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A Holistic Approach for E-Business Engineering

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Abstract

In the recent years, the broader application of web-based technologies caused radical changes and a consequent rapid development within the entrepreneurial environment. In order to exploit first-mover advantages, enterprises often preferred a quick-paced introduction of E-Business solutions, hence neglecting more holistic and integrated approaches. This fact implied that E-Business solutions were usually simply and hastily embedded into the existing business processes and organizational structures. As a result, E-Business projects often did not reach the striven targets or even failed, with the consequently growing lack of trust towards the above-mentioned business approach. Hence, there is a clear need for action in the field of methodical development, deployment and integration of E-Business solutions into the entrepreneurial structure. We present an integrated framework for the engineering of E-Business, which is the result of a 3 year experience at FIR.

1. Background

During the past years, the fast development of new Information and Communication Technologies (ICTs) has been revolutionizing the market arena and it extended the horizon of competition [16]. Such development has been causing radical changes in all business branches [1] [2] [15] [16] [19] [22] [31] [33] [35] [39] [41] [43]. New ICTs and the related new business approaches allow enterprises to design leaner intra-organizational processes, with the result of enhancing efficiency and productivity [28] [32] [38] [40]. Besides that, ICTs can strongly influence inter-organizational processes, by supporting co-operation within entrepreneurial networks as well as by enabling their co-ordination – by means of Internet-based Business Collaboration Infrastructures (BCIs), such as Electronic Marketplaces, Exchange and Communication Platforms or Supply Chain Integrators [18] [21] [39]. Hence, web-based ICT solutions play a crucial enabling role both for new business models and for those models that, up until now, had a higher value on a theoretical than on a practical level (e.g. Virtual Organizations) [13] [31]. Anyhow, a lot of open issues and unsolved problems are still to be faced. As a matter of fact, the selection and matching of organizational approaches and suitable E-Business solutions, as well as their appropriate engineering, is a complex problem. During the past years, it often happened that E-Business solutions were simply and hastily embedded into the existing business processes and organizational structures. As a result, E-Business projects often did not reach the striven targets or even failed, with the consequently growing lack of trust towards ICTs and the related solutions. Because of our experience with reorganization projects, we are convinced that, instead of a partial one, a holistic approach has to be followed. Hence, it is important to abstract from all methods and working procedures in use, in order to be able to build up a holistic "integration framework". Such an approach will enable us to identify and manage causal relationships between the strategic planning, the engineering of new organizational structures and the related controlling. Furthermore, new ICT-based organizational frameworks and E-Business solutions do not have to be only appropriately developed and integrated into the existing organization, but have to be also operated, managed and maintained (operations management). This requires a methodically founded tool. Hence, in order to face all above-mentioned issues, we developed a framework, which we use to systematically develop, implement and integrate E-Business solutions in manufacturing enterprises. We will present it in the next section (section 2). Hence, we will discuss a research work that we conducted with the support of our integration framework (section 3). Thus, we will present a case study to test the concept (section 4). Eventually, we will draw a set of conclusive considerations (section 5).

2. The FIR Integration Framework for E-Business Engineering

2.1 The Research Institute for Operations Management (FIR)

The Research Institute for Operations Management (Forschungsinstitut für Rationalisierung, FIR) is an independent research service provider at Aachen University of Technology (RWTH Aachen), with a 50 year experience in developing and applying methods for the enhancement of economic and industrial growth. The FIR is a registered research association and it has about 150 member companies and associations. The FIR has 4 research departments (E-Business Engineering, Logistics, Production Management, and Service Organization) and several interdepartmental practices, in which 70 permanent employees and further 70 academic and student assistants design the operations management in the company of the future.

In accordance with the public assignment, the methods and tools that are designed in cooperation with partners within and outside of the FIR research association are made available in particular to SMEs. As mediator between practice and theory, the FIR follows the idea of an application-oriented research, and promotes the enterprises' active participation within this process. We adapt our research results to specific lines of business and specific companies, and promote their transfer into the targeted branches.

As a research service provider the FIR acts as a "lobbyist" for the companies in pre-competition research, as a partner of trade and industry and as a research institution for national and international associative projects. These public funded projects are promoted by the European Union as well as by the German Federal Ministry Economics and Technology, and the German Federal Ministry of Education and Research. Furthermore, with the help of projects for industrial and service customers, the FIR deepens its research work within a commissioned research framework. The institute cooperates with consulting institutions, which fulfill important transfer functions within the innovation and research process. Last but not least, the FIR supports its projects through various partnerships with national, European, American, and Asian research and transfer institutions.

2.2 E-Business Engineering at FIR

Currently, there are different and not always concordant definitions of the term E-Business, e.g. in [1] [41] or [43]. E-Business will be here defined as the "holistic ICT-based support of (dynamic) inter-organizational and intra-organizational processes and transactions" [13]. E-Business hence implies the modification of existing business relationships and might thus lead to the development of new or modified business models. Within this context, we define E-Business Engineering as *all the methods and procedures that support companies of different industrial sectors to systematically develop, implement and run E-Business solutions*. E-Business Engineering can be hence defined as the systematic design and implementation of E-Business solutions and models.

