

METHODS AND TECHNIQUES FOR DESIGNING BUSINESSES INFORMATION SYSTEMS

PhD Thesis - Abstract

to obtain the degree of PhD from
Polytechnic University of Timisoara
in Computers and Information Technology

author ing. Marian Stefan NEICU

Supervised by prof.univ.dr.ing.George Gustav SAVII
month June year 2019

In recent years, companies have undergone major changes, mostly due to evolution of information technology. As a result of increased competition, enterprises were forced to improve their offer, while reducing ongoing costs. This would not have been effectively achieved without the significant contribution of information processing technologies.

At the same time, IT hardware and software resources have become increasingly powerful from a technical and financially accessible perspective.

The workforce had a decisive role in the absorption of new technology as the active generations of the last decades no longer feel IT as an extra effort, but as a tool without which they are not willing to carry on current activities.

The design methods and techniques developed in the thesis refer to small and medium business units, mainly characterized by:

- great diversity of the types of businesses in this category, ranging from trade and ending with tourism and catering;
- specificity regarding minimum resources made available from budgets for IT and ending with existing attitudes and quality of the workforce involved in these enterprises;
- high dynamics of these systems and the speed with which decisions are made in many circumstances, situations which these systems must face.

As a result, the main challenge to be answered by the research work covered by the thesis and the research results is developing new methods, techniques and algorithms to enable the effective realization of business information systems specific to small and medium enterprises.

The main objectives of the thesis are:

1. Creating algorithms, methods and techniques to design integrated systems for business applications specific to small and medium enterprises;
2. Developing a specific business information system, tailored to the needs and resources of SMEs, to test the validity of the proposed methods;
3. Establishing a methodology for implementing elements of a computer system in accordance with the objectives identified in the processing of information, created using the proposed methods and the implementation of the components of the developed information system;

4. Development of a methodology and establishing principles for software installation of systems and equipment that provide the best solution based on objectives;
5. Selecting the most efficient systems for processing and storage of data, taking into account the applications and equipment used;
6. Development of methods for optimal transfer of information between different types of databases, application-specific use;
7. Designing and implementing the most effective technical solutions for data transmission between the components of the information system;
8. Development of methods for consolidating data in a single database, at the company headquarters.

To achieve the objectives, the author started from an already existent ERP system that provides basic functions in the processing of information in a company whose main activity is trading. It was developed by the thesis author in previous researches and applied in SMEs under the trade name "Abstract Connection", trademark OSIM.

The development of a new ERP system for SMEs, different from those already on the market, was necessary because:

1. With an experience of over 30 years in the design, implementation, support and operation of ERP information systems, the product is meant to reflect the author's vision on the architecture, development and deployment of these systems, resulting from a critical analysis of the existing market;
2. It was intended to provide a system for SMEs that would meet the highly demanding objectives that these economic organizations desire, but based on their modest budgets for:
 - purchase of IT equipment and services;
 - equipment maintenance and infrastructure;
 - acquisition, deployment and maintenance of software;
 - labour remuneration.
3. The purpose was to reach the lowest cost of purchase by the customer by reducing the cost of developing an integrated system, complete as a set of functions and operational performance for the SME companies as follows:
 - from a computer system, already in use;
 - by adding new modules and functions obtained through the novel methods and techniques developed during researches for the thesis;
 - using a highly efficient method for the validation of information obtained from the system in a manner never before attempted.
4. When developing design methods and techniques, the author envisaged the achievement of a low cost of purchase of equipment, infrastructure and IT services;
5. For businesses which already use the information system from which the research was started, reservations related to the implementation of a new system are removed because this inherits all the properties of the existing one plus new functions and modules produced through the methods and design techniques developed in the thesis;
6. Although the offer of ERP systems on domestic and international market is vast, due to the nature of labor, the only systems which can be implemented effectively in the domestic SMEs are those for Romanian speakers.

Thesis structure includes an introductory chapter, four chapters devoted to the presentation of results of the research work and a final chapter on conclusions and original contributions, a bibliography (106 titles consulted and cited) and two annexes. The thesis

extends itself on 129 pages, with 34 figures and three tables.

Chapter 1, "Introduction" is dedicated to the analysis of the technological, economic and social premises of the research. The objectives of the thesis are also reviewed. To achieve the objectives, the research started from the components of an existing ERP information system, which provides basic functions in the processing of information in a company whose main activity is trade, system developed by the author of the thesis in previous researches and used in SME business organizations.

In **Chapter 2, "The current state in research on designing systems for businesses"**, to define the precise scope that research addresses, the basics of information systems are reviewed, with particular reference to information systems management. To assess the contribution of the thesis, further methodologies and work techniques for information systems design are described.

An important place in this chapter is held by the decision support systems, which are an important component of the business management. At the same time specifying the criteria for assessing a system obtained from this research is a necessary element of the thesis. To highlight the contribution of the research, the thesis deals with information systems used in large companies with respect to some already consecrated solutions.

The characteristics and peculiarities of the information systems used in SMEs clarify the specificity of companies the thesis addresses and the importance of software solutions developed for the business environment. As we want to obtain similar effects to those of the consecrated information systems, the design and development of information systems for this category of economic organizations must be specific.

