ZÁPADOČESKÁ UNIVERZITA V PLZNI
FAKULTA STROJNÍ

DISERTAČNÍ PRÁCE

PLZEŇ, 2012 Ing. Peter Burnickl, MBA & Eng.

ZÁPADOČESKÁ
UNIVERZITA
V PLZNI

Fakulta strojní

Katedra průmyslového inženýrství a managementu

DISERTAČNÍ PRÁCE

v oboru Průmyslové inženýrství a management

Matrix-Method to Enhance the Co-Operation between Digital Firms and Subcontractors

Autor: Ing. Peter Georg Burnickl, MBA & Eng.
Školitel: Prof. Ing. Josef Basl, CSc.

Plzeň 2012

Prohlášení o autorství

Předkládám tímto k posouzení a obhajobě disertační práci, zpracovanou na závěr studia na Fakultě strojní Západočeské univerzity v Plzni.

Prohlašuji, že jsem předloženou disertační práci na téma:

Maticová metoda pro zlepšení kooperace mezi firmami a subdodavateli

vypracoval samostatně, pod odborným dohledem školitele a za použití odborné literatury a pramenů uvedených v přiložené bibliografii.

V Plzni dne 24.09.2012 …….

Ing. Peter Burnickl, MBA & Eng.

Upozornění

Poděkování

Na tomto místě bych rád poděkoval mé školitelce Prof. Ing. Josef Basl, CSc. za pomoc a příkladné vedení při zpracování této disertační práce. Poděkování patří také ostatním členům a kolegům katedry Průmyslového inženýrství a managemntu Západočeské univerzity v Plzni, kteří svou radou přispěli ke zdárnému dokončení této práce.

V Plzni dne 24.09.2012 …….

Ing. Peter Burnickl, MBA & Eng.

ANOTAČNÍ LIST DISERTAČNÍ PRÁCE

AUTOR	Ing. Burnickl, MBA & Eng.	Peter Georg
STUDIJNÍ OBOR	Fakulta strojní Katedra průmyslového inženýrství a managementu	
VEDOUCÍ PRÁCE	Prof. Ing. Basl, CSc.	Josef
PRACOVIŠTĚ	ZČU - FST – KPV	
DRUH PRÁCE	**DISERTAČNÍ**	
NÁZEV PRÁCE	Maticová metoda pro zlepšení kooperace mezi firmami a subdodavateli	

FAKULTA	strojní	**KATEDRA**	KPV	**ROK ODEVZD.**	2012

POČET STRAN (A4 a ekvivalentů A4)

CELKEM	127	**TEXT. ČÁST**	127	**GRAF. ČÁST**	0

STRUČNÝ POPIS	Z důvodu globální konkurence se musí moderní firmy přizpůsobovat stále se měnící poptávce a reagovat na měnicí se výkon prodeje. Hlavně malé a střední podniky bojují o trh. Kromě toho ještě existuje nedostatek odborné síly a to má za následek fluktuaci zaměstnanců, což způsobuje problémy různých podnikových procesů. Digitalizace přináší obrovské množství dat, které musí být zpracovány. Firmy často reagují na tuto situaci získáváním subdodavatelů a osob samostatně výdělečně činnými, aby překonali dočasný nedostatek zaměstnanců a tím získali odborné znalosti. Na základě množství prolínajících se znaků těchto komplexních struktur je efektivní výměna dat v těchto sítích velmi obtížná a management těchto procesů a zodpovědnost úkolů není jednoduché ovládnout.
KLÍČOVÁ SLOVA	Buffer management, cross-company business processes, teams, business process management, time management, buffer reduction, enterprise information system.

SUMMARY SHEET

AUTHOR	Ing. Burnickl, MBA & Eng.	Peter Georg
FIELD OF STUDY	Industrial Engineering and Management	
SUPERVISOR	Prof. Ing. Basl, CSc.	Josef
INSTITUTION	ZČU - FST – KPV	
TYPE OF WORK	**Dissertation**	
TITEL	Matrix-Method to Enhance the Co-Operation between Digital Firms and Subcontractors	

FACULTY	Mechanical Engineering	**DEPARTMENT**	KPV	**SUBMITTED**	2012

NUMBER OF PAGES (A4)

TOTALLY	127	**TEXT PART**	127	**GRAPH. PART**	0

ABSTRACT	Modern companies face of quickly changing demands, selling conditions and requirements because of global competition. Small and Medium Enterprises (SMEs) especially fight for market share. A fast changing fluctuation of employees generates company-intern process issues on top of other problems. An overwhelming amount of data needs to be assimilated. Frequently, companies recruit subcontractors and freelancers to solve short-term issues and to acquire know-how. Because of various interfaces of internal structures and a complex network of interactions between departments, subcontractors, freelancers, employees and consultants, the exchange of information and data is highly sophisticated. The management of those processes and the responsibilities of tasks are not easy to handle. That Dissertation explains the existing problems and issues between digital firms and subcontractors in Europe and especially in Germany. The provided solutions on the market are analyzed and the lack of integrity, responsibilities and task allocations are shown, followed by a new method which legitimates the doctoral thesis.
KEY WORDS	Buffer management, cross-company business processes, teams, business process management, time management, buffer reduction, enterprise information system.

KURZFASSUNG

AUTOR	Ing. Burnickl, MBA & Eng.	Peter Georg
STUDIENFACH	Wirtschaftsingenieurwesen	
BETREUER	Prof. Ing. Basl, CSc.	Josef
INSTITUTION	ZČU - FST – KPV	
ARBEITSTYPE	**Dissertation**	
TITEL	Matrix-Methode zum Verbessern der Kooperationen zwischen Firmen und Subunternehmern	

Fakultät	Maschinenbau	**Studiengang**	Wirtschafts-ingenieurwesen	**Abgegeben**	2012

SEITENZAHL (A4)

TOTAL	127	**TEXTTEILE**	127	**ANLAGEN**	0

ZUSAMMENFASSUNG	Aufgrund der globalen Wettbewerbssituation müssen moderne Firmen sich an eine stetig ändernde Nachfrage anpassen und auf volatile Verkaufskonditionen reagieren. Besonders Kleine und Mittlere Unternehme (KMU) kämpfen um Marktanteile. Darüber hinaus generiert der Fachkräftemangel mit der daraus resultierenden Mitarbeiterfluktuation firmeninterne Prozessprobleme. Die Digitalisierung zieht eine überwältigende Anzahl an Daten nach sich, welche verarbeitet werden muss. Häufig reagieren Firmen auf diese Situation mit dem Rekrutieren von Subunternehmern und Freiberuflern um kurzfristige Engpässe beheben zu können sowie Fachwissen zu akquirieren. Aufgrund einer Vielzahl von Schnittstellen dieser komplexen Strukturen ist der geordnete Datenaustausch in diesen Netzwerken äußerst schwierig. Das Management dieser Prozesse und Verantwortlichkeiten der Aufgaben ist nicht einfach in den Griff zu bekommen. Diese vorliegende Dissertation beschreibt die bestehenden Probleme und Schwierigkeiten zwischen digitalen Firmen und Subunternehmern in Europa und speziell in Deutschland. Die neuen Erkenntnisse der aktuellen Marktsituation werden einbezogen und die Schnittstellen- und Zuständigkeitsprobleme im Prozessmanagement aufgezeigt. Anhand einer neuen Methode wird diese Situation bei kurzfristigen Firmenzusammenschlüssen verbessert, welche diese Dissertation legitimiert.
SCHLÜSSELWÖRTER	Firmenübergreifende Prozesse, Datenaustausch, Schnittstellen, Prozess-management, Projektmanagement, Zeitpuffer.

Acknowledgment

This work was developed during March 2009 and August 2012 at the faculty of Mechanical Engineering at the University of West Bohemia.

During my internships, studies, and professional experience I recognized how important it is that complex co-operations between companies need to be handled in short-term alliances. I struggled a lot of times with various Enterprise Information Systems and data-exchange issues and realized that importance and the possibility to enhance those processes by deeper research.

I wish to thank my mentor Prof. Dr. Josef Basl and Dr. Milan Edl for sharing their experience with me and their relentless support. I also wish to thank Prof. Dr. Jordi Mauri from the Polytechnic University of Valencia. His enormous knowledge in coworking, Innovation Management and the Global Cognitive Theory helped me a lot in solving problems while I also learned from him.

Furthermore I want to thank Helmut Hanika and Prof. Dr. Volker Saak for their recommendation and establishing the contact to Prof. Dr. Basl and Prof. Dr. Leeder.

I deeply want to thank the association "Verein der Freunde und Förderer der Hochschule Rosenheim" for the financial support and the scholarship.

Brandi Stauber closely examined my final version of the thesis for English style and grammar, correcting both and offering suggestions for improvement.

I also deeply thank my family and especially my wife, Maria and my son Paul and my daughther Luisa, for their unconditional support. This thesis would not have been possible without their co-operation.

Contents

List of Figures

Glossary

Cause-and-Effect Diagram .... It shows the relationship of all factors (causes) that lead to the given situation (effect). It identifies major causes and breaks them down into sub-causes and further sub-divisions (if any). Also called fishbone diagram (because of its resemblance to a fish skeleton) or Ishikawa diagram, after its inventor Dr. Kaoru Ishikawa (1915-89) of Tokyo's Mushasi Institute.

