Commerce solution based on a grid computing platform, to enhance collaboration efforts during software development. The work is driven by a long-term view in which SMEs belonging to rural areas will be enabled to establish and run collaborative business relationships with their partners through "plug and do business".

The rest of this paper is structured as follows: Section II provides a brief background on Grid computing. We present the framework in Section III. Section IVprovides a designed prototype and application instances. Section V concludes the work.

II. RELATED WORK

E-collaboration technologies are broadly defined as technologies that enable collaboration among individuals engaged in a common task. It supports an organization team by acting as a facilitator to effectively acquire requirements for a software system and support requirements negotiations in a distributed and asynchronous manner [8]. The tools are usually

Manuscript received April 21, 2006. This work was supported in part by Telkom, Huawei, and Thrip.

S.K Kabanda is with the University of Zululand, KwaDlangezwa 3886, South Africa (+27 721 453 515; fax: +27 359 026 569; e-mail: s.kabanda@gmail.com).

M.O Adigun is with the University of Zululand, KwaDlangezwa 3886, South Africa (+27 359 026 189; fax: +27 359 026 569; e-mail: madigun@pan.uzulu.ac.za).

web enabled, to fit the idea of the virtual organizations where for example the lead developer could be a marketing organization with partnered suppliers in another geographical area. Example includes ART-SCENE Scenario Presenter and the ARENA (Anytime, Anywhere REquirements Negotiation Aids) which of recent still do not fit nor support mobile devices whose requirements are constraint with merging data from different sources and constraints in the transmission and presentation capabilities of the mobile side require sophisticated media scaling and conversion capabilities [8]. Further, the majority of potential users demand to be supported in the way they are used to live and to do things – hence the need to map users needs to the capabilities of technology, especially with emerging technology like knowledge-based grid computing [9, 10].

Grid computing is fast becoming the backbone for most IT infrastructure, in enhancing sharing of widely distributed resources [4]. In most developing countries, these resources are not only widely distributed, but are also limited and scarce to obtain. Resources range from human resources such as skills, to IT infrastructure. Although it would be difficult to deploy skills and integrate them in a grid infrastructure, IT infrastructures can be managed and easily deployed if application development is made easy to exploit by the few employed staff [11].

Most applications offered by a grid infrastructure, for example Exostar [12], tend not to be user oriented but are focused on specific users who are conversant with the applications. For example, most CRM products are focused more on sales management and reporting than on increasing revenue. The trouble is that by focusing on the mechanics of the sales operation, such software implicitly assumes that the salesperson is the sole factor in making a sale and expects him or her to fight alone in an uphill battle against the customer's perception of the company, its products and its level of service [13].

IBM offers their vision of services for their grid infrastructure in figure 1: placement management, Change Publish, Cache, Replication, Meta-data, Discovery, Registration, and Data services. The purpose of information infrastructure support services is to enable appropriate, safe and ready access to information resources for all members from wherever they are working, thus allowing leveraging investment in technology as well as sharing important resources. While there is no system that provides all of these capabilities today, prototypes and even commercial versions of some services do exist [4].

The Registration Services is responsible for registering any new feature. This step provides information pertaining to that source to the Meta-data Services, which know about all available sources and how they ought to be represented within a unified view to the consuming applications.

The Discovery Services is then used to automatically identify possible information sources and help merge them into a unified view by depositing the required meta-data into the Meta-data Repository using Meta-data Services. Of all the services, the most essential is the Data Services, for example, a file (mydata.xls), which handle requests for information from applications or from other services [4].