At the same time, it appears that although the area is of great interest, publications on the subject are few. This is caused by the fact that not all market players are willing to provide information for the design of information systems that are aimed at increasing economic efficiency, so profit business.

Chapter 3, "Development of original methods and algorithms for information systems for SMEs" describes the methods and techniques newly created, used to develop new applications or new functionalities in existing applications in an ERP computer system. This way, a totally new integrated system was obtained at the highest technological level, aiming at complete support of all existing IT processes in a SME.

In order to outline them, the ERP information system is described and analyzed using the methods and techniques introduced by this thesis. Thus reference is made to objectives and stages of designing a system and methods and techniques to achieve established systems.

Through implementing the functions needed to achieve the goals, the development of the information system was carried out both horizontally and vertically with the following objectives:

- a. Systems architecture, equipment and devices used;
- b. Data storage, so as to support the new objectives of the system;
- c. Information flows, defining them as innovative concepts designed to support the system;
- d. Techniques and methods for transferring information among entities within the company;
- e. Suitable carriers for data transfer to match the new structure of the computer system.

The unique technologies implemented occupied a distinct place, one of them being certified as a model of usage entitled "English vocal interpreter for Romanian speaking users." The purpose of the invention is that Romanian speakers should use the keyboards aided by an

English language interpreter. This technology can be used in any application where the user interacts with the computer program.

A model of a system for testing methods and algorithms proposed in this thesis is created by presenting the corresponding diagrams for phase analysis, design and implementation in UML language.

There were designed structures and specific procedures for databases, methods and original algorithms for data transfer, algorithms for data consolidation in the unique central database, specific interfaces for operators with particular profile in SMEs (which will implement information systems).

Chapter 4, "Using virtual factory as a medium for validation of methods and algorithms of computer systems design for businesses", first reviews the established methods of testing and audit systems. Then it describes the new solution proposed by the author, which consists of assessing the obtained information system by using methods, techniques and algorithms created during the research of the thesis by implementing and using it in a virtual enterprise.

As a novelty, evaluation is carried out by the common users, which can introduce stress elements practically unpredictable for applications. At the same time a high degree of diversity is ensured, as extensive groups of users mainly those participating in specific programs of professional training, adhere to these techniques. This way, full and good quality results at low cost of the evaluation process are obtained.

Chapter 5, "Case Studies", assesses methods, techniques and algorithms proposed by the thesis used to develop a computer system typical for SMEs, and highlights the contribution of research in the thesis studying two of the core processes of a company that is supplying and selling goods and delivery.

The case studies covered highlighted two issues tracked by this method of investigation: assessment of obtained information system and the contribution of research in the thesis.

By applying case studies to a virtual enterprise, combining features of case studies with the advantages of enterprise simulation, the results took advantage of even greater accuracy.

Chapter 6 presents "General conclusions. Personal contributions. Future research directions. "

Personal contributions are present in all phases of the research: analysis, design and implementation and can be structured into the following categories:

1. Business systems analysis, for systems which use information technology, in particular SMEs.
2. Design of the specific ERP system for SMEs.
3. The actual development of the information system.
4. Implementation of the information system for real situations.

Direct effects on the activity of the beneficiaries of the information system developed in this research are divided into the following levels:

1. The operational level or exploiting applications.
2. Benefits for the company management.
3. The costs of implementing the new system.

A table is presented comparing the characteristics of the information system developed during the research, *Abstract Connection Business System*, and two ERP solutions for SMEs, established on the market, with a summary of the benefits the system developed based on the methods and algorithms designed according to the research of the thesis brings.

Applications resulting from the research have been implemented for specific situations both in academic and in economic environments, in over 50 SMEs.

Personal contributions have been published for validation by the international scientific community in six scientific papers, two indexed Thomson Reuters, one by Scopus. A certificate of utility model from OSIM was also obtained.

In the future, research will be directed in the following areas:

A. *Horizontally*

- Replacement of PDA devices with tablet PC devices and redesign of applications for these new environments.
- Integration with Web-based applications to meet fully the retail segment requirements.

B. *Vertically*: Approaching the cloud platforms and redesigning applications for these platforms, by adapting the proposed design methods and techniques for developing business information systems.