Change Management ..... A structured approach to transitioning individuals, teams and organizations from a current state to a desired future state. It is an organizational process aimed at empowering employees to accept and embrace changes in their current business environment.

Chat ..... *Chat* can refer to any kind of communication over the Internet, but is primarily meant to refer to direct one-on-one *Chat* or text-based group *Chat*, using software tools. The expression *Chat* comes from the word chat which means informal conversation.

Coworking ..... Coworking is a style of work which involves a shared working environment, sometimes an office, yet in-

dependent activity. Unlike in a typical office environment, those coworking are usually not employed by the same organization. Typically it is attractive to work-at-home professionals, independent contractors, or people who travel frequently who end up working in relative isolation. Coworking is the social gathering of a group of people, who are still working independently, but who share values, and who are interested in the synergy that can happen from working with talented people in the same space.

Digital Firm ..... A digital firm has several characteristics that distinguish it from most of the firms claiming to be digitized.

- Significant business relationships are digitally enabled and mediated
- Core business processes are accomplished via digital networks and span the entire organization
- Key corporate assets are managed digitally
- Internal and external environments are quickly recognized and dealt with

Economy of Scale ..... The cost advantages that a business obtains due to expansion. Reduction in cost per unit resulting from increased production, realized through operational efficiencies. *Economies of scale* can be accomplished because as production increases, the cost of producing each additional unit falls.

EXCEL ..... Software developed and manufactured by Microsoft Corporation that allows users to organize, format and calculate data with formulas using a spreadsheet system broken up by rows and columns.

Freelancer ..... Working on a contract basis for a variety of companies, as opposed to working as an employee for a single company. Freelancers are often considered to be self-employed, and have the freedom to pick and choose their projects and companies they would like to be associated with.

FTP-Server ..... An FTP Server is a piece of software that runs on a computer and uses the File Transfer Protocol to store and share files. Remote computers can connect anonymously, if allowed, or with a user name and password in order to download files from this server using a piece of software called a FTP Client.

Hacker ..... Skilled computer programmer who breaks (hacks) a password code or otherwise gains remote access to a protected computer system.

Human Resources ..... The division of a company that is focused on activities relating to employees. These activities normally including recruiting and hiring of new employees, orientation and training of current employees, employee benefits, and retention.

Information Systems ..... Combination of hardware, software, infrastructure and trained personnel organized to facilitate planning, control, coordination, and decision making.

Information Technology ..... Set of tools, processes and methodologies (such as coding/programming, data communications, data conversion, storage and retrieval, systems analysis and design, systems control) and associated equipment employed to collect, process and present information. In broad terms, *IT* also includes office automation, multimedia and telecommunications.

Medium-Sized Enterprise ..... A medium-sized enterprise is defined as an enterprise which employs fewer than 250 persons and the annual turnover does not exceed EUR 50 million.

Mesh of Subcontractors ..... A *Mesh of Subcontractors* is created, if enterprises are cooperating together with various interfaces. The single Users of the companies, no matter if they are employees, subcontractors or freelancers, can act as contractors and/or subcontractors at the same time. The Users span a mesh of tasks and connections / responsibilities over the involved companies and processes. Every interface is critical, i.e. a mesh of subcontracting parties is created. The connections / responsibilities between the Users can vary during the ongoing processes and steps of the product lifecycle, a *flexible process* is created.

Micro-Enterprise ..... An enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million.

Milestone ..... A milestone is a scheduled event signifying the completion of a major deliverable or a set of related de-

liverables. A milestone has zero duration and no effort – there is no work associated with a milestone. It is a flag in the workplan to signify some other work has completed. Usually a milestone is used as a project checkpoint to validate how the project is progressing and revalidates work.

Multitasking ..... Running two or more programs at the same time on the same single-processor (single CPU) computer. This seemingly simultaneous processing is deceptive because the CPU is actually attending to only one program at any given moment.

Operating System ..... The program that, after being initially loaded into the computer by a boot program, manages all the other programs in a computer.

Organization Chart ..... Visual representation of how a firm intends authority, responsibility and information to flow within its formal organizational structure.

Plug-In ..... A set of software components that adds specific capabilities to a larger software application. If supported, *Plug-Ins* enable customizing the functionality of an application.

Price/Performance Ratio ..... The business ratio between the quotient of the costs and a pre-defined product performance.

Quality Management ..... All management activities and functions involved in determination of quality policy and its implementation through means such as quality planning and

quality assurance (including quality control).

Return on Invest . . . . . A measure of a corporation's profitability, equal to a fiscal year's income divided by common stock and preferred stock equity plus long-term debt. *ROI* measures how effectively the firm uses its capital to generate profit; the higher the *ROI*, the better.

Service-Oriented Architecture . A flexible set of design principles used during the phases of systems development and integration in computing. A system based on a *SOA* architecture will package functionality as a suite of interoperable services that can be used within multiple separate systems from several business domains.

Small Enterprise . . . . . A small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million.

Smartphone . . . . . Mobile phone which includes functions similar to those found on personal computers. *Smartphones* provide a one-stop solution for information management, mobile calls, email sending, and Internet access.

Star-Shaped Structure . . . . . In a *star-shaped structure*, subcontractors have direct contacts with an OEM and the number of indirect subcontractors is limited. This organization results in a broad network of subcontractors, which becomes a network with multiple sourcing of a star-

shaped form. The OEM has a central role in information and material flows and subcontractors are often involved as specialists in discrete processes.

Status Bar ..... An information area typically found at the bottom of windows in a *Graphical User Interface*. Its job is primarily to display information about the current state of its window, although some status bars have extra functionality.

Subcontracting ..... Business arrangement by which one firm (the contractor or 'principal'), contracts with another firm (the 'subcontractor'), for a given production cycle, one or more aspects of production design, processing, manufacture, construction or maintenance work.

Subcontractor ..... The enterprise that is contracted by a contractor for the production design, processing, manufacture, construction or maintenance work.

Supply Chain ..... Encompasses all activities and organizations associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows.

Tiered Subcontracting Structure A *tiered subcontracting structure* can be defined as a pyramidal vertical organization with a multi-tier structure.

Time-To-Market ..... Length of time taken in product development process from product idea to the finished product. It is a critical component of time based competition.

Tool ..... An item or implement used for a specific purpose. A tool can be a physical object such as mechanical tools or a technical object such as a web authoring tool or software program.

Traffic Light Principle ..... Method to visualize the status of a process. Green indicates that everything is all right, yellow indicates a moderate or partially critical situation and red indicates critical situations.

Transaction Cost Theory ..... A theory accounting for the actual cost of outsourcing production of products or services including transaction costs, contracting costs, coordination costs, and search costs. The inclusion of all costs are considered when making a decision and not just the market prices.

Unique Selling Proposition .... Real or perceived benefit of a good or service that differentiates itself from the competing brands and gives its buyer a logical reason to prefer it over other brands. A USP is often a critical component of a promotional theme around which an advertising campaign is built.

Value Chain ..... All activities and organizations associated with the flow and transformation of goods from the raw materials stage through to the end user, as well as the associated information flow.

$Dropbox$ ..... Web-based file hosting service operated by Dropbox, Inc. that uses networked storage to enable users

to store and share files and folders with others across the Internet using file synchronization.

$Filesharing$ ..... Process of direct or indirect data sharing on a computer network with various levels of access privilege.

$GoogleDocs$ ..... Free, web-based office suite and data storage service offered by Google. It allows users to create and edit documents online while collaborating in real-time with other users.

$VirtualPrivateNetwork$ .... A private network that is configured within a public network (a carrier's network or the Internet) in order to take advantage of the economies of scale and management facilities of large networks. VPNs are widely used by enterprises to create wide area networks (WANs) that span large geographic areas, to provide site-to-site connections to branch offices and to allow mobile users to dial up their company LANs.

Abbreviations

abbr.	abbreviation
CEO	Chief Executive Officer
CPU	Central Processing Unit
DS	Dataset
e.g.	exempli gratia (lat.); for example
EDI	Electronic Data Interchange
EIS	Enterprise Information System
etc.	et cetera, and so on
FTP	File Transfer Protocol
GUI	Graphical User Interface
HR	Human Resources
i.e.	Id est (lat.); that means
IS	Information Systems
IT	Information Technology
lat.	Latin

OEM	Original Equipment Manufacturer
$OEM - PL$	Project Leader of the OEM
OS	Operating System
PC	Personal Computer
$R\&D$	Research And Development
RA	Responsible Actor
RIA	Rich Internet Application
ROI	Return on Invest
$SC1 - PL$	Project Leader of Subcontractor 1
$SC1 - U1$	User 1 of Subcontractor 1
$SC2 - U1$	User 1 of Subcontractor 2
SIM	Subscriber Identity Module
SME	Small and Medium Enterprise
SOA	Service-Oriented Architecture
TCT	Transaction Cost Theory
TOC	Theory of Constraints
USP	Unique Selling Proposition
VPN	Virtual Private Network

Chapter 1

Introduction

This Chapter provides a general overview of the current issue of data exchange in modern companies. Chapter 1.1 shows the *Thematic Content* of this thesis, followed by the *Objectives* (Chapter 1.2) and the *Methodic Procedure* (Chapter 1.3).