Within our field experience and our daily interaction with German and European SMEs, we realized that enterprises lack of appropriate and structured methods deploy E-Business in their organizations. As a matter of fact, the decision related to the adoption of E-Business solutions as well as their embedding into an organization is a complex problem which had been too often underestimated in the recent past. Because of our experience with reorganization projects, we are convinced that, instead of a partial one, a holistic approach has to be followed. Hence, it is important to abstract from all methods and working procedures in use, in order to be able to build up a holistic framework. Such an approach can enable decision-makers to identify and manage causal relationships between the strategic planning, the engineering of new organizational structures and the related controlling. Furthermore, new ICT-based organizational frameworks and E-Business solutions do not have to be only appropriate developed and integrated into the existing organization, but have to be also operated, managed and maintained. Clearly, also the operations management under the new ICT-driven constellation requires a suitable and methodically founded support.

In order to deal with all above-mentioned issues, we developed a framework, the *FIR Integration Framework for E-Business Engineering*, which we use to develop, implement and integrate E-Business solutions in enterprises. The approach exploits several established methods from the fields of product and service engineering, business organization and computer science (e.g. methods of business modeling, service engineering, product design, process and system design, monitoring and planning of technology). The basic idea behind this approach is that we intended to adapt and integrate such established modeling, design or engineering methods, in order to fulfill the new modeling and organizational requirements triggered by the potentials of new ICTs and of the related solutions. This approach supports also to the development of new and innovative methods. The four layers of the framework are the most relevant design areas (business models, products and services, business processes, and IT) that, according to our understanding, guarantee a complete analysis of enterprises and help to define the appropriate structure for the development and embedding of E-Business solution in organizations (see Figure 1).

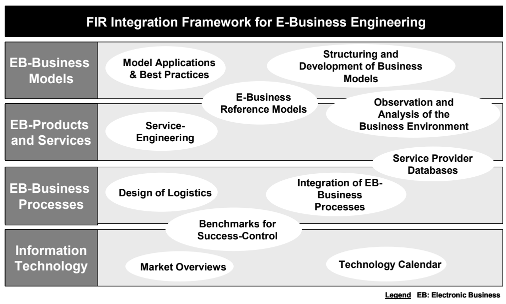

Figure 1 – FIR Integration Framework

All the different partial methods as well as their interactions represent the core elements of the integration framework, which is structured into the following layers:

1. E-Business *business models.* This first layer deals with the design and development of E-Business architectures that strive the achievement of more efficient inter-organizational relationships, e.g. within the exchange of products and services within manufacturing networks. The design of new business models in a networked economy as well as the definition and assessment of E-Business scenarios are also major issues. Furthermore, the design has to be done by taking into specific consideration the achievement of sustainable turnovers and profits.

2. E-Business *products and services.* On this layer the focus is on the systematic development of innovative

E-Business products and service portfolios, both for manufacturers and for service providers.
3. E-Business *business processes*. This layer concerns the analysis of the organizational and entrepreneurial changes triggered by E-Business, especially regarding inter-organizational as well as intra-organizational activities and processes that are heavily supported by electronic Information and Communication Technologies. The target is here the support of the business activities, especially inter-organizational, with integrated and efficient ICT-solutions.
4. Information and Communication Technologies. As a matter of fact, ICTs are the basis for all E-Business activities. A thorough analysis of existing and future ICTs, as well as methods of technology management and planning are the basic requirement for the efficient and targeted use of ICTs. Furthermore, the identification of application potentials of innovative ICTs as well as the attempt to integrate isolated E-Business solutions is a critical success factor.

The *Integration Framework for E-Business Engineering* has been really useful for the work of the E-Business Engineering Department at FIR. As a matter of fact, the framework is shared by the whole department and it hence represents a starting point and a reference for the structuring and solving of problems in our industrial projects. In fact, such an integrated model proved to be really helpful within the development of new methods of higher complexity. In the next section we will present a meta-method to develop electronic Business Collaboration Infrastructures for networked organizations that we developed using the *Integration Framework for E-Business Engineering.*

3. The Design of New Intermediaries: a Path from Business Modeling to Technology Management

As previously stated, web-based ICT solutions play a crucial *enabling role* both for new Business Models and for those models that, up until now, had a higher value on a theoretical than on a practical level (e.g. Virtual Organizations) [13] [31]. As a matter of fact, recent trends show that companies, in order to face the quick-paced globalization process, tend to concentrate on their own core competencies, before starting to co-operate within global networks of enterprises [16] [22] [27] [29]. This transformation process is crucial for the success of the company's business [31]. Therefore, before making a strategic decision regarding the participation to a co-operation network, the management of an enterprise has to take into consideration a wide set of aspects, such as the entrepreneurial organization, the own core competencies, the needs of the customers, the readiness of the potential partners to co-operate, and the availability of the needed technologies and tools [5] [13] [16] [33] [41].

