Information technology: A panacea?

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1. Introduction

Is information technology a panacea? Is it a universal remedy for revitalizing organizations suffering from arteriosclerosis? Or is it just a means for doing your work in a more complicated way, and, if you are lucky, somewhat more swiftly? These questions will be discussed from the point of view that, nowadays, information technology offers us a range of possibilities to reorganize work, reshape organizations, and redefine cooperative relations between institutions. These possibilities can facilitate processes of solving organizational problems and realizing organizational opportunities, but never are the main forces behind these processes of organizational change. The main forces behind organizational change have to be sought in the intentions of people and institutions to cooperate based on vision, intentions that have to be strong enough to redefine existing power domains of people and institutions. However, the road to harvesting the fruits from investments in information technology is not without dangers and possible pitfalls. Information technology can lead to costly projects and even disasters if it is put into service (1) using obsolete technology or obsolete concepts, or (2) in large projects aimed at integration, or (3) in areas where power struggle is predominant, or (4) neglecting the people that have to work with it. Information technology is no panacea that solves organizational problems without having to pay attention to the will of people to cooperate, power domains and organizational culture. If it is used as such, you can be sure that some actor in the organization seeks for a quiet improvement of its authority and power. Information technology can be a source of innovation and a facilitator if it is used properly. Speaking of a panacea, this implicitly means that there is an illness or problem. In the field of information technology, however, it is often better to think starting from the possibilities instead of problems.

2. Where we are now: the state of affairs with regard to information technology in health care

In the field of health care, we have seen a development in the use of information technology from the integrated systems in the nineteen sixties to the communication standards and distributed systems nowadays. The concept of an integrated hospital information originated in the nineteen sixties. Stimulated by the Ministry of Education and Science, several Dutch academic hospitals cooperated in the development of the ZIS (Ziekenhuis Informatie Systeem) project. The basis of this integrated hospital information system was an architecture based on a matrix of processes (to be carried out in a decentralized way) and entities (to be stored in a central database). A special operating system for the ZIS system had been developed (BOS) based on very efficient scheduling algorithms that has survived until today. Furthermore, generic components text processing modules were developed in these days. In the early nineteen seventies, this ZIS hospital information system had been implemented in several hospitals. A centralized organization, named BAZIS, for the maintenance and development of the ZIS system had been set up. Nowadays, the successor of BAZIS, called HISCOM[1], is a mayor player in the market of hospital information systems in the Netherlands. This integrated hospital information system has grown to an enormous size and complexity. For instance, it encompasses 40.000 entity types that are the definition of its database. This means that a level of complexity has been reached that is hardly manageable even with the cleverest people. Because of its size and complexity, such a system cannot be very agile and flexible. Therefore, in the mid nineteen eighties, new concepts of organizing a hospital information system emerge based on a federation of decentralized, relatively autonomous information systems. An example is the 3I project (Hasman, 1991) in the Dutch

[1] See Internet address http://www.hiscom.nl

province of Limburg, in which general practitioners, home nursing services, welfare institutions, home help institutions, speech therapists, physiotherapists, midwives, pharmacists, and dentists cooperate. Several of these federative systems based on the cooperation of relatively autonomous institutions, inside hospitals as well as outside hospitals, have been set up since the mid nineteen eighties. The problem with such a federative model is that the participating systems have to cooperate. For this cooperation, standards have to be developed, of which EDIFACT definitions and the HL7[2] (Health Level 7) standard are the best known and widely used. HL7 has been in existence since 1987. Its main aim is to define precise message types that enable the communication between information systems. These messages are related to events in processes like patient admission/ registration, clinical observations, patient and resource scheduling, accounting, patient care, and so on. Messages can be queries, asking information from another information systems, as well as triggers that update the information in other information systems. Instead of storing information at one place, new information is sent to all relevant systems, enabling them to be up-to-date. Furthermore, some work has been done in HL7 on data definitions (classes and attributes)[3]. This can be seen as defining an extension to the language system needed for efficient communication between relatively autonomous information systems. HL7 supports a central patient care system as well as a more distributed environment consisting of departmental systems. An application of HL7 can be found in the Martini Hospital in Groningen, where a rather decentralized structure of departmental information systems exist, glued together by a central 'post office' information system that delivers query messages and trigger messages to the right decentralized locations (Stegwee, 1996)