Modern companies need differentiation against competitors. I.e. they need competitive advantages, like an *USP*[1] in the market, innovation and a perfect *Price/Performance Ratio*[2]. Because of quickly changing situations in the market, firms have to act and react expeditiously.

Because of short-term commitments, bottlenecks in in-house capacities are generated. It is often necessary to access external expertise and technologies or a geographical area with growth prospects (based on [EIM09]). Also financial issues (e.g. cost-cutting strategies) or the need of special equipment and skills to manufacture either finished

[1] Unique Selling Proposition; Real or perceived benefit of a good or service that differentiates it from the competing brands and gives its buyer a logical reason to prefer it over other brands. An USP is often a critical component of a promotional theme around which an advertising campaign is built.

[2] The business ratio between the quotient of the costs and a pre-defined product performance.

products or specialized components/supplies additionally slows down the overall process [Ber97].

Companies are frequently facing those issues by recruiting subcontractors. Those *freelancers*[3], *micro*[4]-, *small*[5]- or *medium*[6]-sized enterprises are directly connected to the companies' processes and interact with various departments simultaneously.

That causes a lot of issues according to the overwhelming amount of information and digitally stored data which has to be managed within those alliances.

That Dissertation explains the existing problems and issues between companies and subcontractors in Europe. The provided solutions on the market are analyzed and the lack of integrity, responsibilities and task allocation are shown, followed by a new method which legitimates this doctoral thesis.

1.1 Thematic Content

Due to the fact that there exist numerous software *tools*[7], that Dissertation focuses on the issue that subcontractors have to be integrated into all necessary processes on very short-term, even though they use different *EISs*[8]. I.e. rapidly changing interactions, short-term co-operations between companies, various involved experts which

[3] A person who sells services to employers without a long-term commitment to any of them.

[4] A micro-enterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million.

[5] A small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million.

[6] A medium-sized enterprise is defined as an enterprise which employs fewer than 250 persons and whose annual turnover does not exceed EUR 50 million.

[7] An item or implement used for a specific purpose. A tool can be a physical object such as mechanical tools or a technical object such as a web authoring tool or software program.

[8] Enterprise Information System

are spread all over the globe, sub-subcontractors, etc. turn out to be serious issues for companies if they do not meet milestones due to too short time-buffers. The new method provides a solution how to reduce time-buffers in order to enhance quality.

1.2 Objectives

The goal of this Dissertation is, to

1. provide an explanation of the used expressions and
2. explain the current challenges and issues of companies,
3. show existing solutions and their problems in Germany and Czech Republic,
4. show the Prerequisites for new Tools based on Scientific Research,
5. explain the new Proposal for Solution
6. link the previous items with each other in a new theoretical method to solve the mentioned issues and
7. proof the concept by a Case Study and
8. complete those steps for defending this doctoral thesis.

All results are combined to a *Cause-and-Effect Diagram*[9] to visualize the overall issues.

[9]It shows the relationship of all factors (causes) that lead to the given situation (effect). It identifies major causes and breaks them down into sub-causes and further sub-divisions (if any). Also called fishbone diagram (because of its resemblance to a fish skeleton) or Ishikawa diagram, after its inventor Dr. Kaoru Ishikawa (1915-89) of Tokyo's Mushasi Institute.

1.3 Methodic Procedure

First, a review of existing research of bachelor, master and doctoral theses, as well as papers and ongoing research activities from multiple universities, was accomplished to provide basic theoretical knowledge.

Second, existing solutions offered by software vendors were analyzed.

Third, the research results were compared with the existing tools.

Fourth, the lacks of those prerequisites are described and combined with the previous results.

Fifth, the new Proposal for Solution is presented.

Sixth, a new method is developed to counter those issues and provide a new way to handle the mentioned problems, hence provide more time for better execution of the needed tasks.

Seventh, the new method was tested in a Case Study which proofs its functionality and shows cases where and where not the method should be applied.

Finally, a completion and future prospects are shown that defends this doctoral thesis.

Chapter 2

Basics and State of Technology

For increased comprehensibility of the Dissertation, this Chapter contains the basics and definitions of a '*Digital Firm*' and of subcontractors in general (including the benefits of subcontracting) in Chapter 2.1. As a next step, the *Information Deployment within Companies* is explained (Chapter 2.2) followed by the *Demands on Tools* in Chapter 2.3. Then, the *Challenges and Issues* are pointed out in Chapter 2.4.

2.1 Basics and Definitions

In today's challenging global market, companies have to innovate in order to survive. Business innovation must occur in all dimensions — product, process and organization — to push competitiveness and business performance to the extremes. It is unavoidable, hence essential, for modern companies to apply certain tools to enhance the productivity and optimize the processes in order to stay in business. The *time-*

to-market[1] needs to be as quick as possible to obtain advances against competitive products [BE10].

An entire management of all needed information for every task seems to be vital for surviving. According to that fact, the handling of responsibilities is important as well. If the executing expert does not know what to work on and the departmental head in charge does not know what to decide, hence forwarding tasks and sub-responsibilities, the company will not be able to work efficiently [BB10].

As a basis, this Chapter contains the definition of the main content, such as the phrase '*Digital Firm*' (Chapter 2.1.1), *Subcontracting* (Chapter 2.1.2) and *Subcontractor* (Chapter 2.1.3), followed by the *Benefits of Subcontracting* (Chapter 2.1.4) and hard facts of the current situation on the market (Chapter 2.1.5).

2.1.1 Digital Firm

Digital Firm is a phrase which is often used for 'modern, innovative companies'. That is just partially true. Of course, a modern company can be a *Digital Firm*, but not necessarily. There are still *SMEs*[2] which are highly innovative but not digitalized at all. The following items apply best to the needed definition as prerequisites for the Dissertation.

What is a '*Digital Firm*'?

- *'A digital firm is one in which nearly all of the organization's significant business relationships with customers, suppliers and employees are digitally enabled and mediate. Core business processes are accomplished through digital networks spanning the entire organization or linking multiple organizations'* [Ans10].

[1] Length of time taken in product development process from product idea to the finished product. It is a critical component of time based competition.

[2] Small and Medium Enterprise

- *'A truly digital firm has several characteristics that distinguish it from most of the firms claiming to be digitized* [Sar10]:
  - *Significant business relationships are digitally enabled and mediated*
  - *Core business processes are accomplished through digital networks and span the entire organization*
  - *Key corporate assets are managed digitally*
  - *Internal and external environments are quickly recognized and dealt with'*

As those companies are discussed in this Dissertation, the mentioned items are prerequisites for this work. I.e. if a company is still applying processes manually, the efforts would be exorbitantly higher for the methods which are developed as a next step.

Still, there are numerous companies which are not yet optimized to digital processes. As a first step, those companies have to fulfill the prerequisites for *Digital Firms* to being able to use enhanced tools for subcontracting.

2.1.2 Subcontracting

As a basis for the next steps it is important to define a clear definition of the phrase *Subcontracting*. As we can see in the following items there are a variety of possibilities to describe that expression.

What is '*Subcontracting*'?

- *Business arrangement by which one firm (the contractor or 'principal'), contracts with another firm (the 'subcontractor'), for a given production cycle, one or more aspects of production design, processing, manufacture, construction or maintenance work [EIM09].*

- *When enterprises make complex products involving many different processes or when demand is too high or the products too specialized, they have the choice of doing the work themselves or getting others to do it for them. If they buy in specially made rather than standard products, this is known as subcontracting [Com97].*

As shown in the list, there are numerous definitions for subcontracting. We have seen in Chapter 1, that companies have a lot of reasons for choosing subcontractors to fulfill certain parts of their processes.

Basically we can say that subcontractors are always hired companies (mostly SMEs) by other companies during a certain period of time.

That definition provides the need of proper interfaces between the contractors in order to enable digital processes.

2.1.3 Subcontractor

The phrase *Subcontractor* itself has to be pointed out explicitly in order to realize the complex processes between a company and a subcontractor.

What is a 'Subcontractor'?

- *The enterprise that is contracted by a contractor for the production design, processing, manufacture, construction or maintenance work [EIM09]*, hence the hired company.
- *A subcontractor is an individual or company hired by a general or prime contractor to perform a specific task as part of the overall project [WG05].*

As a next step the Subcontractor's Position (Chapter 2.1.3.1), Type (Chapter 2.1.3.1)

and Structure (Chapter 2.1.3.3) have to be faced. Afterwards, the processes between the contractors are easier to recognize.

2.1.3.1 The Subcontractors' Position

The subcontractors' position in the overall process can be explained in the *supply chain*[3] as shown in Figure 2.1. In this case, the subcontractor is involved in the supply chain by creating a subcontracting chain as part of the overall manufacturing process on a long-term basis (based on [Leh01]).

