

Building Aspects of Knowledge-Based Research Network Oriented to SMEs

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In this paper there are presented some ideas, both from literature, and from authors' researches related to the necessity to build a research network for developing knowledge-based management information systems for SMEs in order to improve their efficiency. The dramatically changes that take place at the global level within all social and economical life lead to the necessity of a permanently improving in all the domains. To face with changes it is necessary to develop the interdisciplinary and intersectorial research activities for offering the best solutions to the problems which appear.

Keywords: *management of enterprises, quantitative methods, research management, information systems, software development and databases, algorithms and complexity.*

Introduction

Manufacturing has changed radically over the course of the last decades and rapid changes are certain to continue. The emergence of new manufacturing technologies, spurred by intense competition, will lead to dramatically new products and processes. New management and labor practices, organizational structures, and decision-making methods will also emerge as complements to new products and processes [www04].

The Romania integration in the UE offers, on one side, a lot of possibilities for Romanian SMEs development, but, on the other side, a lot of challenges. To be able to stay on the market Romanian SMEs must to manage the most important manufacturing force: the information. A very flexible structure is necessary in order to adjust the SMEs' activities to the market requirements. The e-commerce cuts the distances and increases the concurrency among enterprises.

To stay on the market the SMEs must adapt their structure to the market global and dynamic challenges. One of the key factors to meet this desideratum is the implementation of the knowledge-oriented management information systems in order to support the top management in decision making. To accomplish this objective it is necessary to develop the interdisciplinary and intersectorial research activities to know the SMEs' problems, to analysis them, and to propose the best solutions for solving them. Taking into account the dramatic changes in all the

manufacturing and scientific areas, a flexible and adaptable, interdisciplinary and intersectorial long-term co-operation between research organizations and SMEs is required. From this point of view, it is necessary to build a high level quality research network, including both academic area and SMEs. The necessity of the proposal project is given by the facts that the manufacturing will remain one of the principal means by which wealth is created and the SMEs' role in products and services development is increasing. The RN's main objective is to develop an interdisciplinary, intersectorial, long-term cooperation, flexible and adaptable, according to the researched topics evolution and permanently using feedback to correct the research process. It is essential that the SMEs be prepared to implement advanced manufacturing methods in a timely way.

SMEs must know the global and local market evolution, the challenges they will face and the new manufacturing technologies. One of the tools for achieving the above mentioned things is the knowledge-based management information system.

The most important step in developing a knowledge-based management information system is to know the user's requirement. The best way to do this is the user involvement in the system development process. From this point of view, in the proposed research network, the SMEs will be part of the network. Research on information technology will help to meet all of the future grand

challenges. Information technology is the primary technology for converting information to knowledge and will be a key technology for concurrency, the integration of human and technical resources, and the rapid reconfiguration of SMEs.

Because the SMEs' activities are inherently multidisciplinary and involve a complicated mix of people, systems, processes, and equipment, the most effective research will also be multidisciplinary and grounded in knowledge of manufacturing strategies, planning, and operations. Knowledge-based Management Information Systems to improve SMEs' efficiency imply interdisciplinary research activities, including management science, mathematics, economics, software engineering. An interdisciplinary approach is, also, necessary for elaborating new methods and techniques to manage such kind of information. Intersectorial cooperation is necessary to combine the academia's knowledge and research experience with practical experience within SMEs, to know the challenges with SMEs face and to find the best solution, to create a permanently communication flow among researchers and managers.

The research network objectives

The Research Network main objectives are: to build links among academic area and SMEs; to establish interdisciplinary and intersectorial virtual research excellence centers; to attract the young specialists in the research field.

The links between academic area, consisting of universities, research institutes, private research associations, and SMEs are necessary to exploit the academia's enormous human potential and practical means to develop a high quality level research for solving actual SMEs' issues. The SMEs needs the necessary tools in order to improve their activity. The main goal of the proposed research network is to put all the above mentioned organizations together. The SMEs will face a lot of challenges, many of them may take the enterprises by surprise, if the enterprises do not have an adapted management information system. Having in view that the SMEs' capacities to develop research activities are,

almost, inexistent, it is necessary a very close cooperation among academic institution, and SMEs. The necessary steps to build the decisional making systems in SMEs:

1. system analysis;
2. model building –to build and use different SME model classes and to integrate the models from the micro level to the macro level;
3. simulation processes –will be defined different variants of the models, will test through simulation the behaviour of the variants and will choose the best model structure; this last variant offers to SMEs a flexibility and adaptability character to the very dynamic economical and social challenges;
4. Management Information System structure definition;
5. Management Information System life cycle;
6. MIS implementation.