In particular, enterprises have to weigh a set of crucial success factors in the fields of standardization and information technology management [15] [23]. For instance, on the one side *communication standard*s are essential to achieve an efficient exchange of information and data [3]. On the other side, *branch-specific collaboration standards* are crucial to establish inter-organizational workflows [19]. Furthermore, the *analysis of the potentials of new technologies* can help to select the most suitable technologies and tools for the support of new entrepreneurial businesses [6] [39]. A proper *technology and innovation management* is important to plan the development of the entrepreneurial core businesses in co-ordination with a strategic technology planning [7] [18].

As a result, in order to deploy innovative network-oriented co-operation structures, new (Internet-based) Business Models can be designed and successfully implemented [1] [34]. Amongst other aspects, the processes of intermediation and disintermediation are relevant phenomena in this context [21] [37] [38] [39].

Within this section we will present a new business modeling approach for a networked economy and hence focus on the design of information models in a networked economy(section 3.1 to 3.3). In order to identify the needed ICTs for a new E-Business Model, we will eventually outline a methodology for technology planning (section 3.4).

3.1 The Internet and the New Business Models

In the management literature there are different and discrepant definitions of the concept of *Business Model* [1] [41][43]. Furthermore, (E)-Business Models can be classified according to the most different criteria, such as the degree of innovation and functional integration, the collaboration focus or the involved actors [35] [41] [43]. The core objective of each company is a long-term creation of *added value* [33]. The entrepreneurial *strategy* defines how such a target has to be fulfilled. A successful strategic positioning is achieved through a sustained profitability, an own value proposition, a distinctive value chain, an entrepreneurial fit, and continuity of strategic direction [33]. According to our understanding, *a Business Model is an instantiation of an entrepreneurial strategy related to a specific business* and it encompasses six different sub-models (see Figure 2): *(1) Market model:* definition of the market(s) of action (targeted customers as well as potential competitors); *(2) Output model:* definition of the output requirements and design of the outputs (products or services); *(3) Revenue model:* estimation and calculation of the expected revenues; *(4) Production design:* design of how the performances have to be deployed; *(5) Network and information model:* partner selection and configuration of the network, as well as configuration and management of the (distributed) information; and *(6) Financing model:* scenario-based definition of risks and expected profits to search for investors or to persuade the stock holders [12].

In the new ICT era, companies strive to exploit the advantages of the networked economy. Lately, Business Models tend to involve different enterprises with the goal of bringing higher profits to each of the participants [1]

[31]. The modeling of such co-operative E-Business Models represents a significant challenge, since there are no appropriate methods to tackle systematically such modeling issue. We developed a customer-oriented business modeling approach for intermediaries within dispersed manufacturing networks.

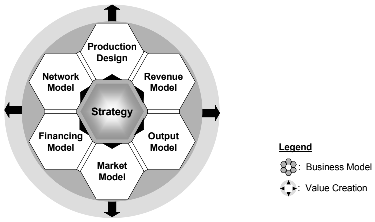

Figure 2 - Strategy, Business Model and Added Value

3.2 The House of Value Creation

Due to the globalization, the growing transparency of the markets and the resulting increased competition, enterprises have to focus more and more on their customers. As a matter of fact, the fulfillment of the customers' needs is an essential precondition to generate turnover. This means that enterprises have to take this aspect into deep consideration and must consequently shape Business Models that reflect the customers' needs [14]. Because of the above-mentioned reasons (see section 3.1), until now the development and adjustment of Business Models has been performed by companies mostly in a creative way. As a matter of fact, in the state-of-the-art there is hardly any holistic methodical support. A successful approach to tackle this methodical lack must be based on a strategic focus on the *customer's needs*. Within a running research project, we developed the *House of Value Creation (HVC),* a method to design customer-oriented and sustainable Business Models (see Figure 3) [12][26]. The HVC is a meta-method, since it consists of *three logical pillars* (input, method, and output) and of *six process layers* (each of the process steps requires a suitable method). The method suits explicitly the design of Internet-based Business Collaboration Infrastructures [14].