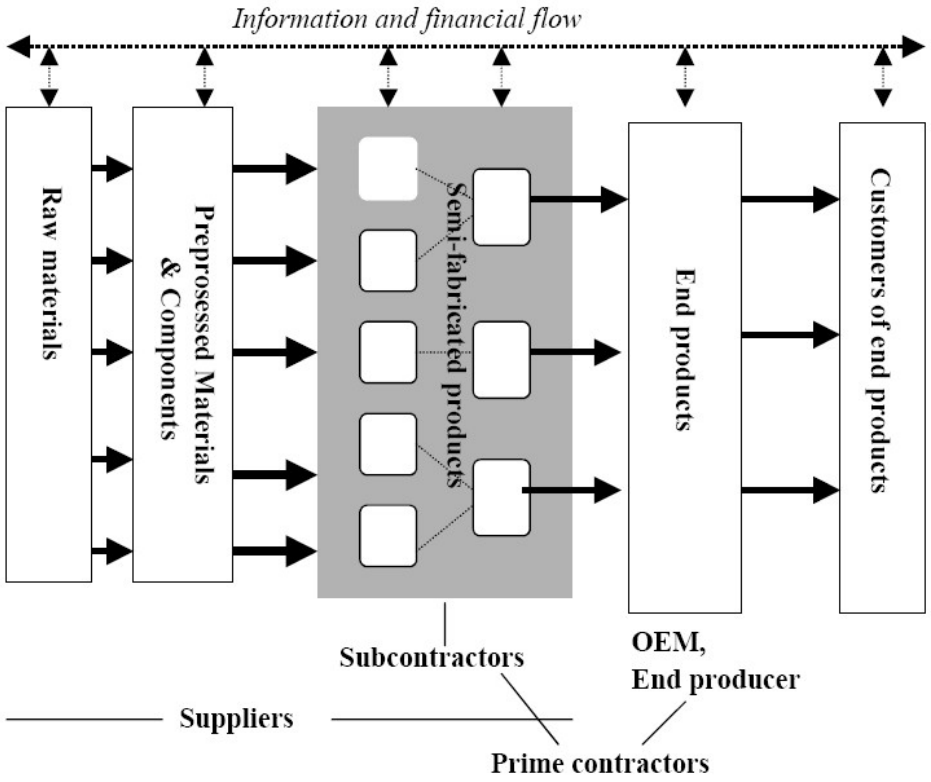

Figure 2.1: The Subcontractor in the supply chain [Leh01]

[3]Encompass all activities and organizations associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows.

In this case, the subcontractor is highly involved into the contractors' processes. If the subcontractor fulfills a vital part of the supply chain in production, the Enterprise Information System is generally the same as the contractors'. The interfaces are extremely intricate and, according to the long-term basis of the co-operations, the subcontractor is contractually forced to adopt the contractor's Enterprise Information System. The challenge of making a substantial investment in the purchase and service costs presents a moderate risk if the contracts are on a long-term basis.

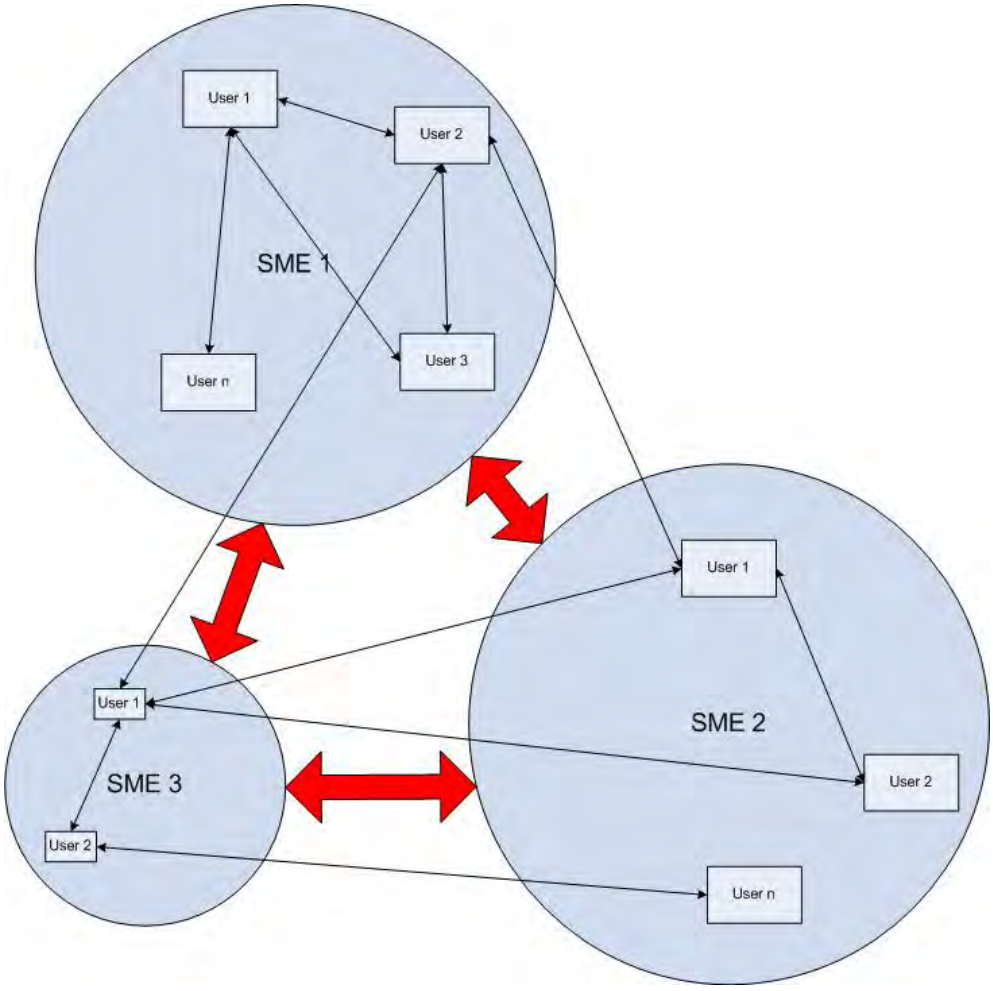

Figure 2.2: Interfaces between Companies [BB10]

Very often, especially in *modular* SMEs (see Figure 2.10 for the definition of modular firms as explained later on), a mesh of subcontractors is created. Figure 2.2 demon-

strates an example of three SMEs. Every company is involved in the same project but utilizing a different Enterprise Information Software. The small arrows show the connections between the different Users. The responsibilities between the Users are not necessary to show exclusively for this example, but also for deeper research highly important. The red arrows are pointing out the fact that the interfaces between those companies are critical [BB10].

The subcontractors' position is hard to define as they can be involved into various processes. They can act as interface between Users and SMEs. One subcontractor can be responsible for a certain task which is bonded to another subcontractors' and Users' task simultaneously.

Every User can be contractor and subcontractor at the same time. I.e. a mesh of subcontracting parties is created. Often, this situation has to be faced by complex processes with the need of continuous exchange of data and information.

That *'Mesh of Subcontractors'* will be used as a new definition for this work, as previous studies are just facing the red arrows as subcontracting, not every interface/connection is necessary for this approach.

The definition of the connections can vary during the ongoing processes and steps of the product lifecycle. I.e. frequently the subcontractors' position cannot be defined rigidly. A *flexible process* is created.

New definition: — *'Mesh of Subcontractors'* —

A *Mesh of Subcontractors* is created, if enterprises cooperate together with various interfaces. The single Users of the companies, no matter if they are employees, subcontractors or freelancers, can act as contractors and/or subcontractors at the same time. The Users span a mesh of tasks and connections/responsibilities over the involved companies and processes. Every interface is critical, i.e. a mesh of subcontracting parties is created. The connections/responsibilities between the Users can vary during

the ongoing processes and steps of the product lifecycle, a *flexible process* is created.

2.1.3.2 The Subcontractors' Type

The interpretation of the relationship between an *OEM*[4] and its subcontractor can be of different types depending on the task complexity and the degree of coordination [ABC92] as shown in Figure 2.3.

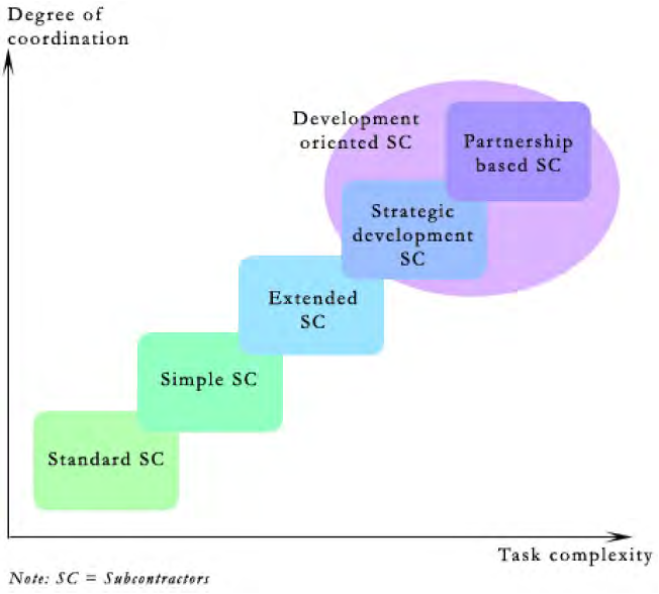

Figure 2.3: Typologies of Subcontractors [WG05] [AC98]

The first elementary types of subcontracting are labeled *Standard Subcontracting* and *Simple Subcontracting*. These types do not involve very complex tasks and the products or services are not highly specialized. Three more typologies for strong relationships are identified. *Extended Subcontracting* contains some mutual specialization and the exit costs are higher for both parties, single sourcing are thus more beneficial here than multisourcing. *Strategic Development Subcontracting* the activities are coordinated through dialog and with long-term planning, here the subcontractor possesses

[4]Original Equipment Manufacturer

competences are of great value. *Partnership-based Subcontracting* is based on strong mutual strategic value and dependency [WG05].