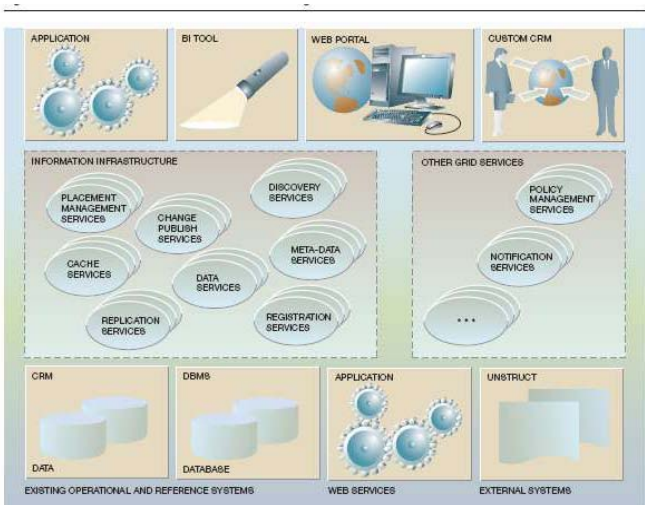

Figure 1: Services for an information infrastructure for the grid [4]

Grids are often categorized, in Table 1, by the type of solutions that they best address [14]. Most require software infrastructure to support interoperability between different implementations reflected in figure 2, where knowledge is represented as relationships between domain concepts. Information is represented as attributes about resources within the grid, and the grid objects are grid elements such as data files, programs, storage resources, and execution resources.

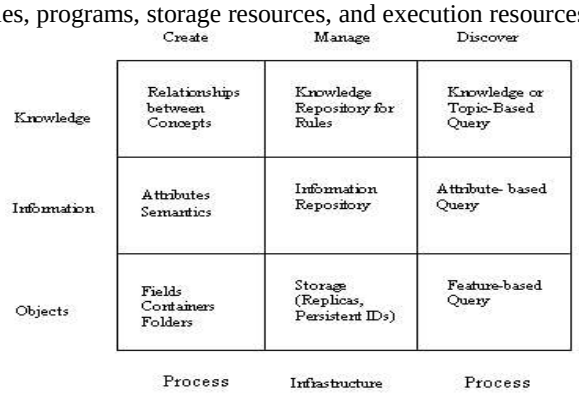

Figure 2: Knowledge-based Grid [15]

Grid Type	Solution to address
Computational	Focused on setting aside resources specifically for computing power
Scavenging	Most commonly used with large numbers of desktop machines
Data	Responsible for housing and providing access to data across multiple organizations.

Table 1: Grid classification

The three infrastructure components in figure 2 represent the technologies needed to manage the registration process, manage the grid infrastructure, and manage the discovery environment. The three rows represent the infrastructure needed to manage knowledge, information and objects [15].

III.MODEL FORMULATION

A.Requirements for effective collaboration in a grid enabled infrastructure.

Many factors are likely to influence the success or failure of enterprise collaborations, and no two collaboratives can progress in exactly the same way or within the same time frame [16]. Thus, factors that ensure smooth collaboration should be defined. The literature on collaboration offers some suggested guidelines that have wide applicability with most laying emphasis on involving key players in discussions so that collaborative decisions and activities will receive widespread support and recognition [16, 17, 18] and also gain wider understanding of key player's environment and behavioral patterns.

Though management tends to think that key players are the stakeholders who provide funding and sustenance of the product, we argue that of the most important key players, are the user and the community in which the product will be applied. They are the ultimate deciders, of the products success and failure. They can choose to accept or reject the product depending on whether the product meets not only their immediate needs but whether also it's in line with their way of life. We need to restructure the grid platform to incorporate these issues and enhance its service delivery mechanism.

B.Restructuring the software development process for the African Context

With most software engineering development, the initial starting point is requirements gathering, a process that set of activities that help develop the understanding of a system's domain, constraints, characteristics and systems functionalities as per stakeholders view, as well as the documentation of the systems specification for all stakeholders involved in systems development [19,20,21].