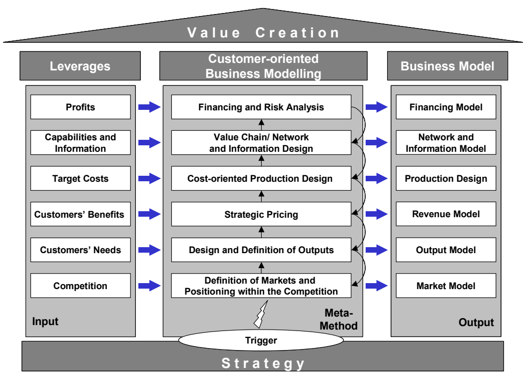

Figure 3 - The House of Value Creation

Because of our understanding of the term Business Model and because of the fact that the ultimate goal of a company is long-term value creation, the design of a Business Model has to be definitely based upon the entrepreneurial strategy. Therefore, if not already done, the first step within a business modeling process is to define the rough entrepreneurial strategy, on which the Business Model will be based [25]. The meta-method of the House of Value Creation illustrates the correlation between a set of significant leverages (first pillar of the HVC), the Customer-oriented Business Modeling process (second pillar), and the resulting Business Model (third pillar).

As previously hinted, our Business Modeling approach encompasses six layers that correspond to six following steps of the method. The first HVC phase is triggered either by the inside or by the outside of the company – through a new idea, invention, innovation or modifications of the economical environment. The six steps of the method are [26]:

1. Definition of the markets and positioning within the competition. The initial decision regards the category of products or services to deal with (as well as the substitutes). Hence, a consequent monitoring of all strong players (suppliers, customers, and possible competitors) has to be done. This phase deals with the branch profitability and with the rivalry among existing and potential competitors. Phase output: *market model*, with a clear identification of the key players, customers and competitors.

2. Definition and design of the outputs. In the product design, a well-proven method is the Quality Function Deployment (QFD) [17] [30] [42]. With this approach, a customer-oriented product development can be successfully realized. Therefore, after defining markets and identifying core customers and competitors, the outputs (physical products or services) have to be shaped in order to maximize the customers' benefit according to a QFD-like method. Phase output: *output model*, with a detailed customer-oriented design of the outputs.

3. Strategic pricing. The identification of prices for the planned outputs should be more the result of a strategic positioning than of a cost-oriented approach [14] [16]. The price calculation should take into consideration the customers' surplus constraint as well as the strength of the competition (existing barriers of entry, such as patents, industry property rights, etc.) [20]. Phase output: *revenue model*, with a detailed description of how earnings will be achieved.

4. Cost-oriented production design. According to the guidelines of the revenue model, the target costs for the output model will be calculated (as the upper bound for direct costs). Hence, the requirements to the value chain will be detailed. Phase output: *production design*, with a detailed description of how the performances have to be achieved.

5. Partners, network and information. In this phase, starting from the requirements on performances of the value chain, the capabilities (core competencies, capacities, available modules and components, ICT infrastructure) of the own performance structure and of the potential partners will be thoroughly scanned. Phase output: *network model*, selection of the partners within a specific instantiation of the value chain and network configuration, as well as *information model*, i.e. the approach according to which the information management issue has to be tackled.

6. Financing and risk analysis. Eventually, based upon the expected profits and a suitable scenario analysis, the risk-level as well as the need for working capital must be calculated to start the search for investors [11]. Phase output: *financing model*.

At each step of the HVC the corresponding targets must be fulfilled. If one step is not fulfilled, then the process should go back to a prior phase as long as the issue is tackled – with an *iterative approach*.

In the following section, our contribution will focus on a specific level of our HVC, namely the one regarding *network* and *information model*. A specific attention will be paid to the necessity to manage information, information flows and ICTs within distributed manufacturing networks and to the approach with which such goal set can be achieved.

3.3 The Design of Information Models in a Networked Economy

In the 5th phase of the HVC customer-oriented Business Modeling, starting from the requirements on performances of the value chain, the state-of-the-art and the capabilities of the own performance, information structures and ICTs, as well as of the ones of the potential partners, will be thoroughly scanned. The striven value chain will be designed and a specific network will be instantiated.

As stated in section 3.1, before making a strategic decision regarding the creation of a co-operation network, the management of an enterprise has to take into consideration a wide set of aspects, such as the entrepreneurial organization, the own core competencies and the ones of the partners, and the available technology. The gathering of all information regarding the potential network participants represents what we define as *capabilities and information*. According to the requirements previously identified within the *production design* (output of phase 4 of the HVC), a crosscheck with the capabilities of all potential partners helps to define the set of suitable partners. This process can be supported e.g. by the use of specific intermediaries such as vertical E-Marketplaces. The data about the entrepreneurial capabilities must regard both the own performances, the ICT capabilities as well as the maturity of the involved technologies [23] [31]. As a result, the instantiation of a *specific network configuration* can be identified. Furthermore, the definition of inter-organizational blue prints and branch-specific process standards is necessary to enable lean and efficient *inter-organizational processes and workflows*. The result is the *network model* (see Figure 4) [25]. The most relevant aspect for the following phase is that the inter-organizational processes determine the *sources* and the *sinks* of distributed information. The *information design* focuses on the management of the information within such entrepreneurial networks and inter-organizational value chains (see Figure 4).