For the near future, the development of information systems focused on delivering coordinated services to the patient seems to be the main issue. This can be done by (1) developing coordinated front office systems and (2) by developing patient-centered logistics. Coordinated front office systems, in Dutch the 'één loket voor alle diensten' idea ('one counter for all services') aim at a situation where, behind the front office, several health care institutions or departments cooperate in order to avoid that patients are sent from pillar to post[4].

Patient-centered logistic systems aim at a situation where services that have to be delivered to a patient by several institutions or hospital departments are scheduled in a coordinated way, thus preventing unnecessary long waiting times between services. Furthermore, it will be necessary to tune information management in the health sector to changes that have been taken place and will take place in the field of information technology, in order to control costs of information technology, enable organizational innovation, and avoid computerization disasters. How to cope with problems of information management in the changing world of information technology, aiming at delivering coordinated services to patients, is the subject of the next paragraph.

3. Long-term developments in the field of information technology

In information technology, long-term developments are important. Information management should look at these long-term developments and avoid being impressed too much by fashions and buzzwords.

Long-term developments can be ordered by looking at the supply side and the demand side of the information technology market (Simons, 1989). The *supply side* concerns the

[2] See Internet address http://www.mcis.duke.edu/standards/HL7/hl7.htm

[3] HL7 distinguishes 108 classes and 80 message types.

[4] An example is the GINO project in Veendam (Groningen). See: Leeftijd, Februari, 1996: 6-9. A similar system is GIRST. GIRST is an information and registration system for home-care, developed by the NIZW. See: Internet address http:// www.knoware.nl/nizw/.

development of new information technology and bringing that new technology to the market. Important developments at the supply side are the ongoing miniaturization and the resulting drop in price of processing power, as well as the emergence of an industry chain in which producers tend to specialize in order to keep up with the speed of product innovation. Information technology enables a variety of new types of organization, and supports more task types than ever before. This means that explicit organization (re)design is possible and necessary. The *demand side* encompasses the application of information technology in organizations. At the demand side, two aspects can be distinguished: the reshaping of organizations enabled by information technology, and information management. In the reshaping of organizations enabled by information technology we see a predominant role for the process organization in which the information system handles administrative tasks and takes the role of a logistic coordinator of material flows and work flows. Information management has the task to make decisions about how to use information technology in an organization, and how to develop information systems. Information management bridges the gap between the supply side and the demand side in the information technology market. In information management, some of our experience over the last decades can be formulated as principles like the congruence principle and the invariance principle, the variety principle, and the programming avoidance principle.

3.1. The development of the supply side of the information technology market

Speed of information technology development

Information technology becomes cheaper continuously and that at an enormous speed. According to Moore's Law, hardware processing power becomes cheaper an order of magnitude each 5 years[5]. Software development becomes cheaper an order of magnitude each 12 years.

This leads to enormous differences in costs between information systems belonging to different generations (latter versions of the same information system being an order of magnitude cheaper than earlier versions). For instance, an in-depth research project at a government agency showed that departments using later generations of software had computerization costs that were 5 to 29 times lower than comparable departments using older generations of software (Gazendam, 1993). Another example is discussed by Taylor (1992), finding a difference of a factor 14 between the costs of two generations of the same information system. Because the maintenance of software is yearly about 10% of the building cost of an information system, after 10 years of use, software can be replaced by new generation software of which the building costs equal the maintenance of the older system. Organizations that fail to replace their outdated, costly systems in time will be trapped in the *legacy trap* in which the burden of costs associated with the maintenance of the older legacy information systems prevents the building of cheaper, new generation replacements for these systems. The differences in costs between subsequent generations of computer hardware and computer software ask for an adequate management, based on using the information technology market that develops at such an enormous speed, and rapid application development rather than large integrated projects that tend to use obsolete technology.