Even during product line development the process starts by capturing domain information and analyzing common elements in terms of services, operating environment, domain technologies and implementation techniques to generate a feature model [21,29,30]. Still, the emphasis is on the system itself. This has overshadowed the most important aspects of software development - social requirements. The inclusion of social requirements component in grid infrastructure has been emphasized and reflected in figure 3. A typical software engineering process requires the corporation of all stakeholders (customer, domain expert, analyst and developer), but with each stakeholder's role clearly outlined.

We associate requirements engineers with the actual initiation of the application development process which entails: eliciting domain information, identifying domain features, and developing application instances of the domain. There are three actors playing these roles namely Domain Expert, System Analyst and the Developer. We then associate social requirements elicitation with the social sciences, management and software disciplines. Figure 3 outlines the additional component to software development. The reasoning behind delegating software engineering to these actors is that:

i. Domain experts are not expected to be familiar with the software development process but are a good source for domain knowledge information;
ii. Domain experts are not familiar with societal problems, needs and wishes. They also do not understand the impact which developed software can have on the people it is to serve. Hence the need to incorporate business management and social science disciplines;
iii. System Analyst and the Developer are responsible members of the software development team who define requirements for an application instance. But what a System Analyst considers input to a given model or component, the developer could regard as an output element.

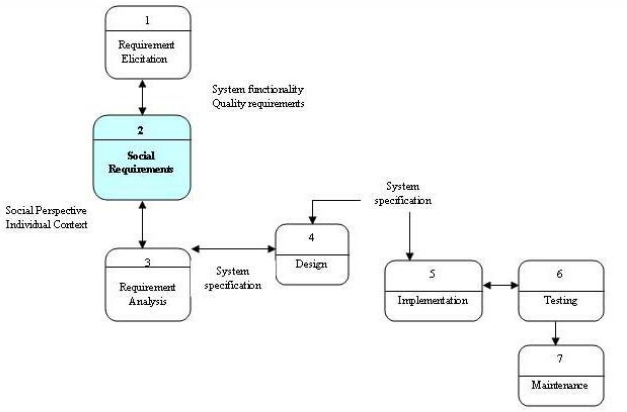

Figure 3: Enhanced Software Development Cycle

IV.ENHANCING THE GRID INFRASTRUCTURE FOR EFFECTIVE COLLABOATION

A.Comprehensive Grid Services

Grid services tend to define and describe the technology infrastructure without providing guideline on social requirements services such as: Cultural theory, Symbolic Interactions and Ethical theories; and on Individual requirement services such as educational status, psychological and behavior requirement services. Even among the subsidiary services such as Policy Management Services and Notification services, none provide a detailed description for the social and individual services.

Although we know that these services fall under the requirements phase of the software development program, we do also understand that these features are not integrated into the grid infrastructure but are acknowledged in requirements specification document. This document usually does not efficiently depict the social context of the domain, but illustrates the product requirements, and defines features [23] together with possible domain variations. Usually the RSD is written in a natural language which the customer understands but difficult to integrate with the Developer's language. Therefore factors like organizational and social requirements

cannot be adequately captured in the developer's language. These are left out during development and caught up with later after the product is at its final stage.

For example, an SME based in rural South Africa where the speakers are Zulu, would prefer a grid infrastructure that is customized to suit their needs in terms of communication language and offering of products that meet their ethical and social behavior. Most grid based infrastructures do not have an application or a service that can be tuned to suit the markets preferable communication language. This phenomenon constitutes communication barrier and hinders the development process, causing the right product to be marketed to the wrong traget market.

As grid computing gains more popularity in e-business, these social and individual issues cannot be ignored. Societal aspects of current e-business models are crucial elements in achieving sustainable product adoption and their incorporation as part of grid services. Grid services are typically divided into two categories namely: Information infrastructure and subsidiary services (see figure 1). We categorize social requirements under subsidiary services and group them using the societal e-factors namely: Region/Geography, Culture, Legislation, Economic, Ethical and Professional, Social Capital and Networks, and Social Structure [24].