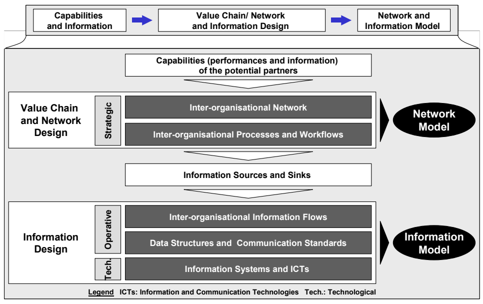

Figure 4 –Design of Network and Information Models

Within the modeling of an inter-organizational information management model, we distinguish three different layers [24]:

1. Inter-organizational Information Flows. Starting from the sources and the sinks of distributed information, the inter-organizational information flows can be derived and consequently defined. Within this process, several different aspects have to be taken into consideration: *direction* (e.g. one way or bi-directional information flow), involved *actors* (broker, network members, and related intelligent agents), involved *systems* (e.g. knowledge management, distributed Data Base information sources), and *relationship* (e.g. 1:1, 1:n, m:n). Furthermore, information flows encompass two other major dimensions: *information width*, which sets the different degrees of information broadcasting and transparency within the network, and *information depth*, which defines the scope, aggregation level and content of the information flow.

2. Inter-organizational Data Structures, Communication Standards. A crucial issue is the development of an inter-organizational *data model* to ensure the consistency, quality and transparency of the data. A data model encompasses also the aggregation levels for Management Support Systems (e.g. Data Warehousing and Data Mining). Furthermore, the branch-specific development of *shared communication standards* (e.g. based on XML) is essential to achieve and ensure a fast exchange of information and data through inter-organizational networks, as well as the integration of different ERP systems within an Internet-based BCI. The identification of the most appropriate technology standards is also important to deploy a back-end integration in each of the involved enterprises. Eventually, an appropriate solution for the *security issue* has to be identified.

3. Information Systems and ICTs. Enterprises have to weigh a set of crucial success factors in the field of technology management. The analysis of the potentials of new technologies as well as their diffusion and maturity can help enterprises to select the most suitable technologies to face challenges in the context of new collaborative businesses. For instance, the technical support of information flows in relation of complexity of the considered job and of the media richness (regarding e.g. real-time or asynchronous response) can be done according to the *Media Richness Theory* [8]. As a matter of fact, a proper *technology and innovation management* is important to plan the development of the entrepreneurial core businesses in co-ordination with a strategic technology planning [6] [7] [23]. Last but not least, a *make or buy* decision has to be taken, e.g. between the exploitation of the services of an Application Service Provider and the development of an own platform.

Within the definition of Information Systems and ICTs, one of the most crucial issues is the identification of the most appropriate ICTs out of the set of all suitable technologies that might suit to the striven target [2] [6] [7] [8] [15] [23] [28] [32] [40]. Because of the dynamic technology development, the temporal horizon has to be considered in detail within the network and information modeling phase. As a matter of fact, the development of innovative ICT-based solutions requires an appropriate consideration of both available and future technology potentials. Furthermore, the future technology potentials usually imply an impact on the network organizational structure. This means that interdependencies between the network model and the information model have to be taken into consideration, when carrying out a middle or long term analysis. In order to meet this peculiar challenge, in the next section we outline a new *planning methodology* that incorporates the interdependencies between network structure and processes on the one hand and ICTs on the other hand.

3.4 Planning and Management of Technology

In order to fully benefit from the advantages of the inter-organizational co-operation, the network needs a sustainable support of *Information Systems and ICTs*. As pointed out above, the adequate identification, selection and management of suitable Information Systems and ICTs is a great challenge. In fact, there might be many different, often even partly competing network partners, whose different needs (also over the time) must be considered when selecting and assessing ICTs and electronic services to support the network [2] [6] [15] [37] [39]. Within our research, we observed that various ICTs are capable to support the different inter-organizational processes and workflows [4]. In order to guarantee smooth inter-organizational processes, the selected ICTs must therefore be integrated seamlessly. Furthermore, the high pace of technical development requires a *planning process* that considers both currently available and also future ICT-solutions [6] [7] [23] [40]. Finally, the potentials of future ICTs might influence the network structure, so that the business relations between participating companies may also change over the time [15] [37] [38] [39]. Therefore, potential impacts on the network must be considered and evaluated when *selecting* and *assessing* specific Information Systems and ICTs as network infrastructure. This is what we define as *Integrated Planning and Management of Networks and of Information Technology* [4]. Figure 5 shows how the temporal interdependencies of network structure and processes and ICTs should be integrated into the planning process. This enables the decision-makers to assess the mutual influences and hence to deploy appropriate measures. We will now present an approach with which such an result can be achieved.