[5] If we would apply such a speed of development to, for instance, the automobile sector, we would find out that, within 20 years, an expensive car like a Mercedes would drop in price from 100000 guilders to 1000 guilders, and would gain a factor 100 in performance (for instance, have a speed of 2000 km/h and run 100 km at one liter of fuel).

Emergence of an industry chain

Because of this development speed, the market of information technology has developed to an *industry chain* in which organizations have developed core competencies (specific organizational knowledge) (Gazendam, 1993: 75). The concept of supply stages in an industry chain has been explained by Galbraith (1983). There is no longer a single stage in which an information system builder builds a system and delivers it to the user, but a much more complex chain of work. Sprague and Carlson (1982: 13) have distinguished the roles of (1) *toolsmith* developing new technology, new languages, new software, (2) *technical supporter* developing components to be used in a specific information system, (3) *builder* building a specific information system for a user based on the assembly of components, and (4) the intermediary helping the user in using the information system. Galbraith (1983) distinguishes the following stages in the industry chain:

1. raw materials;
2. primary manufacturing;
3. fabrication;
4. product producer;
5. marketer and distributor;
6. retailer.

The *toolsmith* role corresponds to the primary manufacturing stage, the *technical supporter* role corresponds to the fabrication stage, and the *builder* corresponds to the product producer role. The rise of object-oriented technology, leading to reusable objects and modules (Cox, 1986) can be seen as corresponding to the rise of the fabrication stage in the industry chain. The marketer and distributor stage is fulfilled by the 'shops' of information system products in and outside the organization such as information centers. The retailer stage is fulfilled by information centers, information coordinators, and other intermediaries rendering services to the users of information systems. The emerging structure of the information technology industry chain, and the falling costs of information technology, have enabled a way of information systems development known as rapid application development (RAD). RAD is based on a use of the products offered in the information technology market and an extensive re-use of designs in which specific organizational knowledge is stored. Builders (product producers) preferably use RAD. The emergence of the information technology industry chain has led to positive effects such as standardization and low costs at the upstream stages of the chain, and modularization and customization downstream.

Using the information technology market in the health care sector

Applied to the health sector, this means that a development takes place from developing everything yourself to buying in the information technology market based on standards like Windows, Internet, EDIFACT, and HL7[6]. This leads to the following recommendations.

(Recommendation 1) Buy as much as possible in the information technology marketplace, and do this looking at industry standards.

(Recommendation 2) In order to do this in a cost-effective way in such a situation, an institution in the health sector needs to develop two kinds of competence: competence in using information technology, and competence in information management. The information management competence consists of being able to operate as a competent buyer in the information technology market, and to realize small-scale rapid application development

[6] By now, the ZIS system has developed to a commercially available system that conforms to most industry standards. It remains, however, a system based on a rather centralistic, integrated information system concept.

projects. The organization has to invest in its own personnel by building these (limited) competencies rather than being totally dependent on external advisors. Your advisor about outsourcing your information technology should not be the management of the company you want to give the outsourcing assignment, but a competent internal employee.

3.2. Organizational forms enabled by information technology

Introduction
Information technology has enabled a variety of new forms of organization. Examples that have emerged in practice are the process organization, the integrated front office, and the virtual community.
From a theoretical point of view, different types of information technology enabled organizations have been distinguished based on metaphors. These metaphors are the mill, the cell, and the mind. The mill metaphor organization optimizes efficiency and quality control, the cell metaphor organization optimizes flexibility and attention to customers, and the mind metaphor organization optimizes variety and innovation.
An organization that wants to survive in the long run will have to be a combination of subsystems according to the mill metaphor (the operational core), the cell metaphor (the customer-oriented integrated front office), and the mind metaphor (the innovation subsystem).