V. SOCIAL E-FACTORS

A.Region Support Services

Region Support Service describe the geographical boundaries in which the grid infrastructure is being implemented or to be used. It is related to specifics geographic issues such as linguistic singularities, environmental and country specific features that characterize that area. Despite the geographical diversity of participants who will be using the infrastructure, the communication channel employed (e-mail, interactions, electronic bulletin) will have to be conquered to ensure that regional differences do not interfere with the success of the program. As one of the information infrastructure, we propose an addition component - language interpreter, to ensure that user's medium communication language is not compromised.

B.Cultural and Ethical Issues

The different aspects of culture and ethics, such as values and beliefs, adoption, acceptance, attitudes, awareness, and business practices; influence the e-business models to be implemented. Users need to know the impact the new product will have on the entire community and especially how the new business model will influence the way the organizations does its business.

C.Legislation

Although most organizations do not seriously take into account issues of policy making and abiding to them, security and confidentiality, reliability, regulatory firms and government require that such factors be observed. Stakeholders need to engage themselves and understand the effect of employing or adopting a particular form of doing business. This also requires that customers as well as the community be informed about the rights with respect to the new adopted technology.

D.Economic and Capital

As technology evolves, so are the needs of its community. Users need better services at a fast pace. This necessitates organizations to embark on investing in new and sophisticated infrastructure that is able to use limited resources with maximum output. Stakeholders need to understand the capital income of its subjects to reap the benefits of its investment.

E.Network and Social Structure

With the current of business collaboration and collaborative commerce (c-commerce), the value of social networks becomes evident. C-commerce has arisen as a key enabler for enterprises to secure resource advantage and to promote global competitiveness. In the less developed countries, collaboration amongst enterprises has not been fully exploited. Thus, successful businesses need to form alliances and partnerships to compete in the new IT-enabled world. Strengthening collaborative networks gives enterprises a foothold in promoting innovation and competitiveness. It assists related enterprises to engage collectively in markets and creates an environment that fosters c-commerce. This facilitates the flow of ideas, the transfer of technology, market development, as well as regional economic development.

F.Individual Perspective

According to the Technology Acceptance Model (TAM), when users are presented with a new product, a number of factors influence their decision about how and when they will use it. Thus user acceptance and adoption is a concern for both customers and employees that utilizes e-business [25]. Factors that affect a user's acceptance to a product include among other: geographical region, culture background, educational status, experience obtained previously, individual differences, and psychological reasons. Stakeholders need to ensure effective commitment, autonomy, and trust to directly have a positive effect on the beliefs and norms that lead to IT acceptance and use [26].

VI.CASE STUDY: SOUTH AFRICA SMEs

A.Business Proposal

The case study aims at developing an infrastructure for rural SMEs reap the benefits of collaborative commerce by developing a localized/ customized e-Commerce solution. This includes building an innovative enabling platform based on grid computing, to promote a new collaborative business model for the Arts and crafts SMEs. The generic nature of the Grid computing approach allows customization of the functions of the platform according to specific business requirements.

B.Requirements Elicitation.

Requirements elicitation is carried out by domain expert using a requirement template for eliciting and scoping domain

features such as domain name, its description, goal and actors. There are two main templates designed for elicitation and scoping of domain information: Domain Template, figure 4 and Product Template, figure 5.

The templates define features of the domain or product in terms of domain-specific or product specific services. The techniques used in the template include questionnaire elicitation approach that consists of both closed and open-ended questions. This technique enables sufficient information to be captured and allows flexibility. Close-ended questions are more specific and take up less time than open-ended questions. The questionnaires are set up as Textual Use Cases as suggested by Cockburn [27] and Fantechi et al [28] to elicit domain and product information. A domain template snapshot that elicits elementary domain features is presented in figure 4. While figure 5 elicits and scopes behavioral features, figure 6 elicits quality features.

