Association for Information Systems
AIS Electronic Library (AISeL)

2000

Leapfrogging for Modern ICT Usage in the Health Care Sector

Reima Suomi
Turku School of Economics and Business Administration

Follow this and additional works at: http://aisel.aisnet.org/ecis2000

Leapfrogging for Modern ICT Usage in the Health Care Sector

Reima Suomi

Turku School of Economics and Business Administration

Rehtorinpellonkatu 3

FIN – 20520 Turku, Finland

Abstract- **Health Care has traditionally been dominated by a strong professional culture, to which information and communications technology has not maybe fitted in the optimal way. Currently, however, strong currents are changing the intellectual climate in the field. Modern information and communications technology is being taken into usage in the Health Care sector at an increasing pace. This article provides and overview of the activities related to modern information and communications technology in the Health Care Sector. Our research questions are:**

1. **Which reasons led to the late adoption of modern ICT in the Health Care sector?**
2. **Why is the situation now changing fast?**
3. **Which seem to be the main application areas?**
4. **Which kind of progress we can now see?**

To each of the research questions, we allocate one chapter in our paper. This article is conceptual in nature, but argumentation is supported by concrete examples. The main conclusions are that

- **Starting from "scratch" has made a fast development in the field possible as it comes to modern ICT**
- **Developments have been very fast: on the other hand demand for information and ICT has too grown enormously**
- **ICT has been a total change agent for the industry, and a needed one**
- **Fast introduction of modern ICT has been made possible through the simultaneous introduction of many modern management techniques such as quality assurance**
- **Internet was and is the "killer platform" in this industry too**
- **The whole sector has turned from a handicraft industry to knowledge industry**

I. INTRODUCTION

Health Care and information systems have met quite rarely. One of the early signs of the change was the classical American Hospital Supply case [1], which, even when limited to supply and demand on medicine and other hospital supplies, first opened our eyes to the huge improvement potential within the Health Care sector. Some less known individuals saw the development trends already very early: *"Wholly new forms of encyclopedia will appear, ready-made with a mesh of associative trails running through them, ready to be dropped into the memex, and there amplified... the physical, buzzled by a patient's reaction, strikes the trail established in studying an earlier similar case, and runs rapidly through analogous case histories, with side references to the classics for the pertinent anatomy and histology..."* [2].

Our view is that the Health Care industry, together with retail and tourism, are going to be major turnaround industries in Information and Communication Technology (ICT) usage in the next ten years. That's why we want to introduce the readers to the changing trends in the industry.

Our analysis focuses on the patient consultation and interaction level. How have the patient-related processes changed? This means that several important developments in the nearby disciplines have to be ignored. For example, in the more technical field, several telemedicine, image processing and computer modeling techniques exist. To take a more administrative point of view, we could long discuss process development initiatives in the Health Care sector. The management and resource allocation systems of the Health Care industry would too be of most interest. However, we see that the patient contact is the moment-of-truth too in medical services, and we should focus on that and the developments in that field because of modern ICT.

Major trends in the Health Care sector as such are too out of the scope of this article. The reader should anyway be reminded of the major developments: the population is altering fast and life expectancy is growing. New diseases are being discovered all the time, and even small malfunctions of the human body are intervened with nowadays. Also the demand for services is growing very much because of several reasons. At the same time, in many countries the proportion of Health Care oriented costs of the total Gross National Product is at its peak: no increase could be tolerated. So, without extra resources, ways to answer to the increased demand must be found. The key is increased effectiveness and efficiency, for which ICT applications are major tools.

Other main trends are those of privatization and increase in information intensity. Activities are turning from public hierarchies to private markets and networks. This means new cost-awareness. Information, often costly and difficult to gain, is a key to success in the market, instead or at least at the side of other production inputs.

Networking of the actors in the field is a key trend. The services needed are so complex, that no organization can provide them alone. This means increased communication and control needs. Fortunately, modern ICT is a key enabling technology in this sense.

Our research questions are:

1. Which reasons led to the late adoption of modern ICT in the Health Care sector?
2. Why is the situation now changing fast?
3. Which seem to be the main application areas?
4. Which kind of progress we can now see?