Emerging new information technology enabled organizational forms
Information technology has enabled a variety of new forms of organization. Middle management and clerical work have been replaced by information systems. Knowledge work has changed due to computerized support systems. Examples of new information technology enabled organizational forms that have emerged in practice are the process organization (Valens, 1994), the integrated front office, and the virtual community.

Process organizations

In a *process organization*, the logistic decisions about the flow of materials and documents are taken by the information system. Clerical work has been automated as far as possible. The rest of it is organized as work flows. Where possible, robots are used for mechanical work. Data are registered automatically, where possible. Work is standardized and these standards are described in procedure books and quality control standard books. Electronic data interchange is used to speed up external transactions with suppliers, consumers and banks. Where possible, these process organizations emerge because they are good at doing standardized work swiftly, efficiently, and with high quality. In process organizations, registration and calculation takes place before acting. For instance, in a MacDonald' s fast food restaurant, your order is registered before any action is taken to deliver that order. Because the high grade of informatization of the business process, non-financial events, activities, and objects are easily registered, enabling the use Activity Base Costing, Core Task Budgets, Performance Indicators, and so on. The process organization has to work as an efficient, reliable, invisible machine, operating in the background (the back office), enabling the front office to reach an optimal service level.
An example is the way in which beer is ordered at the Albert Heyn supermarkets in the Netherlands. The amount of beer that has been sold is automatically registered by the computerized cash registers at each supermarket. Daily, these data are sent to the central logistic information system that calculates a prognosis of beer sales in the next time period,

and makes up an order for the delivery of beer based on logistic formulas. This beer order is sent by electronic data interchange to Heineken, where the Heineken logistic information system receives it and calculates an optimized delivery scheme of beer to the supermarkets. The interesting characteristic of this ordering and delivering procedure is that is goes automatically. There is no longer a role for the supermarket manager in registering sales, thinking about the amount of beer that will be sold the next week due to holidays and good weather, and writing an order. In a process organization, middle management tasks in the field of logistic management and operational control are fulfilled by the information system. Middle management, therefore, tends to disappear or to get more people-oriented roles. The task of top management is to control and to adjust the information systems that are the logistic core of the organization.
Process organizations tend to form chains of organizations to attain an optimal cost-effective way of operation (Lucas and Baroudi, 1994). By contracting-out parts of the business process, horizontal chains of organization modules emerge. By linking organizations in the industry chain based on contracts, vertical chains emerge. These chains are relatively stable based on the advantages of specialization of each of the participating organizations as well as the investments that have been done in electronic data interchange. These investments represent sunk costs that make participating organizations more loyal to its partners in the organizational network.

Integrated front offices

Information systems also enable the separation of front office units from back office units. The integrated front office units use concepts and ways of work that are customer-oriented, and no longer oriented towards the logic of production of goods and services. The integrated front office is organized aimed at giving optimal attention to the customer' s wishes. The principles of attention management, however, state that attention is a scarce resource (Simon, 1976). This means that in the integrated front office, the complexities of clerical processing cannot be paid much attention. These complexities must be left to the back office. An example of an integrated front office is the single counter concept in municipal government or the personalized advice given by bank employees. The back office units have been informatized in a very efficient way, more or less as a process organization. The existence of an efficient back office and of flexible support tools enables the front office employee to be customer-oriented and to pay attention to the wishes of his customer.

Virtual communities

A further example of information technology enabled organizational forms is the rise of virtual communities of 'netizens' or even virtual organizations on the Internet. Professionals use their networks of professional contacts (sometimes called invisible colleges, de Solla Price, 1963) for identifying important developments and gathering relevant information. Communication media like the Internet can facilitate these 'invisible colleges' and inspire the creative activity.

Types of information technology enabled organizational forms from a metaphorical point of view

From a theoretical point of view, different types of information technology enabled organizations have been distinguished based on metaphors[7] (Gazendam, 1993). These

[7] The use of metaphors to characterize organizations has been explained by Morgan (1986).

metaphors are the mill, the cell, and the mind. The mill metaphor organization optimizes efficiency and quality control, the cell metaphor organization optimizes flexibility and attention to customers, and the mind metaphor organization optimizes variety and innovation.