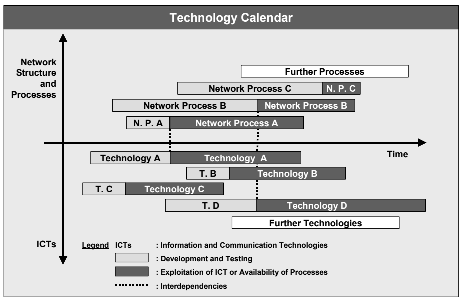

Figure 5 – Integrated Planning of Network and ICTs

First of all, because of the complexity related to this planning task, a suitable description model is fundamental for a successful planning. As a matter of fact, such a model must describe all characteristics of potential networks, the different parameters of ICTs as well as the complex links between these two clusters. As previously stated, this approach has to enable the full and sustainable exploitation of technologies over the time and herewith the implementation of new and unique network structures.

For this reason we developed an *integrated description model* to identify and highlight the interdependencies between different network instantiations and the underlying technologies (see also [9]). Our model (see Figure 6) fulfils the above-mentioned requirements.

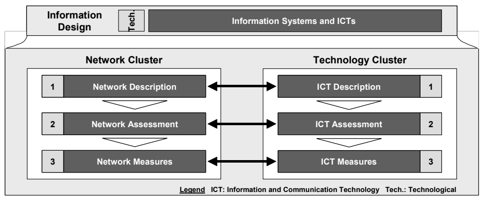

Figure 6 –Description Model for Integrated Planning

The description model consists of three layers for each of the two clusters. These layers correspond to three different steps within the planning and management process. The first layer is a crucial step within the model and it aims at the description of networks and ICTs as well as their matching. In Figure 6, the matching is represented by the arrows. In the second layer all relevant factors for the assessment of the feasibility as well as the sustainable cost-effectiveness are collected and compared. Eventually, in the third layer the necessary measures to deploy a specific network as well as to develop and exploit the appropriate ICT-infrastructure are derived. Within the last two steps a particular attention is paid to temporal constraints, as illustrated in Figure 5.

As mentioned above, the description and matching of the network and ICTs in the first layer is a complex task, because of the existence of several interdependencies between the two clusters. In order to enable an easier matching it is helpful to distinguish between *network processes* and *organizational potentials* on the one side as well as *ICT functionalities* and *ICT potentials* on the other side (see Figure 7).

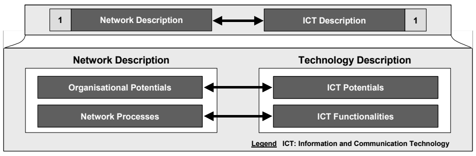

Figure 7 – First Layer of the Description Model

According to our understanding the *organizational potentials* represent the capability to develop and implement innovative organizational concepts (in this specific case regarding the network structure). Clearly this requires a creative process that has to take into consideration the potentials of existing and planned ICTs. Examples for organizational potentials are for instance the ability to work in distributed environments without suffering the disadvantages caused by the lack of e.g. face-to-face communication. Furthermore, examples of *ICT potentials* are the overcoming of temporal and spatial barriers through the use of the web-based technologies.

The *network processes* are the specific instantiation of the inter-organizational processes and workflows, as we previously defined within the value chain and network design of the network model (see Figure 4). These processes need to be supported by ICTs. The ICTs can be further described by their *functionalities*, which specify which task the particular technology can perform. According to our understanding, the functions have to be elementary, this meaning that each technology can be associated with exactly one function (see also [36]). As a matter of fact, we identified four clusters of elementary functions, and namely :

1. Input and Output functions. These functions, often also called User Interface, include especially audio and video technologies. The decision about the input and output technology that is the most appropriate to support the network partners and customers depends heavily on the information that needs to be presented.

2. Processing functions. Processing technologies allow the modification and analysis of input data to generate the needed information. The necessary processing capacity for a certain task is a relevant criterion in this context, and operating systems and programming languages must also be taken into account.

3. Transmission functions. Since the co-operating enterprises are often widely distributed, communication technologies and standards are needed to transmit information between technical devices and/or network partners.

4. Storage functions. Clearly, before and after any handling and modification of information, the corresponding data must be stored.

Although all these functionalities are not completely independent, hardware and software technologies can be identified in each cluster; hence, each cluster can be to some extent dealt with separately. The functions are described in detail by a set of parameters. Furthermore, the parameter set depends on the particular function and technology. Storage technologies, for instance, are characterized by capacity and access time, while transmission technologies are classified according to e.g. bandwidth, bit error rate and jitter.

After the network processes have been defined, each specific network process step has to be matched with all suitable technologies that might support it. For example, the requirements related to the exchange of information and data between different network partners need to be matched with all available technologies that enable transmission functions, e.g. transmission protocols, standards or light-wave cables. As a result, the technology or set of technologies with the most suitable parameters is selected.

According to our understanding, the above-mentioned method is a successful approach to deal with the challenge to match value chain and network design with the management of technology within the information design process. In the next section we will show, with the help of a case study, how the potentials of our method can be exploited.