ERP complex systems are defined for SMEs through a total quality management:

- equipment quality through charge stocks quality;
- personal quality through permanent training;
- process quality assurance;
- product quality;

The knowledge-based SMEs' management information systems will provide a permanent market feedback. The feedback is used by the top management in order to adjust the SMEs' structure and processes to the market requirements.

The SMEs in the next decades will bring new ideas and innovations to the marketplace rapidly and effectively. Individuals and teams will learn new skills rapidly because of advanced network-based learning, computer-based communication across extended enterprises, enhanced communications between people and machines, and improvements in the transaction and alliance infrastructure.

Collaborative partnerships will be developed quickly by assembling the necessary resources from a highly distributed manufacturing capability in response to market opportunities and just as quickly dissolved when the opportunities dissipate.

The form and identity of SMEs will be radically changed to encompass virtual structures that will coalesce and vanish in response to a dynamic marketplace. The SMEs may be part of larger corporations, but they will be located in and serve local markets and will operate autonomously.

The SMEs will have to identify current real problems and forecast the problems they will face in the future and articulate these problems in terms that are accessible by academic and research organizations.

The researches results will offer a base to SMEs in order to develop themselves in the future EU business environment.

A critical step in preparing for the future will be the development of an underlying technical foundation through research by industry, academia, and government institutions, which must be guided by a clear vision of manufacturing in the next future and an understanding of the fundamental challenges that must be met to realize this vision [IVAN04].

Interdisciplinary character is given by the following disciplines: Economic Sciences; Engineering and Information Sciences; Mathematics, in order to combine methods and techniques to develop the SMEs' infrastructure using Knowledge-Based Management Information Systems, as result of an evolutionary research process.

Manufacturing systems in the next decade will be complicated, dynamic amalgams of human and machine intelligence, knowledge, materials, equipment, and processes..

Two crucial elements are necessary for successful SME models and simulations - a comprehensive set of models and human-machine interfaces that enable individuals to interact with the models for learning, planning, and manufacturing control. The semantics of manufacturing that encompasses all enterprise operations and functions within a globally distributed real (or virtual) manufacturing enterprise must be consistent across all levels, operations, and functions of the enterprise. Ideally, the semantics would support global multi-objective optimization of the enterprise and its operations; that is, it would be

robust enough to be the basis for a theory of manufacturing and adaptable enough to support change.

Individuals will be critical components of any manufacturing system. Models and simulations must account for individuals from two points of view. First, the behavior and actions of individuals, as part of a manufacturing system, must be included in the models. This implies an understanding of how individuals relate to each other within the system, as well as an understanding of how individuals relate to equipment and processes (which may or may not be automated). Second, models and simulations must be described and delivered in a usable form to facilitate the decision or action that must be taken.

Meeting the grand challenges of concurrency in all operations and rapid reconfiguration of SMEs will depend on accurate predictions and timely decisions based on modeling and simulation to develop virtual prototypes. The enterprise modeling and simulation—would have a profound impact on manufacturing of the future. Research on modeling and simulation will help meet the challenges for SMEs concurrency, the utilization of human and technological resources, the conversion of information into knowledge, and the rapid reconfiguration of SMEs.

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An effective interdisciplinary approach in RN is offered by economists, mathematicians, informatics specialists and SMEs employees. All these ones give the assurance that new modes of thinking will be implemented by researchers. The process cuts

across the more traditional discipline-based academic structures and makes a more knowledge-based flexible framework.

The research network is a cohesive partnership because it includes universities, research institutes, nongovernmental organizations and SMEs with experience and results in knowledge-based management informational systems, specially in SMEs' knowledge-based management information systems.

The RN will carry out interdisciplinary developments involving the complex environmental systems, humanities and social sciences areas.