To each of the research questions, we allocate one chapter in our paper. The article is conceptual in nature, but illustrated through case-examples from the literature and from the research projects the author is involved in.

II.   TRADITIONAL OBSTACLES FOR ICT IN THE HEALTH CARE SECTOR

We have found the following reasons for the late adoption of modern ICT in the Health Care sector:

- Fragmented industry structure
- Big national differences in processes
- Strong professional culture of medical care personnel
- One-sided education
- Handcrafting traditions
- Weak customers
- Hierarchical organization structures

Good competitors and customers are a key to success for any company and industry [3]. Unfortunately, the Health Care sector has not been able to enjoy from neither of them. For a long time Health Care has been considered as a faceless public service, where normal competitive forces are not in effect.   Health Care organizations have not felt as competitors, but neither have they documented productive co-operative behaviour. First with penetrating privatization the situation is starting to change.

As it comes to customers, most often they get into touch with the industry when in a critical and sensitive situation, where bargaining power is very low.   Bad service has just to be suffered.   First during the last few years the concept "customer" has started to substitute the word "patient". Regulative bodies have too become active in this respect, and for example in Finland a special patient-ombudsman has been institutionalized and legislation on patient reclamation and insurance has been introduced.

Professional cultures can have a profound outcome on organizational outcome [4].   Within the Health Care sector, there are many strong professional cultures, the strongest of them being those of doctors and those of the nurses. People seeking for these professions usually value human interaction, and are not much up for abstract systems such as computers.

A part of hospital organization has always been a strong hierarchical, professional and specialized structure. Work on the computers, unfortunately, is low on the hierarchy list, especially of course in the activities of keying in patient data

that would be a natural thing to do for the doctors. As [5] puts it: *"…for many Health Care applications, the most difficult obstacles can be social and cultural."* It is well known that information system development and application can be very difficult or at least different from less bureaucratic organizations than the health care[6].

Even when we conclude that Health Care is a very information intensive industry, it has not been considered as such one.   A good doctor is valued because of his handcrafting skills, especially in surgery, and it is not being understood that behind the handcraft operations a vast amount of knowledge is needed.   Some, anyway, have understood that human body is the most complex entity in the world and of which information and knowledge has been collected over thousands of years.

Finally, education of Health Care personnel has traditionally not focused on computer skills.   Even the classical university tradition has kept medical and natural science (and thus computer) faculties apart from each other. Fortunately, during the last years, the drive for deeper co-operation between different science fields has begun to bear fruit.

Patient care is very culturally bound, and especially the administrative processes behind vary greatly from one country to another. This, of course, makes standardization very difficult and the industry a bad target for suppliers of standard software and platforms. Neither do we have any dominant players in the field, that would behave in the market as strong customers and trend-setters.

III. PRESSURES TOWARDS OLD WAYS OF WORKING WITHIN HEALTH CARE

Several pressures affect the Health Care industry too. Here are some of them which we found to be of most importance and which we want to discuss:

- new networked way of handling patients and processes
- increasing cost justification needs
- advances in ICT
- growing demand
- better education of personnel
- more demanding customers

As a whole, the society is turning away from hierarchies and simple value chains to complicate networks and value systems. This is too the case for the Health Care industry. Increasing skill demands and cost pressures drive even this industry towards specialization, and an individual patient - the customer - is being circulated in a network of service providers.   Mastering of processes in this network and catering for the needed data to follow the patient to different service points, all necessitate heavy usage of information technology.

Even more, the boundaries between Health Care and other industries blur. Especially this is true for the social sector. For example elderly people need other services than just health-oriented services, their needs are many and intertwined. For example, providing electronic commerce services to them can be a major help [7] [8]. A good example of a Finnish innovation is that by the Finnish Post. Their internal innovation prize was given 1997 to a product, where postmen during their daily distribution rounds too visit older people to see that everything is ok, and if needed help with minor tasks or call for further help.