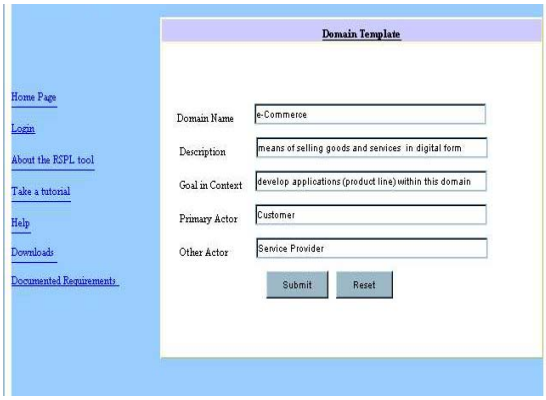

Figure 4: Domain Elicitation

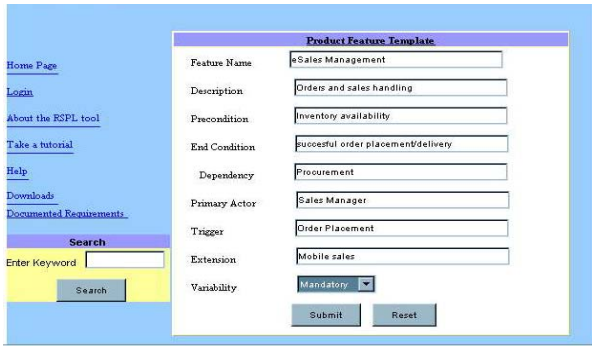

Figure 5: Feature Elicitation

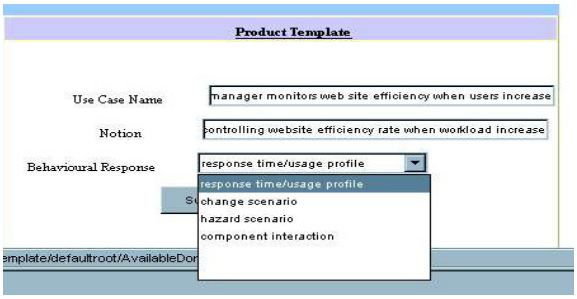

Figure 6: Quality Requirements Specification

C.Eliciting Social Requirements

South Africa is regarded as a rainbow nation compromising of all races and religions. What makes it an interesting study is that it is a developing country which is not only overcoming racial barriers but trying to adapt to the evolving dynamic international market. Serving the market of South Africa is a challenge in which the African, Western and Asian virtues cannot be compromised.

South Africa's rural SMEs are characterized by low skilled workers whose educational background is underprivileged; the community environment lacks infrastructure required to improve performance and global competitiveness, as well as to be aware of available products, services and initiatives to meet these requirements. Although there has been many IT strategies employed, the portal included, none has made a breakthrough in rural enterprises where resources are scarce and social barrier poses as a threat.

For an e-Commerce solution to be applicable in South Africa (with specific to rural businesses), understanding of both business as well as social requirements will have to be performed. Social requirements includ understanding the nature of each race's four social needs and expectations. To ensure maximum understanding of social requirements, a South African rural person from the Zulu Culture, was incorporated into the project to add in the Zulu cultural values and to make it easier for the team to understand the Zulu's perception of the product.

During domain engineering, the domain expert, together with the social sciences and management disciplines, uses the Social Context Form (figure 7), to fill in social requirements observed in the community. Each requirement can be further refined to its simplest element. For example in Figure 7, once the Culture was selected, the tool automatically uploads pre-defined requirements (figure 8) to identify the specific social status and buying behavior of that culture with respect to other cultures. This serves to properly document social user requirements. Software developers can now easily retrieve this data to map product features to what users wants and subsequently define and add in product features suitable for that particular culture or subset of group.