The mill metaphor organization

The *mill metaphor organization* can be characterized as a machine that processes large volumes of material in an efficient, precise, reliable and rapid manner. The mill metaphor organization is optimized with respect to efficiency and quality control. The realization of the mill metaphor organization is done by designing it and building it, fitting machinery parts together, using craftsmanship. Examples of mill metaphor organizations can be found in the automobile industry and the back offices of banks, insurance companies and government agencies. In these organizations, the infrastructures to process material flows (in industry) or document flows (in the back offices of organizations that have information processing as a primary process) have to be designed carefully. The information systems used by mill metaphor organizations stress the quantity of information to be processed. Information is like water that has to be pumped through pipes and channels.

The cell metaphor organization

The *cell metaphor organization* is a group of people that is coherent based on the personal work contacts these people have. Direct supervision and mutual adjustment (Mintzberg, 1979) are important coordination mechanisms to attain its cohesion. The cell metaphor organization is optimized for flexibility in its reaction to the environment. Larger organizations can be seen as complexes or networks of cells. An example of such a cell complex is the organization module defined by Kastelein (1985), an organization unit that can be managed as a whole consisting of about 70 to 300 persons. Cells can be seen as the organisms controlling themselves. Each cell has to survive in an environment that consists mainly of other organization modules, sometimes entangled in an organizational web. The exchange of persons, goods, materials, money and information with the environment is determining for the structure as well as for the survival of the organization module. For a cell metaphor organization, paying attention to customers is very important. It is the basis for survival that results from the fluxes into and out of the cell. Examples of cell metaphor organizations are health care units (these are often based on cooperation around a specialism), and the customer-oriented, integrated front office units of banks, insurance companies and government agencies. An information system can be part of an organization module, or perhaps be a special organism for communication between organization modules, but is never shared by two or more modules: you cannot share each others organs. Cell metaphor organizations are grown based on (genetic) information inherited from predecessor organizations.

The mind metaphor organization

The *mind metaphor organization* is characterized by the idea that organizations are networks of actors. People, computers, and organizations are actors. They cooperate in order to perform work. Mind metaphor organizations emerge and persist because they are good at creating variety and innovation. People create mind metaphor organizations as a result of emerging processes of cooperation, rather than designing them or growing them. Schmidt (Schmidt, 1991) distinguishes the following forms of cooperation: augmentative, integrative and debative. The augmentative form is based on the fact that single actors are limited by mechanical and

physiological capabilities and cooperation can be useful to overcome these limitations. Integrative cooperation consists of the cooperation of people with different special skills en specialized knowledge in order to do a complex task in an efficient and effective manner. Debative cooperation is based on the fact that political agreement between actors about what to do as well as new scientific, technical and organizational ideas can only be constructed and tested by debate. Debative cooperation can be found in scientific communities and in the political component of government. A mind metaphor organization is typically a dispersed organization in which every task is processed dispersedly by a specific actor, emphasizing the development of competences at the level of autonomous actors. Examples of mind metaphor organizations are professional organizations (for instance, management consultancy firms), and the virtual communities of Internet. In an mind metaphor organization, professionals use information systems to attain a higher level of productivity and quality of their products. The have grown together with their supporting information systems as virtual instruments (for instance, knowledge based decision support systems, knowledge based design tools) and as virtual worlds (for instance, Internet, Alpha World).

The complete information technology enabled organization
An organization that wants to survive in the long run will have to be a combination of subsystems according to the mill metaphor, the cell metaphor, and the mind metaphor (Homburg and Gazendam, 1996). In other words, an organization needs an operational core in the form of a process organization, a customer-oriented integrated front office, and an innovation subsystem organized as a virtual community. The idea behind this proposal of a combination of organizational forms is that each organization has to optimize on a combination of efficiency of operations, attention to customers, and innovation of products and processes. This optimization can often been done most efficient if subsystems are created for each of these criteria: the back office for the efficiency of operations, the front office for paying attention to customers, and the innovation subsystem for innovation. In the innovation subsystem, knowledge is created as well as absorbed form the environment. Knowledge is created based on learning from practice or based on research. Knowledge is absorbed by human gatekeepers, and by software agents from the Internet. In this way, scientific innovations can be found much earlier than using official scientific publications. Resuming, an organization will have to be efficient (requiring a mill metaphor subsystem), responsive to clients (requiring a cell metaphor subsystem) to be able to exist in the short term, and will have to survive in the long run by innovation (requiring a mind metaphor subsystem).