In contrast to OEMs, SMEs are more focused on *Standard* and *Simple Subcontracting*, as they need to act more quickly to changing demands on the market and order situations. *Extended Subcontracting* is already the exception.

'Task complexity' of [WG05] and [AC98] is focused on OEMs' requirements. I.e. the interconnections between manufacturing processes, hence the flow of information. As shown in Figure 2.2, the interfaces between *Standard* and *Simple Subcontractors* and Users can be highly complex also. That leads us to a certain different definition of the abscissa (x-coordinate) of Figure 2.3. It would need to be extended to *'Task complexity and/or time-frame'*.

2.1.3.3 The Subcontractors' Structure

Two basic structures of the subcontracting systems have been identified: the *tiered structure* and *star-shaped structure* [ER97] as shown in Figure 2.4.

In a *star-shaped structure* an OEM has a central role in information and material flows: Subcontractors have direct contacts with an OEM and the amount of indirect subcontractors is limited. During the last decade there has been an evident trend towards the *tiered structure* in assembly manufacturing (automobile, aircraft, telecommunication, electronics etc.) and it has become the paradigm of best practice, even for firms in other industries [SDMK98] [Leh01]. An important fact is that each company can act as contractor and subcontractor simultaneously.

In a *star-shaped structure*, subcontractors have direct contacts with an OEM and the number of indirect subcontractors is limited. This organization results in a broad network of subcontractors, which becomes a network with multiple sourcing of a star-shaped form. This model is applicable in a situation where wide varieties of items

are offered to the customers. The OEM has a central role in information and material flows and subcontractors are often involved as specialists in discrete processes.

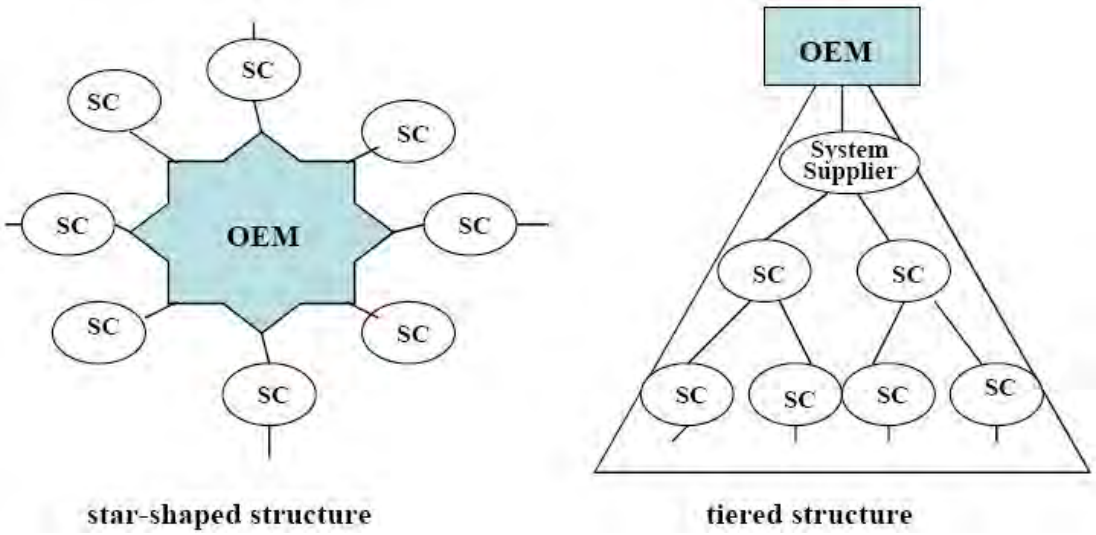

Figure 2.4: The star-shaped and tiered structure of a subcontracting system [Leh01]

A *tiered subcontracting structure* can be defined as a pyramidal vertical organization with a multi-tier structure. In this type of narrow structure (often known as the 'Toyota model' as this car manufacturer was one of the first ones to develop this model), the final OEM controls both the final product to be delivered to the market and its first-tier suppliers, but no longer controls the whole system of production [dl06a]. First-tier suppliers are given the responsibility for product development and systems undertakings, together with the delivery of these systems to the OEM (often on a just-in-time basis). Second-tier suppliers (usually SMEs) generally specialized in a narrower range of products or subsystems. Finally, third or lower tier suppliers (basically micro or small enterprises) are less sophisticated in terms of competence and activities and they usually manufacture simple components and parts [dl06b]. In this case, the challenge for a SME is typically how to engage as second- or third-tier suppliers, as first-tier suppliers are usually already large enterprises [OEC07] [EIM09].

In this point of view, a mixture of both variations is applied in a *Mesh of Subcontractors*, as the contractor acts like the OEM in a *tiered subcontracting structure*. The responsibility of the execution is not interesting to them at all. The single subcontractor can apply the *star-shaped structure* as various interactions with other team members are necessary.

2.1.4 Benefits of Subcontracting

There are a number of reasons motivating companies to subcontract as part of a new mixture of overlapping strategic priorities. Still, the reasons are not obvious.

For this reason, this Chapter shows the benefits of subcontracting to main contractors (Chapter 2.1.4.1) and the benefits of subcontracting to subcontractors (Chapter 2.1.4.2) followed by a summary of benefits for clarity (Chapter 2.1.4.3).

2.1.4.1 Benefits of Subcontracting to Main Contractors

The following list shows the most significant benefits of subcontracting to main contractors (based on [Mor03]):

1. Cost reduction
2. Higher quality
3. Efficient mechanism to respond to demand fluctuations
4. Accessing regions with potential growth prospects

First of all, companies are driven to subcontract to take advantage of national, regional or international differences. For industrialized countries, production or purchasing abroad can be cheaper than domestic production or domestic buying. Ultimately, this

enables companies to reduce the costs of the final product and thereby to offer competitive prices.

Second, the search for higher quality products with high reliability in a growing, sophisticated environment pushes companies to subcontract. Very often, in-house specialists may not match and may not meet the required criteria. As a result, companies refer to the specialist skills and higher degrees of competencies available through outside suppliers or subcontractors.

Third, the availability of products/raw materials is an additional reason why companies decide to source internationally. In order to meet product demands, companies can add international suppliers to their portfolio of domestic suppliers [Ver99]. In other words, using international subcontractors, acts as a hedge against fluctuations in demand.

Finally, international subcontracting offers commercial opportunities by penetrating markets with growth prospects. By subcontracting in a promising country, companies establish a link with that particular location and penetrate new markets with growing outlets and purchasing power such as the *BRIC*–states.

In addition, by increasing the local content of products sold in countries with trade barriers it is often possible to lower the obstacles for their own products [Ver99] and to lower the break even point between cost-benefit and thus to decrease the sales price in this new market.

2.1.4.2 Benefits of Subcontracting to Subcontractors

The benefits of subcontracting are also plentiful for subcontractors, especially those in developing countries.

The following list shows the most significant benefits of subcontracting to subcontractors [Mor03]:

1. Higher productivity and efficiency
2. Use of spare capacity
3. *Economies of scale*[5]
4. Technology transfer
5. Risk mitigation
6. Financial support

First, subcontracting leads to a specialization in the completion of specific activities or specific components or parts. This type of specialization enables the subcontractor to achieve a higher level of efficiency and skill and thereby higher levels of capital and especially labour productivities.

Second, subcontracting arrangements also enable enterprises to increase the rate of utilization of the installed capacity and to improve capital and labour productivity. Indeed, very often, they have under-utilized facilities. Finding outlets for spare industrial capacity helps to increase production and thereby raising output and ultimately revenue. An additional consequence is that it generates the creation of employment opportunities. In fact, contractors, even occasional ones, enable subcontractors to stabilize their orders over a certain period of time.

Third, by concentrating on a single and specialized activity or discipline, subcontracting service providers can gain economies of scale whilst at the same time further the cost advantages they offer to OEMs. Scale economies result from larger facilities, broader and denser networks and even greater purchasing clout.

[5]The cost advantages that a business obtains due to expansion. Reduction in cost per unit resulting from increased production, realized through operational efficiencies. *Economies of scale* can be accomplished because as production increases, the cost of producing each additional unit falls.

Fourth, subcontracting arrangements act as very efficient mechanisms and tools for the technological enhancement of SMEs. By engaging in an active collaborative agreement with specific customers, suppliers and subcontractors benefit from a large amount of technology transfer. Technology refers to *'all forms of physical assets, knowledge and human learning and capabilities that enable the efficient organization of goods and services'* [Dun93].

Fifth, the most recent thinking concerning subcontracting relates to risk mitigation. It is argued that one of the reasons for engaging in subcontracting arrangements is rooted in the need to reduce business risks (such as inventory obsolescence, uncertainty and stock-outs related to volume fluctuations [CJL02]) while increasing the rate of profit through special orders and improved payment conditions [Hay02].