Health-care –related expenses grow in all modern societies. People live longer, and even severely handicapped or sick people can be offered quite normal live environments and conditions. New diseases are being discovered all the time, and even small malfunctions in the human body, that before went unnoticed, are being addressed by modern medical science (say plastic surgery). This all is of course to cause enormous costs for the society. If new extra resources are not available from other sectors of the society, the only way to answer to the increased demand is increased efficiency. A key to this efficiency is information technology, which frees Health Care professionals from routine tasks to patient care.

As in other sectors of live, modern information technology can offer very much. Note that we have constantly in this article used the term ICT, information and communication technology. Actually, at the moment, telecommunications-based systems are developing faster than traditional information systems. Keywords in this area are Internet and Mobile communications, both to be integrated in the near future.

A key new technology is too that of smart cards, which allow patient data to be stored efficiently. Advances in telemedicine and especially in graphical data manipulation should neither go unnoticed. Computer files are slowly beginning to substitute old media for x-ray picture storage. Computers, for example, can too very effectively scan vast amounts of pictures and select outstanding cases for further human inspection. Visualization techniques have too been a key for faster product development in the drug industry [9].

Education of Health Care staff is growing in intensity and coverage. Computers are essential tools for future doctors already in the education phase, and they get into interaction with them even in the private lives, say at homes. Internet and other digital sources are substituting traditional books and journals as sources of knowledge in the sector.

Because of the more intensive care needs, customer groups have become more heterogeneous. *"Satisfaction with Health Care across Europe is thus relatively high at a general level but variations inevitably occur as the services and groups of patients under consideration become more specific"* [10]. Not all get into contact with the Health Care

system in severe conditions, especially too as health-care has become more protective and proactive instead of being just reactive. Customers demand more, and so the quality of actions needs to be improved. Many of them, especially in the case of chronic diseases, became nearby experts in the area. Applications such as on-line patient communities provide mutual help. Actually, what would connect people better than a common disease - on line patient communities fit well to the definition of Internet communities [11]: *Virtual Communities are social aggregations that emerge from the Net when enough people carry on public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyperspace".*

Even small mistakes and malfunctions of the system fast find their ways to the public knowledge and discussion. Power of the customers is too increased through patient – insurance and through different bodies to protect them, among them the patient-ombudsman –institution available in many countries.

The difference between being a patient and being a consumer is nicely put in Table 1.

TABLE 1
DIFFERENCES BETWEEN BEING A PATIENT OR A CONSUMER
[10]
_____

the role of patients	the role of consumers
patience	activity
dependence	integrity
weak position	equality
lack of freedom	mobility, freedom of choice
to be represented by experts	to represent oneself
unawareness of quality	awareness of quality
unawareness of costs	awareness of costs

IV. APPLICATIONS OF ICT IN MODERN HEALTH CARE

Classifications of ICT techniques in the Health Care sector are few. We propose the classification as shown in Figure 1.

The heart of our classification is in the interaction between the medical personnel and the patient. Both the systems that support discussions in the interaction situation: these we call the customer support and consultation tools. These tools become active as a relationship between the patient and care-taking personnel has been established. Customers, the patients, as well as the medical staff have however the interaction needs to be established, timed and synchronized, and for these purposes we introduce the systems of interaction support toolsand process support tools.
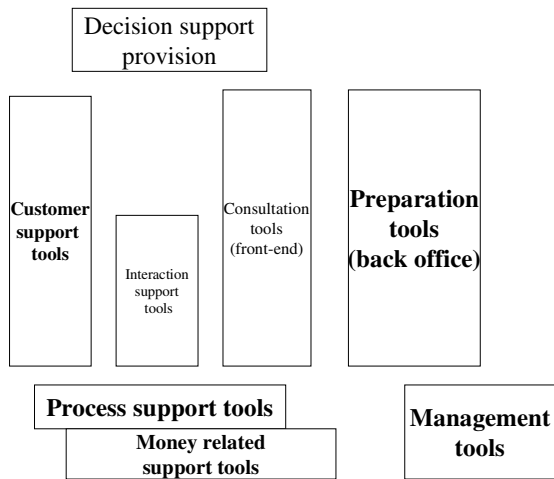
Fig. 1.   Classification of ICT tools in Health Care

Interaction-related support tools address the situation from the viewpoints of the primary actors, patients and care-taking personnel, whereas process support tools take the viewpoint of the total value chain. Finally, the transactions have to be financially tracked, and for that purpose introduce the category of money-related support tools.