Selective Bibliography

1. Amirul, S.M. et al. Critical Failure Factors for Enterprise Resource Planning (ERP) Implementation: A Case Study on SME in Sabah, Malaysia. *International Journal of Research Science & Management*, 4(6), June 2017
2. Arrahmane, A.A. and Abdellah, Z. Open Source ERP, What Opportunity for Moroccan SMEs? Case Study of a Moroccan Agribusiness SME. *Journal of African Research in Business & Technology*, Vol. 2016
3. Bernard, S.A. *An Introduction to Enterprise Architecture*. 3rd Edition. AuthorHouse, 2012
4. Cascarino, R.E. *Auditor's Guide to IT Auditing*. 2nd ed. Wiley, 2012
5. Curtis, G. și Cobham, D.P. *Business Information Systems: Analysis, Design, and Practice*. Pearson Education Limited. Fifth edition, 2005.
6. Khaleel, Y. et al. Components and Analysis Method of Enterprise Resource Planning Requirements in Small and Medium Enterprises. *International Journal of Electrical and Computer Engineering (IJECE)* Vol. 6, No. 2, pp. 682-689, April 2016
7. Khaleel, Y.K. and Alkhalidi, A.N. Enterprise Resource Planning (ERP) Model for Small and Medium Sized Manufacturing Firms Based on UML. *International Journal of Information, Business and Management*. Vol. 9, No.3, 2017
8. Lasisi, M.O., Owens, J.D. and Udagedara, S. Key benefits of enterprise resource planning adoption within small family businesses: a conceptual framework. *United Kingdom Academy for Information Systems Conference*. Oxford University. Oxford, UK. 4-5 April 2017
9. Leyh, C. Critical Success Factors for ERP Projects in Small and Medium-sized Enterprises – The Perspective of Selected German SMEs. *Proceedings of the 2014 Federated Conference on Computer Science and Information Systems*. pp. 1181–1190, 2014
10. Monk, E. and Wagner, B. *Concepts in Enterprise Resource Planning*. 4th.ed. Boston: Course Technology Cengage Learning, 2013
11. Neicu, M.Ș. and Savii, G.G. Design methods and techniques for information systems intended for the contemporary business environment. *Proceedings of the 3rd World Conference on Information Technology*. University of Barcelona. 14-16 November 2012. Barcelona – Spain, Vol. 03. pages 1947-1954. 2013
12. Neicu, M.Ș. and Savii, G.G. Development of an Information System for the Modern Business Environment, Adapted to SMEs. *Proceedings of 7th International Conference on Advanced Manufacturing Technologies – ICAMaT*. October 2014. București. Published in: *Applied Mechanics and Materials*. Vol. 760, pp 695-700. Trans Tech Publications, Switzerland, 2015
13. Neicu, M.Ș. and Savii, G.G. Evaluation of Algorithms and Methods for Developing

- Business Information Systems Using Virtual Factory. Proceedings of International Conference on Aerospace, Robotics, Mechanical Engineering, Manufacturing Systems, Biomechanics, Biomechatronics, Neurorehabilitation and Human motricities - OPTIROB 2016. Published in: Applied Mechanics and Materials. Vol. 841, pp. 367-372. Trans Tech Publications, Switzerland, 2016
14. Neicu, M.Ș. and Savii, G.G. Keyboard emulation with a voice interpreter of English for Romanian language users. Proceedings of the 12th IEEE International Symposium on Electronics and Telecommunications (ISETC16). Timisoara, Romania. Oct 27-28, pp. 215-218, 2016
 15. Neicu, M.Ș. and Savii, G.G. Validating Algorithms and Methods Destined for Information System Design Meant for the Business Environment Using Simulated Companies. IManE International Conference. May 29-30, 2014, Chișinău. Published in: Applied Mechanics and Materials. Vol. 657, pp 931-935, Trans Tech Publications, Switzerland, 2014
 16. Neicu, M.Ș. Interpretor vocal de limbă engleză pentru utilizatori vorbitori de limbă română. Model de utilitate nr. RO 2013 00053. 27.11.2015
 17. Neicu, M.Ș., Savii, G.G. and Benea, M.C. Simulated company as validation environment for the design methods and algorithms of informatics systems meant for the business environment. Proceedings of the 15th WSEAS International Conference on Systems. Corfu Island, Greece. July 14-16, pp. 180-184, 2011
 18. Qian, L.Y., Suhaimi, B.A. and Abdulkarim, K.J. Factors Affecting the Adoption of Enterprise Resource Planning (ERP) on Cloud Among Small and Medium Enterprises (SMEs) in Penang, Malaysia. *Journal of Theoretical & Applied Information Technology*. 6/30/2016. Vol. 88 Issue 3, pp.398-409. 2016
 19. Raier, R.K., Watson, H.J. and Prince, B. *Management Information Systems*. 2nd ed. Wiley. 2013
 20. Rezaeian, M. and Wynn, M.G. The implementation of ERP systems in Iranian manufacturing SMEs. *International Journal on Advances in Intelligent Systems*. 9 (3/4), pp. 600-614. 2016
 21. Sauter, V.L. *Decision Support Systems for Business Intelligence*. 2nd Edition, Wiley, 2011.
 22. Sharda, R., Delen, D. and Turban, E. *Business Intelligence: A Managerial Perspective on Analytics*. 3rd ed. Prentice Hall, 2013
 23. Tomar, J.S. ERP Implementation Lifecycle in SMEs – A Review. *International Journal of Emerging Research in Management & Technology*. Volume 6, Issue 11, November 2017
 24. Usman, U.M.Z A Review of Key Factors of Cloud Enterprise Resource Planning (ERP) Adoption by SMEs. *Journal of Theoretical and Applied Information Technology*. Vol.95. No.16, pp. 3884-3901, 31 August 2017
 25. Wallace, P. *Information Systems in Organizations: People, Technology, and Processes*. Prentice Hall, 2012