Finally, contractors could provide financial support or improved access to credit to their subcontractors, for instance a contract could serve as collateral for loans. For large contractors originating from industrialized countries such as Japan, financial assistance could take the form of advanced payments or low-cost rental of standard factories [GSdCS97] and even the form of equity participation in the suppliers'/subcontractors' capital. Subcontracting improves creditworthiness through the use for instance of debt guarantees by parent firms [Hay02].

2.1.4.3 Summary of Benefits

Figure 2.5 is summarizing the benefits of subcontracting partnerships from the previous Chapters.

Complementary subcontracting activities enable firms to reduce their costs, to improve the quality of their products and to respond effectively and rapidly to demand fluctuations. Economies of scale are made as the level of output increases. In turn, the labour and capital productivities of the given company are enhanced as it becomes more organizationally efficient. Companies can therefore focus on their key or core

productive activities and spend more on R&D in order to significantly differentiate the characteristics of their products from those of their competitors. It thus gains market share and hence achieves a higher level of national and international competitiveness. Enough revenue is ultimately generated for the company to create new job opportunities in whilst maintaining its core productive activities and hence saving employment [Mor03].

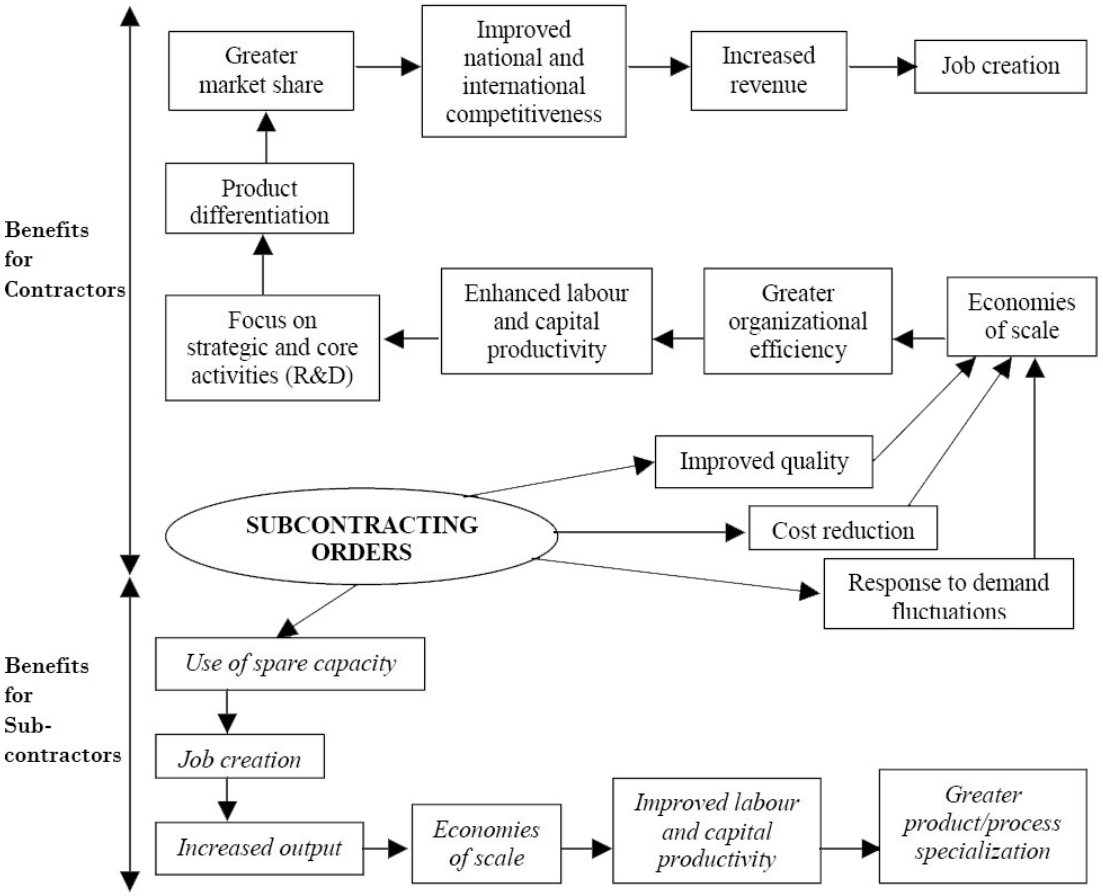

Figure 2.5: Summary of Benefits for Subcontractors and Contractors Resulting from Subcontracting Partnerships [Mor03]

From the subcontractor's point of view, the advantages of receiving subcontracting orders are equally beneficial. By drawing upon its spare capacity, it generates more

products and at the same time creates a number of job opportunities. Through this, it reaps the benefits of economies of scale as the demand for specific and precise products rises in parallel with orders from main contractors. The subcontractor's labour force thereby becomes more productive. As the labour force focuses on and specializes in the completion of specific products or processes, it becomes more efficient and acquires specific skills. Very often, these skills are enhanced as a result of the technology and knowledge of the contractor transferred on to the subcontractor through spillover mechanisms [Mor03].

Overall, the dispersion of production processes, assets and technologies of subcontractors and contractors are complementary and lead to increased efficiency on both sides.

2.1.5 Facts

This Chapter is based on the final report of EIM within the Competitiveness and Innovation Programme 2007–2010, supported by the Commission of the European Communities [EIM09].

SMEs account for a large proportion of Europe's economic and professional activity: 99% of enterprises in the European Union are SMEs, and they provide around two-thirds of all private sector jobs[6].

According to EIM/GDCC Survey in [EIM09], 17% of the EU-27 SMEs are engaged in a subcontracting relationship as subcontractors: 16% in the EU-15 Member States and 20% in the new EU-12 Member States. Around 15% of the EU-27 SMEs are involved as contractor enterprises: 16% in the EU-15 Member States and 14% in the new EU-12 Member States (see Figure 2.6). These figures imply that in the European Union,

[6]See http://ec.europa.eu/enterprise/entrepreneurship/craft/sme_perf_review/spr_main_en.htm

around 3.7 million SMEs are engaged as subcontractors (approximately 2.9 million SMEs in the EU-15 and 0.9 million SMEs in the EU-12 Member States), whereas 3.4 million SMEs are involved as contractor enterprises (2.8 million SMEs in the EU-15 and 0.6 million enterprises in the EU-12).

Focusing on those enterprises involved solely as subcontractors, 8% of the total EU-27 SMEs act as subcontractors, whereas 9% combine their role as subcontractors with a role as contractors with other enterprises. That implies that up to 54% of the EU-27 SME subcontractors combine their role as subcontractors with a role as contractors for other enterprises.

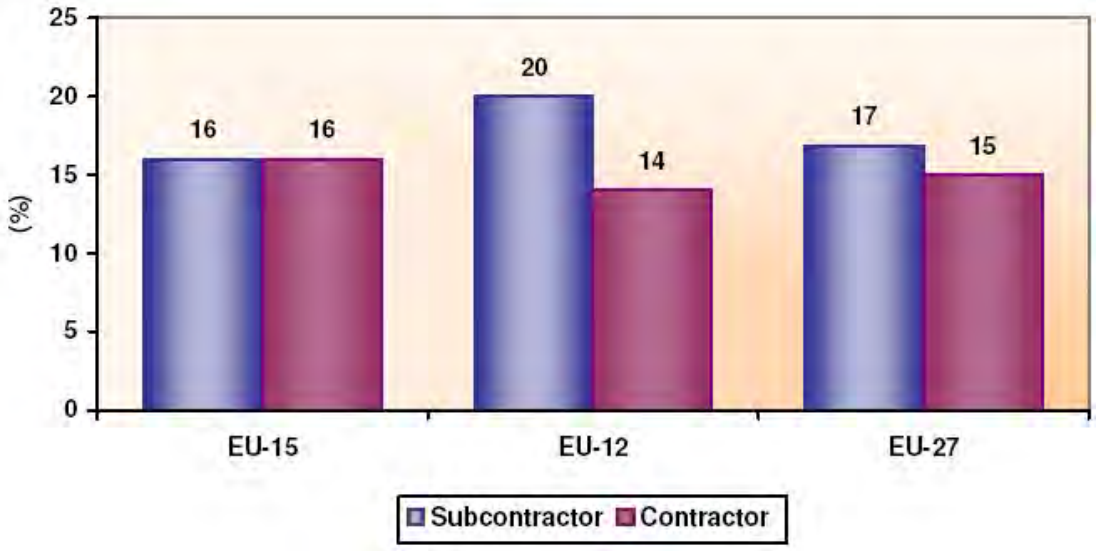

Figure 2.6: Percentage of SMEs engaged as Subcontractors and Contractors, EU-12, EU-15 and EU-27 [EIM09]