Medical care is very knowledge-intensive, and an important category of systems falls into the category of decision support provision. With this name we focus on the knowledge needs of each individual care-taking action, but of course knowledge is being produced and used in other connections too.

We feel that the distinction used in services, that of front-end and back-office systems is usable in Health Care sector too. Preparation tools support the customer - care-taking personnel interaction, but is not active in the actual transaction.

Finally, we have a category of management tools for the Health Care sector. In our classification, they are active at a general level, and not used in an individual consultation situation. Most likely they are of the same character as in any management activity.

All the components of this ICT infrastructure interact with each other, some more intensively, some hardly at all. However, as we are not able to go very deep into that topic in this article, we leave the presentation of the connections between the components out from the figure.

As we can see, individual system installations can be active in many of these categories. For example, basic patient data systems fall into many of these abstract categories. Next we have a closer discussion of all the system types.

A.   Customer support tools

Information systems in this category are targeted at giving support for the customer, patient, in his or her daily coping with his/her health (sickness), as well as specifically in interactions with Health Care Personnel or systems.

In the broad sense, all information systems contributing to the well-being of humans belong to this category. More specifically, however, we should focus on systems that help the patients in coping with health data. A simple spreadsheet where someone keeps track of his/her weight would belong to this category. More specific examples are tailored equipment to measure and keep track of different health-related data, such as the Nokia-generated Wellmate® concept for measuring and delivering blood pressure data. The concept has since then been commercialized and expanded through the Lifechart –brand (see http://www.lifechart.com/). Smart cards with patient data belong to this category too.

B.   Interaction support tools

With these systems we mean mainly computerized reservation systems for consultation. They are often pioneering applications. With modern Internet-based techniques, these systems can be turned into self services. From the personnel point of view, different systems to keep track of consulting hours and other activities belong to this category.

As a further step, the whole consultation process can be conducted through information systems. Finally, the whole hospitals can become virtual ones. To see an example, take a look at the Finnish Atuline (see http://www.atuline.com/).

C.   Consultation tools

Consultation tools are there to help the care-taking personnel in the customer interaction situation. This area is of key importance: "the doctor-patient relationship tends to be of primary importance to most patients" [10]. They deliver the basic patient data, and may direct the consultation situation through data input demands and workflow and customer interaction process recommendations.

To give an example, surgeon operations are often a most critical point in a care-taking chain for a patient. However, current systems and work-habits do not cater for proper information to be collected for them. Solutions that allow for fluent collection of data without disturbing the delicate actions or surgery are badly needed.

D.   Decision support provision tools

Whereas the consultation tools deliver the basic patient data, with decision support provision we refer to information

systems that deliver general information that needs to be assessed and assembled for use in the specific consultation situation by the care-taking personnel. It is well known that the amount of medical know-how is growing very fast all the time. For example, the known number of effects medicine components have on humans is currently increased to 500 from 50 some ten years ago, and very soon we will recognize some 5000 effects. Internet has been here the tool that has suddenly made huge amounts of information accessible for every doctor.

E. Process support tools

Process support tools guide and escort the patient through different caring activities in the Health Care value system. They of course interact with the interaction support tools, but take a broader view on the process than just one consultation interaction. Here critical things are among other the routing of the customer through different consultations, and taking care that needed data follows the customer. From the viewpoint of the service points, even and right-sized load is a key factor. Major cost benefits can be gained here through directing the customer to the right level of consultation, at the right time and place. These systems are among the most difficult to implement, because they are co-operative in nature (see [12]). However, we have seen documents of even early success stories (see for example [13]).