Intersectorial character is given by the universities, SMEs, research institutes, nongovernmental organizations participation in research activity focusing to integrate them in the global EU research network.

SMEs are coming with problems sets that are solved only by scientific research activities. Research institutes are coming with the experience, methodologies, techniques, methods and tools. Nongovernmental organizations are coming with the capability to put together interests and objectives. Universities are coming with the research management, logistics and training and education capabilities to develop the student's research skills and to select the future ESRs. In the Research Network framework, universities train selected ESRs.

The academic and research community will have to articulate the results of research in terms that are accessible by SMEs leaders.

The RN will provide actual topics for SMEs and will generate research subjects that will lead to the SMEs' development through solutions offered by researchers involved in RN.

The research is focused on developing a new models and assessment capabilities, adapting existing models to develop an integrated reference set of multilevel models. These models would be used to facilitate the participation of SMEs in extended enterprises, to facilitate the transition of present-day SMEs into next-generation SMEs. The research is focused on tools for assessing a SMEs' capabilities.

The development of a usable repository of

manufacturing knowledge could be an easily accessible core for a knowledge base. The processes for capturing knowledge would conform to a consistent set of rules applicable across the entire product life cycle. People applying the knowledge would also be guided by consistent rules, possibly incorporated into automated systems.

Research results dissemination

There are a lot of ways to build bridges among SMEs and academic area by the proposed research network. In order to achieve the proposed objectives, the following activities could be organized:

Research Activities on competitive basis regarding the SMEs role in the changing environment, offering solutions to the problems that the SMEs are facing. The interdisciplinary and intersectorial Research Centers will create the framework for research activities at EU standards. The team structures will be flexible, dynamics and oriented to the project goals.

Doctoral School on SME-Oriented Informatics Applications Quality – DSIAQ – topic. The DSIAQ curricula include special courses, scientific seminars and supervised research activity. Curricula and all the activities from DSIAQ are collaboratively made. For the young researchers admitted to the doctoral studies will be proposed topics from the SMEs problems.

Workshops, Symposiums and Conferences where will be present the original research results. The SMEs representatives and sponsors representatives must take part in these activities.

Summer Schools on Project Management, Research Management, Research Ethic, Research Evaluation, Long Term Research Implications on the SME Efficiency, Market Influences over the SMEs' Development, SMEs' Adjustment to Informational Society Requirements topics.

Researchers and SMEs managers joint meetings. It will be a permanently exchange of ideas, intermediary and final results.

Dissemination activity through Internet resources. It will be built the web site in order to assure a dynamic exchange of informa-

tion, and a feedback. For assuring a high scientific quality of the proposed RN, some measures are necessary. The research cycle includes specific steps to realize a complete documentation, to use efficient research methods, to compare the own solutions with the literature ones, to use quantitative methods and the new research methods in simulation, artificial intelligence, expert systems, genetic algorithms, data warehouses, economic model base, data mining, entity engineering. A rule set that will be used by all the researchers will be established; there are defined steps, tools and it is imposed a flow for hypothesis definition, model building, model verification and validation; the theoretical results are tested at SMEs in practical activities; the model is validated by testing results. It is anticipated, also, to enable and to promote the use of modeling and simulation for building the necessary framework to advance the state of the art by establishing standards for the verification, validation, and accreditation of modeling tools and models.

The scheduled activities will assure solutions for the SMEs problems, and, very important, will train the young researchers in the interdisciplinary areas, in order to be able, in the future, to address the research topics in the vary research areas, both applicative and fundamental. It is, also, very important to establish a methodology to assess, both the researches activities in their development, and the results.