Application of information technology enabled organizational forms to the health care sector
(Recommendation 3) The health care system should pay adequate attention to its basic logistics. This logistics is patient-based: patients go from general practitioner to hospital department, form hospital department to laboratory, from hospital word to nursing home, and so on. This patient logistics should be organized as an efficient process organization based on information technology. In this way, unnecessary waiting times can be avoided, unnecesary examinations have not to take place, and quality control is better possible. Patient logistics should be the backbone of the informatized health care system.

(Recommendation 4) The health care systems should be more aware of its customers, the patients, and organize units that follow the philosophy of the (information technology enabled) integrated front office. This means, for instance that each hospital should have an organization unit that stands up for the interests of patients. An additional task of this unit could be to maintain relations with the general practitioners in the interests of the patients. For

instance, it is in the interest of a patient that his or her general practitioner is well-informed. Computerization should be done according to 'human measure' in this integrated, patient-oriented front office.

(Recommendation 5) The health care sector should foster innovation and dissemination of information by using the power of virtual organizations based on the Internet and on knowledge-based decision support systems. For instance, there should be a general practitioners net that gives access to knowledge-based decision support systems incorporating specialist knowledge, and training in new developments in the medical profession that are of interest too general practitioners. Similar nets could be developed for other professionals that work extramurally.

3.3. Information management

Some of our experience in information management over the last decades can be formulated as principles like the congruence principle and the invariance principle, the variety principle, and the programming avoidance principle. Derived from these principles, information management has three tasks: (1) organizing itself according to organization modules that use zoning plans and general building regulations, (2) explicit (re)design of organizations enabled by information technology, and (3) acquiring information technology products in the marketplace and developing organization-specific information systems by rapid application development.

The congruence principle

The *congruence principle* states that information systems and the organizations they support have to be congruent. Parts of information systems that are not used by an organization module will not survive. Parts of organizations that do not exploit the advantages of supporting information systems will not survive either. Because organizations can be seen as consisting of a network of semi-autonomous organization modules, information systems will have to be organized as units that support these organization modules. The traffic between these organization module oriented "islands of automation" will have to be well-organized based on a common technical infrastructure, a common syntax for messages, a common language of description of the world, a common object identification system, and other standards.

The invariance principle

The *invariance principle* states that organizations have to define and institutionalize invariant work processes in order to be able to computerize them (Valens, 1994). This leads to parts of organizations that are organized as computer-supported process organizations. Such a process organization can form an operational core of an organization, like in banks or insurance companies. It can also function as an infrastructure that serves several more or less independent organization modules, like the patient registration system in hospitals. Organization modules that depend on the efficiency of their operations and that do not succeed in creating invariant work processes profiting from computer support will have difficulties in surviving in the long run. Not all organizations, however, depend on operational efficiency. Organizations can also derive their viability from their innovative power, or their ability to give attention to their customers.

The variety principle

The *variety principle* states that, nowadays, information technology enables a variety of new organizational forms (Gazendam, 1993). This is different from one or a decade or so ago, when hardware and software more or less required a rather centralized and bureaucratic organization. Information technology is developing fast, and offers new possibilities every year for organizing work, coordinating work, and developing new ideas. Because of that, it will be a source of organizational innovation for the next few decades. However, information technology is no panacea that solves organizational problems without having to pay attention to the will of people to cooperate, power domains and organizational culture. If it is used as such, you can be sure that some actor in the organization seeks for a quiet improvement of its authority and power, for instance a financial department seeking for centralized control of all financial issues.