Figure 7: Social Requirement Specification

Figure 8: Sub-factors of the Cultural Feature

VII. Conclusion

Although there is some awareness for the strategic and sociological aspects, the current state of affairs in the area of integration is poor. In this paper we have argued, that the mere concept of software engineers developing products in isolation is wrong. It is not a discipline of just collecting system specifications and developing the system, but is a collective collaboration effort of software engineering, social sciences and management disciplines. Software engineers need to take human and social factors into consideration to obtain clear incentives, such as overall cost and time reduction, real-time communication, lead-time reduction, and improved collaborative planning and forecasting.

References

[1] S. S. Chan, V. Kellen and C. Nair. "Adopting Web Services for B2B e-Collaboration - Research Directions", School of Computer Science, Telecommunications, and Information Systems; Available: http://www.kellen.net/WebServices.htm

[2] J. Burn and R. Hackney, "Strategies for I-business change in virtual markets: A Co-Evolutionary Approach", Americas Conference on Information Systems 2000, pp. 879-884.

[3] J. R. Henderson, "Networking with E-commerce in Rural America", Economist, Center for the Study of Rural America. The Main Street Economist, September 2001.

[4] O. T. Anderson, L. Luan, C. Everhart, M. Pereira, R. Sarkar, and J. Xu "Global namespace for files". IBM SYSTEMS JOURNAL, VOL 43, 702 NO 4, 2004.

[5] K. Sandkuhl, L. S. Indrusiak, L. Karlsson, "State of the Art and Future Challenges on Collaborative Design", A Special Issue of the Journal: International Journal of e-Collaboration, 2006Available: http://cce.ecolleg.org/2006/IJeC-060203.pdf

[6] A. Collins., P. Hyland, A. Ghose, S.K Lau, and G. Ditsa, "Using Portal Technology for Collaborative E-Commerce" ,

[7] Maarten Steen and Henri ter Hofte. Integrating Collaborative Support and Business Transaction Environments towards a Research Roadmap for Europe. Telematica Instituut P.O. Box 589 7500 AN Enschede, The Netherlands, www.telin.nl .

[8] P. Grunbacher and P. Braunsberger "Tool support for Distributed Requirements Negotiation", In Cooperative methods and tools for distributed Software processes, 2003 pp. 56-55.

[9] H.M. Deitel, P. J. Deitel, and S. E. Santry, "Advanced Java 2 Platform: How to Program", Prentice Hall, 2002.

[10] T. Pfeifer,; R. Popescu-Zeletin, "A Modular Location-Aware Service and Application Platform", Computers and Communications, 1999. Proceedings. IEEE International Symposium on 6-8 July 1999 pp. 137 – 148. .

[11] S.Bourbonnais, V. M. Gogate, L. Haas, R. W. Horman, S. Malaika, I. Narang, and V. Raman "Towards an information infrastructure for the grid". IBM SYSTEMS JOURNAL, VOL 43, NO 4, 2004.

[12] W. M. Ulrich, "Collaboration Counts in C-Commerce", 2001. Available: http://www.computerworld.com/industrytopics/defense/story/0,10801,57775,00.html

[13] R. Conrad, "The Need for Customer-Centric CRM", Enterprise Support Manager http://www.enterprisewizard.com, Available: http://www.crm2day.com/library/pdf.php?pdf=50223-0.pdf.

[14] I. Foster and A. Iamnitchi, "On Death, Taxes, and the Convergence of Peer-to-Peer and Grid Computing", Available: http://people.cs.uchicago.edu/~anda/papers/foster_grid_vs_p2p.pdf

[15] R. Moore, "Knowledge-based Grids (Research in Progress)". San Diego Supercomputer Center September, 2000. Available: http://www.sdsc.edu/GridForum/RemoteData/Papers/knowledge-grid.doc

[16] NCREL's Policy Briefs, "Integrating Community Services for Young Children and Their Families", Report 3, 1995. Available: http://www.ncrel.org/sdrs/pbriefs/93/93-3guid.htm

[17] R. B. Richards, "Effective Collaboration - Roles that Make It Work", CCC/SP, Available: http://hsfo.ucdavis.edu/download/Effective_Collaboration.pdf

[18] H. L Hollingsworth, "We Need to Talk Communication Strategies for Effective Collaboration", Teaching Exceptional Children, Vol. 33, No. 5, 2001, pp. 4-8.