Research development guidelines

The future challenges SMEs will face impose that the basic research be focused on breakthrough technologies, including modeling and simulation and focus interdisciplinary research and development on the priority technology areas. Some key considerations for the long-term are listed below [www04]:

- understanding the effect of human psychology and social sciences on decision-making processes in the design, planning, and operation of manufacturing processes
- managing and using information to make intelligent decisions among a vast array of alternatives

- adapting and reconfiguring manufacturing enterprises to enable the formation of complex alliances with other organizations
- developing concurrent engineering tools that facilitate cross-disciplinary and enterprise-wide involvement in the conceptualization, design, and production of products and services to reduce time-to-market and improve quality
- developing educational and training technologies based on learning theory and the cognitive and linguistic sciences to enhance interactive distance learning
- optimizing the use of human intelligence to complement the application and implementation of new technology
- understanding the effects of new technologies on the manufacturing workforce, work environment, and the surrounding community
- developing business and engineering tools that are transparent to differences in skills, education, status, language, and culture to bridge international and organizational boundaries

Information is a core technology that is applicable to grand challenges for concurrency in all operations, integration of human and technical resources, **transformation of information into knowledge**, and rapid reconfiguration of SMEs.

Information technology will be adapted and incorporated into collaboration systems and models through manufacturing-specific research and development focused on improving methods for people to make decisions, individually and as part of a group

The participation of young researchers is necessary both for giving them the necessary skills in research areas, and to give a large perspectives to RN development.

Focus long-term research on developing SMEs' capabilities to meet the grand challenges. Information systems, and modeling and simulation are the research areas that address several grand challenges. Having in view the above mentioned challenges, for the beginning, the research topics could be:

- adapting the ERP structures to SMEs requirements;

- strategically Management Models for SMEs;
- real time flows - based Integrated Systems to improve the processes and products quality;
- market studies and researches concerning the market opportunities for SMEs, using performance rank algorithms;
- elaborating studies concerning workforce training in the less-favored regions;
- adapting document management to the SMEs' requirements;
- SMEs cross border co-operation information systems, based on real situation in Euro-Regions;
- interconnecting Romanian SMEs in extended enterprises, maintaining their local autonomy;
- information system for SME processes and products analysis, taking into consideration the pollution sources elimination;
- data mining problems SME-orientated;
- expert systems for SMEs;
- defining analysis techniques for SMEs information systems, in order to adapt them to the market requirements;
- customizing the SMEs information systems;
- comparative analysis of the analysis - design - development SMEs MIS;
- the SMEs within Euro-Regions similarities;
- generalized information systems for SME in EU;
- comparative studies among SMEs from Romania on the one side, and EU states from the other side, in order to find out the best solutions for improving the former ones efficiency and to realize the cooperation among both sides.

These topics include the following domains: Management of Enterprises; Quantitative Methods; Research Management; Information Systems, Software Development and Databases; Algorithms and Complexity. All these give the possibility to combine methods and techniques to develop the SMEs' infrastructure using Knowledge-Based Management Information Systems, as result of an evolutionary research process.

Conclusions

The RN project will combine expertise from economics, mathematics, engineering and informational systems knowledge domains and will assure a flexible and efficient communication ideas, partial solutions, scientific events and dissemination through papers, research reports, scientific meetings and seminars, and informal meetings among researchers from the disciplines involved in the project. All these aspects will lead to realize a synergistic working framework.

Having in view the SMEs increasing participation in economical life and the challenges they face, it is necessary to intensify the research in areas related to SMEs efficiency. The increasing SMEs' problems complexity, both short-, and long-term, implies a large scale research development. A such kind of project could be sponsored by SMEs' organizations.

The interdisciplinary and the intersectorial character of the RN require strong research team building to solve problems that SMEs are facing related to Management Information Systems.

The proposed Research Network does not mean a huge building were a lot of people work. Research centers will be organized or will be developed in each university included in the Research Network. These research centers will have a scientific level, compatible with EU standards. The researches results will offer a base to SMEs in order to develop themselves in the future EU business environment.

Bibliography

[IVAN04] Ion IVAN, Adrian VIȘOIU – *Bază de modele economice*, "Economistul" Journal, 1614 (2640), May 10, 2004

[POPA04] Ion IVAN, Marius POPA, Doru UNGUREANU, Adrian VIȘOIU – *Economic Models Foundation*, International Symposium „European Integration and Economic Competitive”, Chișinău, Moldavia Republic, September 23 – 24, 2004, pg. 189 – 195

[www04] Board on Manufacturing and Engineering Design: *Visionary Manufacturing Challenges For 2020*, Executive Summary, <http://www.nap.edu/html/visionary/index.html>