4. The Development of an E-Business Collaboration Infrastructure

Each industrial sector has its own peculiarities; therefore, it is necessary to develop approaches and solutions that take into account such specific requirements. Our institution has experience with German SMEs of the manufacturing and machinery industry. Since we identified a remarkable *need for "e-action"* in this traditional and static industrial branch, we therefore decided to develop *customized Business Models* and *E-Business solutions* with a high impact onto this industrial sector. In this context we developed the case study for the present contribution. The case study has been conducted in the field of *manufacturing networks for metallic material* with 10 German SMEs. As a matter of fact, the generation and mailing of so-called *paper-based test reports* for metallic material, which documents and guarantees to the buyer specific material properties, is nowadays accompanied by several serious problems. For instance, the open issues concern the archiving of reports, the specification check of corresponding material standards or norms referenced in a test report [10]. The innovative *trigger* for this case study is the worldwide dissemination and acceptance of the Internet as communication and information exchange channel as well as the idea to exchange material test reports electronically. This makes the development of new intermediary services for the efficient exchange and storage of material test reports based on an electronic Business Collaboration Infrastructure feasible. Based upon the innovative idea of exchanging *electronic material reports* on a collaborative Internet-platform, we proposed a Business Model for an information service intermediary. We are now going to present the *results* obtained within the business modeling process.

1. Market model. After a thorough market analysis we identified similar solutions to manage and exchange material reports (e.g. Document Management Systems, DMS), but we realized that none of them fulfils all relevant requirements. Hence, in the resulting market model there are no *direct competitors* because of the fact that the planned service is innovative and therefore it is not offered in the market yet. Furthermore, the *potential customers* are all the manufacturing enterprises that exchange metallic products – i.e. both ferrous metals (all sorts of steel) and non-ferrous metals (such as tin, copper, and brass) - with specified and guaranteed properties, as well the different testing and inspection organizations (such as TÜV or Dekra in Germany, Det Norske Veritas in Norway, BSI or ITS in Great Britain, SGS in Switzlerland, Bureau Veritas in France)

2. Output model. We conducted several workshops with the involved SMEs and thus we gathered all the requirements related to the exchange of electronic material test reports in the manufacturing field. We distinguish two kinds of groups of services required by the potential customers of the platform:

a) Basic service, e.g. storage, access, and remote archiving of electronic material test reports over the Internet.

b) Value-added services, e.g. assessment and evaluation of the suppliers, nominal/actual value comparison of measures certified in a test report, batch management, offering of detailed information about material-related quality.

Other general requirements on the overall performances of the platform are: a high operating efficiency and flexibility, specific security requirements (e.g. transmission and privacy), a 24x7 hours system availability, a suitable multi user concept with different and adjustable levels of authorizations, support of surveyors of independent testing and inspection organizations.

3. Revenue model. After an analysis of the customers' benefit, we used a two-step *price corridor method* for the strategic pricing for shaping a revenue model [14]:

a) Identification of the price corridor of the mass, i.e. search for the price corridor that the majority of the customers is willing to bear. According to the market model, there are no direct competitors, but only some possible substitutes, i.e. providers of DMS, whose products, though, do not fulfill all relevant customers' requirements. We observed that the innovative services of the planned intermediary service infrastructure might therefore crucially change the power balance in the market of tools for the management and exchange of material test reports. The current cost to process a single material report amounts up to about 50 US$, which clearly represents an upper bound for the price model. Since the process cost for an electronic test report drops drastically by the use of the intermediary service infrastructure, the decision was to pursue a *low* price corridor strategy to target a high number of customers.

b) Specification of a level within the price corridor, i.e. identification of an appropriate price level within the chosen low price corridor. A detailed analysis of the customers' benefit of the DMS underlined that none of them can fulfill all industrial requirements. Therefore, the intermediary service infrastructure with its innovative customer-oriented services has realistic chances to be widely accepted by the target group and thus to penetrate successfully the market. In order to conquer the market and achieve the striven critical mass in terms of traffic (reports/period of time), it was furthermore decided to choose a lower pricing-level within the chosen low price corridor. A high traffic, though, does not yet guarantee a long-term success, because second-movers might come up with similar solutions and gain quickly market share. Hence, the price should be maintained very low until the critical mass in terms of branch members is also reached. With the achievement of this goal, the developed *format for electronic test reports* will be widely disseminated and it has therefore good chances to be accepted and adopted as a branch-specific standard. At this stage, barriers for market entry for possible competitors will be significant. The deployment of a mid or upper-level pricing within the selected price corridor will be then possible without risking to loose market shares. A potential cash cow for the business is represented by the portfolio of attractive value-added services.

4. Production design. According to the guidelines of the revenue model, the target costs for the output model will be calculated within the *cost-oriented production design,* i.e. design of the electronic transmission, management and storage of material reports. In the case of the "production" design for the transmission of material reports, the attention was paid to the fixed costs (i.e. target costs for the infrastructure) since direct costs (i.e. cost for the report transmission) tend to zero. Hence, the result is a platform with a targeted low fixed cost (e.g. hardware, software and mainly personnel costs). The lower the fixed costs are, the sooner the critical mass in terms of participants and transactions will be reached.