F. Money-related support tools

Money-related support tools master the money flows in Health Care. They are used also by the customer, but the more they can be handled as back-office -functions the better for the customer. Through these systems, the payer, say public administration and insurance companies, get involved to the processes. Because of the strong players in the field and the huge economical values at stage, even information technology innovations have traditionally born fruit there (see for example [14]

To emphasize the complexity of the area, for example in Finland, for a long time the budgeting system distributing state support for different Health Care organizations was one of the heaviest to use and maintain in the whole public administration [15]. A key solution here will too be the smart card that will include payment data in addition to patient data.

G. Preparation tools

Preparation tools are systems at a service point, that help the care-taking personnel to prepare for the customer interaction, but are not self active at the consultation time. Typical examples are different systems for handling laboratory activities and mastering x-ray pictures. Decision support provision of course heavy interacts with these systems too.

H. Management tools

Management tools support the management of health-care. Most importantly, they collect statistical data for directing purposes from all other information systems. Management tools can be very classically divided into systems at operational, tactical and strategic level. Especially strategic planning tools are badly needed. In our definition, strategic decisions are decisions that affect the total amount of resources available for a certain purpose (see [16]). To take an example, for years the Finnish political decision-makers have had difficulties in deciding, how many doctors should be educated. Some years reductions in education are demanded, some years proofs of doctor shortage are presented.

An alternative typology basis is that of classifying primary stakeholders in the process. For each stakeholder, a number of systems exist, but for space reasons we do not start a discussion on the systems per stakeholder category here. The stakeholders are summarized in Figure 2.

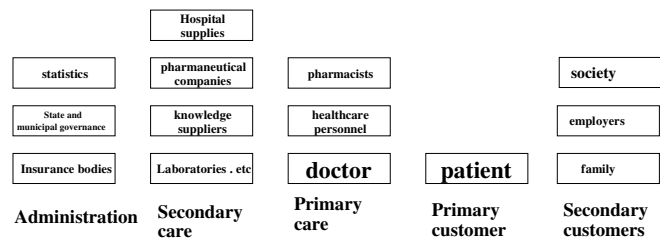| | Hospital supplies | | | |
statistics	pharmaneutical companies	pharmacists		society
State and municipal governance	knowledge suppliers	healthcare personnel		employers
Insurance bodies	Laboratories . etc	**doctor**	**patient**	family
Administration	**Secondary care**	**Primary care**	**Primary customer**	**Secondary customers**

Fig. 2. Stakeholder analysis of Health Care

The figure separates five groups in the value chain. The patient is the primary caring object, but his/her well-being is of course in the interest of a groups we call secondary customers, the family being the foremost, but shortly followed by his/her employers and the society as a whole, we hope.

With primary care we mean those parties, that get into direct interaction with the patient. Here we of course have the responsible doctor, the other care-taking staff and pharmacists. The secondary layer of care suppliers is already more vague, but in our classification stakeholders that produce direct inputs for the consumption of the primary care as their main business belong to this group. Administration refers to those stakeholders that provide the regulative and infrastructure basis for Health Care, but do not give any direct inputs to the consultation of the patient.

V. PROOFS OF CONCRETE CHANGES

Not just are the pressures to take modern ICT into use in Health Care enormous, the accomplishments so far seem to be promising ones. We have been witnessing the following trends:

- active research initiatives in the field
- major scientific advancements because of ITC
- major investments of hospitals into Health Care information systems
- active regulative and infrastructure investments
- boom of medical data on the Internet
- cheap equipment for home usage
- new pharmacy products
- functional food offerings

Research on Health Care information systems has boomed up during the last five years, this ECIS track being a good example of that. Both European Union and national research programs have allocated research funds into this field, the EU 5th Framework program discussion the theme under the title "Improving the quality of life and management of living resources" with the following subtitles [17]
- Food, nutrition and health
- Control of infectious diseases
- The "cell factory"
- Environment and health
- Sustainable agriculture, fisheries and forestry and integrated development of rural areas including mountain areas
- The aging population and disabilities

Major improvements in medical science are there because of the research possibilities allowed by modern ICT. Maybe the biggest promise is the completion of the human gene map, made possible by extensive databases and modeling techniques unavailable still a few years ago.