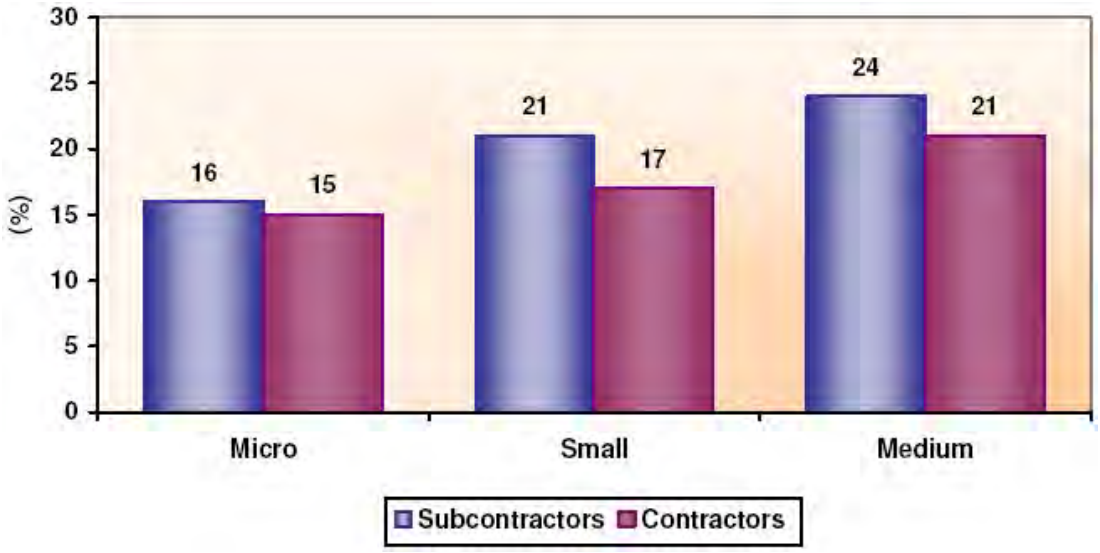

Figure 2.7: Percentage of Micro-, Small- and Medium-Size Enterprises involved as Subcontractors or Contractors [EIM09]

The survey results also show that the percentage of SMEs involved as subcontractors or contractors is directly related to the size of the enterprises (see Figure 2.7). Whereas 16% and 15% of the micro enterprises are engaged as subcontractors and contractors, respectively, these percentages increase with the size of enterprises. Approximately 24% of the medium-sized enterprises are engaged as subcontractors and 21% as contractors.

As illustrated in Figure 2.8, subcontracting and contracting activities are highest in the construction sector. About 36% of the SMEs active in this sector are involved as subcontractors and 26% as contractor enterprises. Other important economic sectors include transport/communication (30% and 23% respectively), business services (18% and 21% respectively) and manufacturing (16% and 14% respectively).

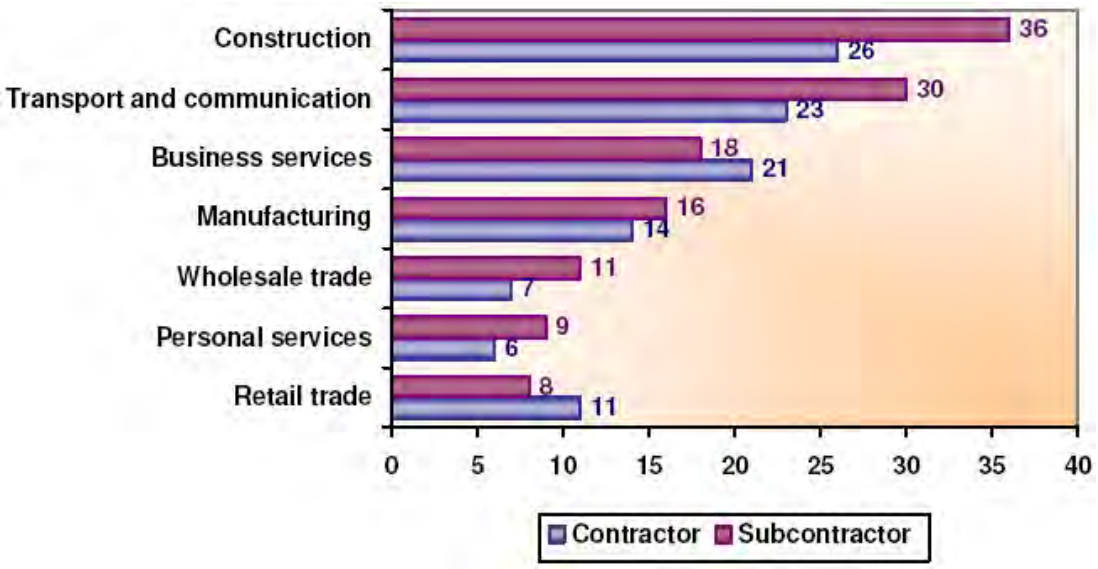

Figure 2.8: Subcontracting and Contracting Activities by Industrial Sector [EIM09]

This survey highlights the importance of proper interfaces between companies and their subcontractors. Competitive advantages according to higher performance of the spoken interfaces, hence tools, can result in a tremendous benefit against competitors.

2.2 Information Deployment within the Company

As previously shown, there is a high amount of data to be handled in nowadays *Digital Firms*. Picot, Reichwald and Wigand are explaining in [PRW08] that '*...complementary to the information intensity is the current competitive position and the business area's attractiveness. The strategic competitive position influences the urgency with which information technology and communication systems are deployed. If a firm enjoys a strong competitive position in successful and future-oriented markets, the deployment of information and communication systems is of great importance*'.

It is possible to deduce strategic directions and priorities for information management

by means of a joint examination of business areas' information intensity and competitive position [KP88], see Figure 2.9. This approach by Krüger and Pfeiffer presented in [KP88] generates non-proprietary solutions, i.e. solutions that are principally available to all market participants. As we will see later on, this is still not yet the fact. Because of an overwhelming amount of proprietary solutions on the market, a lot of issues according to implementation and interface costs have to be faced [BB10]. That problem will be discussed in Chapter 2.3.

According to Gartner [HAP10], the overall ERP software market (for both large and midmarket accounts) was $23.8 billion in total software revenue for 2009. Given the current economic and business climate, Gartner has a cautious, but still positive, forecast for the ERP software market. The ERP market is very fragmented and is served by hundreds of vendors covering every conceivable geography and industry. According to Gartner's market share data for large and midmarket ERP software in 2007, the top five vendors in market share were SAP (28%), Oracle (14%), Sage (7%), Infor (6%) and Microsoft (4%). Of the top five vendors, three (Sage, Infor and Microsoft) are focused on the midmarket, while SAP and Oracle serve the midmarket with parts of their ERP portfolios: SAP with Business All-in-One and Oracle with JD Edwards and the Accelerate offerings for E-Business Suite (EBS). Further down in terms of market share, there is a large number of midmarket-focused vendors, such as Epicor, IFS, Lawson, QAD, Exact Software and others, that are specifically focused on regions or niche industries. The diversity of vendors, therefore, demonstrates how important and vibrant this particular segment of the market is.

As there is no standardized interface to subcontractors' EIS, non-proprietary solutions are not yet possible. I.e. every subcontractor which is involved into company-intern processes has to be adopted by customization. That is highly time and cost intensive.

As shown in figure 2.9, it is to be recognized, that SMEs, which need to fulfill a strong success of a certain business area, have big trouble if they cannot handle the flow of

information. The immense costs of an aggressive development strategy have to be faced.

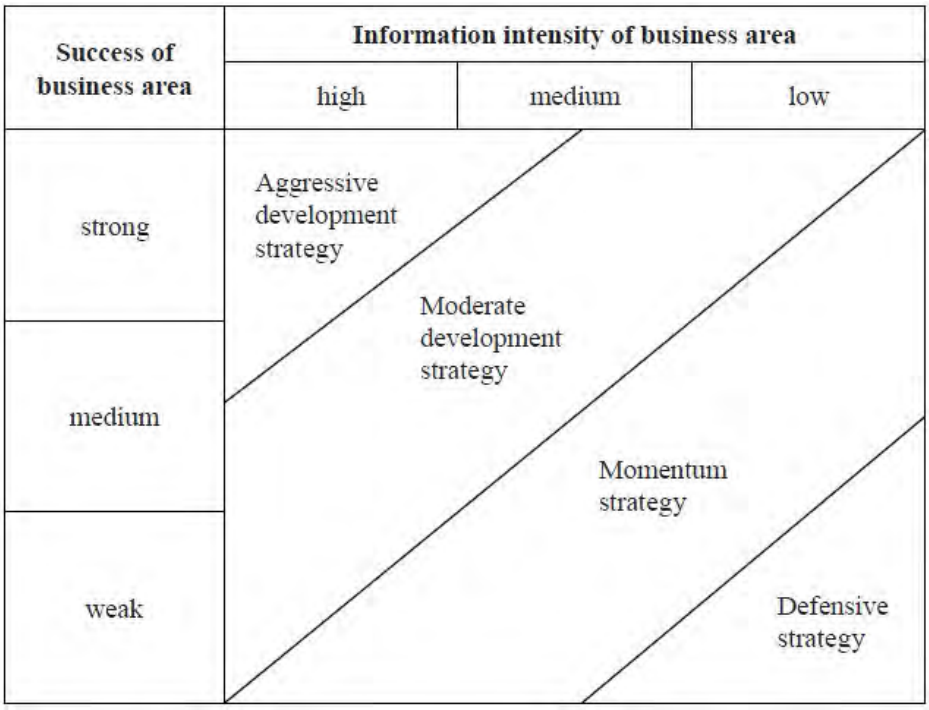

Figure 2.9: Strategy-oriented development and deployment of information and communication systems [PRW08]

2.3 Demands on Tools

Modern companies are facing various issues, i.e. they have certain demands on tools in order to obtain the wanted results. The goal should be to serve the people through the help of an adequate software solution.