As far as concerns the design of the platform, we identified the need for the following capabilities: database based material test reports management and archiving, material science know how, trust management, and information content for value-added services.

5. Network and information model. In this phase, starting from the requirements on performances and from the capabilities, core competencies and IT infrastructure of the involved potential partners, a specific performance network as well as an information and technology framework were defined. The targeted market consists of several SMEs, of which none of them is dominating the market. It is important that all enterprises that take part to the platform must trust and be able to rely on the carrier. Hence, the managing institution of the transaction platform for electronic test reports must be an independent company. It was thus decided that the collaboration platform should *not* be managed by one of the manufacturers of metallic material, but by a neutral intermediary with material science know-how as well as ICT competence (e.g. data base management and archiving). As a matter of fact, the archive management and value-added services that require particular material science know-how will be performed by the intermediary, who will outsource the other competencies to two different partners; one partner was identified to deal with trust management and another to provide information content for the other value-added services. Within the analysis of the information infrastructure, the crucial issue was the modeling of processes and the management of shared information to enable the *inter*-organizational and *intra*-organizational workflow capabilities of the planned ICT-System. Furthermore, some of the other most interesting aspects that were dealt with are the definition of *process standards* for inter-organizational processes and workflows, the development of an appropriate and flexible interface to deploy a *back-end integration* in each of the involved enterprises, and the branch-specific development of a *shared standard* for electronic test reports. Such standards ensure a fast exchange of the required information through inter-organizational networks as well as the integration of different ERP systems.

Last but not least, as far as the *ICTs* planning *and management* is concerned, an important part was the assessment and availability verification of the technologies that were previously selected to support the intermediary service processes. As mentioned in the section 3.4, suitable measures (i.e. further evaluation, acceptance and implementation, further development, or rejection) had to be derived for each of the selected technologies. Within the assessment phase, in order to cope with the different requirements and the need to identify the necessary measures for each partner, the use of a technology calendar proved to be really helpful to visualize critical temporal constraints (see Figure 8).

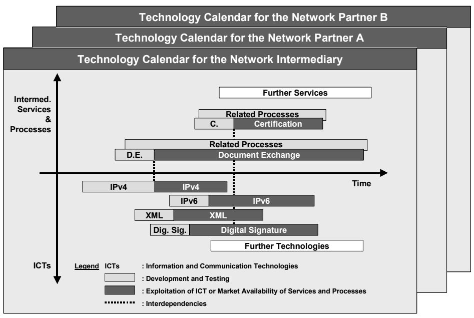

Figure 8 – Integrated Planning of Services and ICTs

6. Financing model. Because of clear privacy reasons, we are at the moment not allowed to distribute information about the financing model.

5. Critical Review and Conclusion

The selection and matching of organizational approaches and suitable E-Business solutions, as well as their appropriate engineering, is a complex problem. As a matter of fact, during the past years it often happened that E-Business solutions were simply and hastily embedded into the existing business processes and organizational structures. As a result, E-Business projects often did not reach the striven targets or even failed, with the consequently growing lack of trust towards ICTs and the related solutions. In order to face successfully this issue, a holistic approach, instead of a partial one, has to be followed. In this paper we presented the *FIR integration framework for E-Business Engineering*, a holistic framework to systematically develop, implement and integrate E-Business solutions in enterprises. Hence, we presented the House of Value Creation, a meta-method to design customer-oriented and sustainable Business Models, which we developed with the help of our integration framework. The meta-method was validated in a specific case, namely for an information service intermediary of a collaboration network in the manufacturing industry. The HVC is also a promising approach for the development of Business Models in the case of *inter-firm networks*. Hence, in order to verify such a fact, we plan to test its validity also in other cases and for other branches, such as IT and logistics. As far as the project of the case study is concerned, the first step was the development of the prototypic BCI solution. Nowadays, a commercial business pilot is being deployed with the participation of all the 10 enterprises of the consortium; and the objective is to gather precious information about the feasibility of the developed Business Model as well as about the acceptance of the BCI as an efficient means to exchange material test reports. The next phase will be a commercial rollout, initially in the German market and, if the sustainability will be confirmed, on European level.

To conclude, the trend towards a tightly inter-connected economy seems to be nowadays unquestionable. On the other side, the development process towards a dynamically networked economy has just recently started. We strongly believe that, in order to be successful within a networked economy, enterprises will thus have to undergo a deep transformation process in their organizational philosophy, in their structure, in the used methods as well as in their approach to interact with external organizations. We are convinced that, in order to face the challenges of such a dynamic and insecure business context, an appropriate holistic approach is helpful to plan and hence deploy sustainable businesses.

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