[19] K. Cox, "Fitting Scenarios to the Requirements Process", IEEE Proceedings of the 11th International Workshop on Database and Expert Systems Applications (DEXA'00), 2000.

[20] IEEE, Standard VHDL Language Reference Manual. Standard 1073-1993, New York, 1993.

[21] D. L. Parnas, "On the design and development of program of families. "IEEE Transactions on Software Engineering, vol.2, no. 2, Mar.1976.

[22] P. Marshall, J. McKay, J. Burn, and M. Wild, "The Essence and Logic of the Virtual Organisation", Americas Conference on Information Systems 1999, pp.594-596.

[23] K. C. Kang, J. Lee, and P. Donohoe, "Feature-Oriented Product Line Engineering", IEEE Software 19, 4 July/August 2002, pp. 58-65.

[24] A. Pouloudi, Z. Ziouvelou, and K. Vassilopoulou, "A Societral Perspective on E-Business Adoption", ELTRUN – The E-Business Centre, Department of Management Science and Technology, Athens University, Greece. Info, Comm&Ethics in Society. Troubador Publishing LTD, 2003.

[25] K. Vassilopoulou, Z. Polyxeni, P. Adamantia, and A. Pouloudi, "Examining E-Business Models: Applying a Holistic Approach in the Mobile Environment". ELTRUN – The E-Business Centre, Department of Management Science and Technology, Athens University, Greece. 2003.

[26] J. B. Thatcher, H. D .McKnight, and M. L. Ahuja, "The Work Environment and Technology Acceptance: The Influence of Affective Commitment, Autonomy and Trust", 2002, Available: http://www.indiana.edu/~isdept/research/papers/tr132-1.doc

[27] D. E. Herlea, "Users involvement in requirements engineering", in the Proceedings of the Workshop on Internet-based groupware for users involvement in software development, Seattle, USA, 1998.

[28] A. Fantechi, S. Gnesi, I. John, G. Lami, J.Dörr, "Elicitation of Use Cases for Product Lines". 9th IEEE Conference and Workshops on Engineering of Computer-Based Systems, 2002. Available: http://fmt.isti.cnr.it/WEBPAPER/25-PFE-ucf.pdf

[29] K. Schmidt, M. Schank, "PuLSE-BEAT, A Decision Support Tool for Scoping Product Lines", Third International Workshop on Software Architectures for Product Families, March 2000, pp. 197-203.

[30] I. John, and J. Dorr, "Elicitation of Requirements from User Documentation", Available: http://crinfo.univ-paris1.fr/REFSQ/03/papers/P01-John.pdf",2003.

Salah K. Kabanda is an MSC student in the department of computer Science in the University of Zululand. She holds a Bachelor of Commerce degree in Information Systems. She is currently involved in a community based project to enable rural enterprises reap the benefit of a grid enabled infrastrucutre.

Prof. Mathew O. Adigun

Prof. Matthew O Adigun received his PhD in Computer Science at Obafemi Awolowo University. Nigeria in 1989. He is currently the Head of the Department of Computer Science, University of Zululand, a position he has held since 1989. His research interests are in Software Engineering and Architecting of Mobile and Pervasive Systems. He has presented papers at

national and international conferences in his and related areas of research interests.

As a Professor, he has led research in theNRF Research Niche Area titled Software Infrastructure for E-Commerce and E-Business with a group of CS, IS and Business Management researchers from inside and outside of the University of Zululand.

Dr. Adigun received the 2004 THRIP Excellence Award in Category A, from the South African National Research Foundation, for his contribution to development of research in an historically disadvantaged university where he runs a small Centre of Excellence in Mobile e-Services with about 15 Masters and Doctoral students.