Hospitals and other service providers in the area invest huge amounts of resources into ICT. For example, in Turku, a deliberate decision was made 1992 to abandon the building of one more health center and to invest the money into ICT in the sector, which was the start for a on the Finnish scale considerable project called Primus (see http://www.turku.fi/tervi). An average patient is not maybe at the first hand understanding the intensity of modern ICT usage in hospitals, as back-office functions are many times automated first [18].

Active regulative investments are too called for in the field of Health Care. Patient privacy seems to be a major problem area. "Care must also be taken to safeguard patient privacy and the confidence of medical records." [5]. A lot of activities already happen in the field. As it comes to the telecommunications infrastructure, many main links and techniques in the area have become feasible because of medical applications giving the basic load for the infrastructure.

On the Internet, the amount of medical data is booming. This is of course true for other areas of life too. In addition to bulk data, currently personal consulting in the form of virtual

hospitals is available on the Internet too. Of course Internet is a key technology for many activities eroding health too, say drug business. And finally we must remember that the demand for Health Care –related information is too growing very rapidly [19].

What we still seem to miss is a documentation of the benefits the customers have met. The trick is to separate which improvements are there because of modern information technology and which because of some other reason. As an integrated one, it should be safe to conclude that both the quality and efficiency of Health Care have improved over the last decades. We are too safe to assess that at least a part of this development is there because of modern information systems.

Large-scale production and cheap microchips have made it possible to build equipment for home usage with reasonable quality and price. A prime example is that of hearth rate monitors (see for example http://www.polar.fi/). Earlier we discussed the Wellmate® concept. New products both in the traditional pharmacy as well as in more traditional nutrition category – the product groups that are fast integrating – have been witnessed. For new medicine development, computer simulations can speed up the process reasonably. New functional food stuffs such as the Benecol® with the fat soluble plant stanol ester that effectively restricts the absorption of cholesterol from the digestive tract and thus reduces serum total and LDL cholesterol (see http://www.raisiogroup.com/group/products/index.html).

VI. CONCLUSIONS

Many information technology professionals dream of starting something from the "green field". In the Health Care sector, this has come partly true. Sometimes starting from scratch is better than repairing old systems, as was too documented in the case of the build-up of the ex-DDR telecommunications infrastructure [20]

ICT applications of Health Care are in many places not just modernized, but leapfrogged to the future. Actually, for example in more technical computing, many advantages are put forward by the hard demands from the medicine side in disciplines such as computer modeling and visualization techniques. ICT can be seen as a powerful change agent for the whole Health Care sector. The tradition-rich and conservative industry is not only suffering from the changes. We have already seen similar almost radical changes in other traditional industries such as insurance (see [21]) or the publishing industry. Most evidently, the changes have been positive as seen from the macro perspective.

It is not to be forgotten that the patient is a human. The too old proverb "high touch – high tech" is getting new contents in the case of Health Care information systems. Fortunately, nowadays ICT is seen as an extension of human capabilities,

not as a substitute for them. Introduction of modern ICT has coincided with several other developments supporting it. For example, disciplines such as focus on business processes, quality systems and thinking, organizational learning and break-down of hierarchies – all topics active in the Health Care sector – support and actually necessitate the introduction of modern ICT.

Even in the Health Care sector, one can not escape the power of Internet. First Internet has launched several critical applications to the field and made it possible to communicate really efficiently and internationally. All too often Internet is however still seen as an information distribution tool, and real interactive solutions in the Health Care sector still remain unseen. Especially this is true for structured business/consultation transactions. Maybe the transactions between patients and the care-taking staff in Health Care are so complicated and human-oriented, that structuring them to a computer screen are almost impossible. This means that growth-paths for usage of Internet in Health Care remain there for a long time to come. When are we to speak of electronic commerce in the Health Care sector?

Finally, let us focus back on the strong professional culture of Health Care. Health-care profession is turning from a handicraft to a knowledge profession. As diseases grow more complex, they are won through knowledge, not solely through experience. Handcrafting skills are needed in some areas such as surgery, but those activities become forums for specialized professionals, and the average staff is not having a material contact with the patient. As we speak of a knowledge profession, ICT is to be natural part of the total, not just some odd add-on.