The programming avoidance principle

The *programming avoidance* principle states that organizations will reach the best cost/performance ratios by buying cheap, standardized information technology products, and only developing those information system components that incorporate specific organizational knowledge. The programming avoidance principle is based on the emerging industry chain in information technology. Based on the products offered by this industry chain, it becomes clear that, in developing information systems you have to stay near your core competencies and only make those parts of information systems that concern your specific organizational knowledge. For the rest, information technology products can be best bought in the marketplace. These products enable rapid application development of your own specific information systems. Rapid application development needs an effective management in order to achieve high rates of re-use of organizational knowledge in the form of rule bases, interface component libraries, software libraries, and so on. Information system development can now be done in several months or even weeks instead of several years. In this respect, the situation has changed in the last decades. Twenty years ago, it was possible that a company developed its own operating systems and word processor in order to support its applications. Nowadays, this is hardly imaginable looking at the relatively cheap and standardized operating systems and word processors that are available in the marketplace.

Coordination forms in information management

A consequence of the programming avoidance principle is that, in the last decades, information management has shifted its attention from relatively heavy and expensive forms of to relatively light and cheap coordination forms. The ‘heavy’ coordination instruments of the past include detailed information planning methods (Martin, 1982). Two decades ago, most information system development had to be done by organizations themselves, leading to tailor-made information systems. In those days, systems development was an order of magnitude more expensive than the rapid application development we have now. In this situation, careful and detailed information systems planning could, in principle, lead to gains in efficiency of system development that compensated for the costs of planning. Nowadays, detailed planning is no longer cost-effective because the presence of the products offered in the marketplace and rapid application development. In such a situation, we need relatively light and cheap coordination forms like zoning plans allocating responsibilities for information system development (Gazendam and de Jong, 1992), standardization based on de facto standards (building regulations), and an adequate selection procedure for products offered in the information technology marketplace.

Perspectives on information management in the health care sector
Taken together, the congruence principle, the invariance principle, the variety principle, and the programming avoidance principle lead to the following perspective on information management in the health care sector.

(Recommendation 6) Information management should be organized organization-wide as well as department-wide. Departments based on specialists are the natural organization modules in health care. The development of information systems should follow this department-wise organization rather than trying to aim at large centralized systems. Information management has the task to foster the organization-wide development of a common infrastructure using industry standards in order to ensure a smooth communication between the department-wise 'islands of automation'.

(Recommendation 7) Information system development projects should have two phases. The first phase is explicit organization (re)design. The second phase is acquiring information systems. It consists of selecting and buying the necessary information technology products, and the consequent rapid application development of organization specific components. Instead of developing tailor-made information systems, one should try to buy as much as possible in the information technology marketplace, following industry standards. If certain components are so organization-specific that programming is necessary, this should be done by rapid application development.

4. Conclusion

Information technology is not a panacea. It is an enabler of new forms of work and organization. If there is no will to cooperate, information technology cannot force cooperation. The development of information systems can be difficult to manage. Based on developments in the information technology industry chain, experiences in information management, and the examination of several information technology enabled organizational forms, the following recommendations can be done for the health sector.
(Recommendation 1) Buy as much as possible in the information technology marketplace, based on industry standards.
(Recommendation 2) Develop two kinds of competence: competence in using information technology, and competence in information management.
(Recommendation 3) Patient logistics should be the backbone of the informatized health care system.
(Recommendation 4) Each hospital should have an integrated, patient-oriented front office unit that stands up for the interests of patients and their general practitioners.
(Recommendation 5) The health care sector should foster innovation and dissemination of information by using the power of Internet and knowledge-based decision support systems.
(Recommendation 6) Realize department-wise information systems rather than large centralized systems. Foster the organization-wide development of a common infrastructure in order to ensure a smooth communication between the department-wise 'islands of automation'.
(Recommendation 7) Information system development projects should have two phases. The first phase is explicit organization (re)design. The second phase is acquiring information systems.

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