REFERENCES

[1] J. Short and N. Venkatraman, "Beyond business process redesign: redefining Baxter's business network," *Sloan Management Review*, vol. 34, no.1, pp, 7-20, 1992.

[2] V. Bush, Vannevar "As We May Think", *The Atlantic Monthly*, 1949, reprinted in I.Greif, (editor) *Computer-Supported Cooperative Work: A Book of Readings.* San Mateo, California. Morgan-Kaufmann, pp. 32, 1988.

[3] M. Porter, M " The Competitive Advantage of Nations," *Harvard Business Review*, pp. 73-93, March/April 1990.

[4] J. Martin and C. Siehl, "Organizational Culture and Counterculture: An Uneasy Symbiosis," *Organizational Dynamics*, no. 2, pp. 52-64, 1983.

[5] *The European Information Technology Observatory*, 1995

[6] P. Middleton, "Managing information system development in bureaucracies,". *Information and Software Technology* , vol. 41, pp. 473-482, 1999.

[7] J. Heikkilä, J.Kallio, T. Saarinen and V. Tuunainen, "EC of groceries for elderly and disabled - Comparison of alternative service models," *Information Technology and People*, vol. 12, no. 4, 1999.

[8] V. Tuunainen, "Different Models of Electronic Commerce – Integration of Value Chains and Business Processes," *Helsinki School of Economics and Business Administration, A-153*, 1999.

[9] K. Karjaluoto, "*Knowledge management in customer relationship on high-throughput screening market: Case EG&G Wallac*," Master's Thesis. Turku School of Economics and Business Administration, 1999.

[10] *European Health Care Reforms – Citizen's Choice and Patients' Rights,* World Health Organization Regional Office for Europe. Copenhagen, 1996.

[11] H. Rheingold, "*The Virtual Community - Homesteading on the Electronic Frontier*," Addison-Wesle, 1993.

[12] R. Suomi, "*Assessing the feasibility of an inter-organizational information system on the basis of the transaction cost approach,*" Doctoral Thesis. Turku School of Economics and Business Administration. A-3:1990.

[13] P. Ribbers, "*RHCNET - A regional healthcare EDI-network in the Netherlands,*" Commission of the European Communities, TEDIS Programme, 1991, Task B12, Information Campaign 3, Case studies and training material for management, 1991.

[14] J. Martin and R. Eckerle, " A Knowledge-Based System for Auditing Health Insurance Claims," *Interfaces* vol. 21 no. 2, pp 39-47 March-April 1991.

[15] *Tietoja valtionhallinnon atk-toiminnasta* (1997) Valtionvarainministeriö.

[16] J. Barney, "Firm resources and sustained competitive advantage," *Journal of Management*, vol. 17 no. 1, 1991.

[17] Cordis www-site. http://www.cordis.lu/fp5/src/t-1.htm. Read 12. November 1999.

[18] S. Klein and H. Schad, "The Introduction of EDI Systems in Health-Care Supply Chains: a Framework for Business Transformation,". In P. Swatman, J. Gricar and J. Novak (eds.) "*Electronic Commerce for Trade Efficiency and Effectiveness, Proceedings of the Ninth International EDI-IOS Conference Bled, Slovenia, June 10-13,*" Kranj: Moderna Organizacija, 1996, pp. 28-53, 1996.

[19] S. Klein, R. Lee, L. Lei and S. Quereshi, "Pharmatica-Supporting the Complex Information Needs in the Changing Healthcare Sector," *EM – Newsletter*, vol. 6 no.2, pp. 25-26, 1996.

[20] G. Tenzer, "*Statement anlässlich der Pressekonferenz dum Aufbau Ost am 10. December 1997 in Neubrandenburg*". Deutche Telekom AG, 1997.

[21] R. Suomi, "Alliance or alone - how to build inter-organizational information systems," *Technology Analysis & Strategic Management*. vol. 3. no. 3., pp. 211-233, 1991.