The following key demands need to be fulfilled by any software in order to support the involved referees (based on [BB10], [Hur06]):

- *Flexible, Agile and Non–Monolithic Applications*

  The flexibility of a tool is an essential requirement to tools according to the

ephemerality of products and processes, quick changes in companies according to the firm's strategy, adjustments in paperwork and so on. If it is sophisticated, time and cost intensive to change processes of the software, the entire processes will be slowed down, i.e. every involved task will produce damage.

- *Adaptability*

  Adaptability with the capability of dynamically reflecting new business requirements is a basic prerequisite for every tool. Modern firms are quickly changing their demands on their employees, thus on their paperwork, processes and data flow. If those spoken modifications take too long it is hard to catch up with competitors.

- *Openness*

  Ensure interoperability among applications and support the development and sustainability of business ecosystems is highly important. Every *Digital Firm* is using an Enterprise Information System. The adaptability is highly important, associated to that, the openness is essential. Openness is solved very easily by big enterprises, for example in the car industry. If any subcontractor wants to cooperate he/she has to sign contracts in order to use their tools. Then, of course, openness is not an issue any more in this case. Certainly, SMEs cannot force every small subcontractor to use their customized, proprietary tools. I.e., that their demand on *Openness* on a software is highly important for them. Furthermore, the *Openness* to 'quasi-standard' software tools is fundamental. Software which can be processed by almost every user (no matter in which country or company), such as spreadsheet programs or text processing software are essential for every product. The possibility to store data in those 'quasi-standard' formats is unavoidable for all software solution.

- *Data Safety*

  Every involved information and data needs to be stored in a secure environment.

- *Data Access*

  Information needs to be disposable at any time for any involved, responsible person. On the contrary, i.e. non-responsible persons must not have any access to secure data which is not meant for them.

- *Up-to-dateability*

  All stored data needs to be up-to-date. I.e. every involved person has to work on the same data simultaneously in order to have the same data status.

- *Responsibilities*

  Every data record has to be 'owned' by somebody. I.e. the responsibilities have to obvious and clear for every task/data in order to avoid misconceptions and further corresponding issues which are based thereupon.

- *Task-Allocation*

  The mesh of the involved people has to be clear at any time. I.e. the tasks which have to be fulfilled and shifted to somebody else, e.g. according to specialist areas of team partners, need to be shiftable to the corresponding expert.

- *Time Management, Time Schedule*

  The overall current *Time Schedule* has to be clear for every team member at any time in order to have a proper *Time Management*.

It needs to be the goal of a tool to fulfill every single item of this list, but most of the solutions have issues in the demands as described above or in Chapter 3.

Big enterprises have the resources to develop their own tools or customize solutions to their own needs. Consultancies earn a lot of money in readjusting software to the customers' standards and demands. Usually, a whole team of software developers are working non-stop to adjust the customized tools and handle the bugs and issues even if the tools are already implemented since years. That is very cost-intensive and often not affordable for small companies with a variety of small subcontractors.

SMEs, in addition have to deal with a lot of subcontractors who use different software tools from very small providers with a low market share, which are not compatible to other system without extra customization at all as previously mentioned in Chapter 2.2.

No matter which tool had been chosen by the management, the criteria for success and failure for new tools have to be considered anyhow [Bax10]:

- It should be delivered on time
- It should be delivered within budget
- It should deliver the expected functionality
- It should be acceptable to the users (and hence used)

2.4 Challenges and Issues

With the increasing importance of information as a production factor, the problems associated with the appraisal of the economic efficiency of information deployment have intensified. Increased information and communication technology networking in the business has made traditional calculations of economic efficiency largely obsolete.

The following Sub-Chapters describe the *Six Factors* which need to be considered (Chapter 2.4.1) by every *Digital Firm*, the *Costs* (Chapter 2.4.2) faced, and *Mangers' Goals* (Chapter 2.4.3) that need to be considered.

2.4.1 Six Factors

Based on [Pic79], [Pic87], [RW99], [PRW08], there are six factors / problems on Enterprise Information Systems to be considered:

- *Measurement Problem*

  Which measurements and / or indicators reflect the effort and utility effects most accurately?

- *Situational Problem*

  To what extent do prevailing and specific situational conditions influence economic efficiency effects?

- *Integration Problem*

  In which segments of labour-divided activities in firms do the effects of economic efficiencies arise?

- *Attribution Problem*

  How can temporally delayed or spatially dispersed economic efficiency effects be attributed?

- *Innovation Problem*

  How can the innovative applications of new technology that transcend mere substitution of traditional work processes be appraised?

- *Holistic Problem*

  How can the complex, interdependency in the organizational, technical and human resource system as a whole be taken into consideration during an appraisal of economic efficiency?

Those factors need to be faced and solved by every Enterprise Information System. Complex benchmarks need to be executed to analyze the actual position. Often, those questions can be just answered by a pool of the management level in co-operation with managers and team leaders of all departments in order to have a perfect overview of the overall processes of the firms' demands on the specific software solution. A wrong decision can be fatal according to the high investment as explained in the next Chapter.

2.4.2 Costs — State of the Art

Benchmarks and a good negotiation can decrease the costs immensely. If a company decides to use a certain ERP solution, they are bounded to this supplier for years – *'Never touch a running system'*. The bargaining about the license contract has a significant influence on the license costs, the operating costs as well as the follow-up (consequential) costs by repurchasing modules and licenses. New price lists, product lifecycles and increased operating costs are breaking in on the companies and produce extraordinary costs. For that reason it is important to pick the right product for the specific needs [BB10].

The preselection as a result of the branch's demands is reducing the wide range of possible providers, but not the complexity of the different license models. The big variety of demands and the special subjects are increasing the need of supplemental, user-specific, modules which produce extra costs on each license.

The direct comparison of license proposals is very challenging, because the models are very different to distinguish the sections and hence, hard to compare [ALM95] [ZBP06].

Most models are based on the definition of concurrent users (simultaneously signed-in users) or named users (namely 'known users'). Whereas the named users are countable for companies, the number of concurrent users is virtually. Consequently, the impact of utilizing named users vs. concurrent users is the ability or inability, respectively, to identify the communication flow from user to user (hence forward defined as *recoverability*).

The price of a single license is measured by the entire system. I.e., depending on the duties and responsibilities of the users, two alternatives are possible. Each license can be linked to the used modules of every user. If just few tasks have to be executed, the license is cheaper than the use of more modules. Generally speaking the more rights

a users needs the more expensive the license will be. From this it follows that if the majority of users is executing multiple modules, the unlimited package is the better choice.

The usage of junctions of non-ERP-products is licensed as volume-dependent. This can be the amount of transactions, records, products, location and even the turnover of a company which is using the software. That makes it possible to use a simple cost-effective analysis to calculate the *ROI (Return on Investment)*[7].

Last but not least, the servicing costs have to be considered as well. A small purchasing price does not mean that the service costs are small, too. A high set for servicing does not mean that the service is high. The service is linked to the set of servicing and the definition of the basis of the servicing. Those commitments are the most important position by facing the costs.

Every model offers latitudes to indicate the recoverability of license costs by branch dependent pricing, volume-dependent licensing or the degree of freedom of various user categories or user models. This interpretation has to be defined by the company itself. Recoverability benefits all users.

Often, if single license costs are relatively high, SMEs share accounts for Users in order to save money. That is not recommended, because the interoperability and interfaces in *Digital Firms* are very complex as previously shown in Figure 2.2. The responsibilities that are bonded to various tasks need to stay flexible in the *Mesh of Subcontractors*. That is a basic requirement.

[7] A measure of a corporation's profitability, equal to a fiscal year's income divided by common stock and preferred stock equity plus long-term debt. *ROI* measures how effectively the firm uses its capital to generate profit; the higher the *ROI*, the better.

2.4.3 Managers' Goals

For a company and its development in the market, a meaningful integration of the company information and communication system is required for the planned support to be implemented [MG00b].

Technology should serve the company, not the other way around. Information and communication systems unify human resources (qualification, motivation), organizational (design and process organization) and technical (hardware, software) components [PRW08]. The combination of these components determines information and communication systems' structure and influences their efficiency with regard to organizational task accomplishment. Different tasks make specific demands on organization structures; different organization structures require specific support by means of information and communication systems.

As we can see in Figure 2.10, there is a trend towards virtualization. Mostly, Form 1 is implemented in European SMEs, still. CEOs, company founders and managers are leading the entire company. Usually, the decision making process is very short because of flat hierarchies. Persons in charge can directly contact the head of department or even the CEO so as to apply the new ideas. That is one of the biggest advantages between SMEs and large companies.

It is usually quite different within co-operations, for example, for the development or production of new products. Often, the responsibilities are spread over a couple of team leaders and subcontractors. In addition, the responsible contractors shift their responsibilities to their employees. Very quickly, Form 4, a modular firm, is created. A mesh of coherencies, divided into 'sub-meshes', creates the previously mentioned issues.

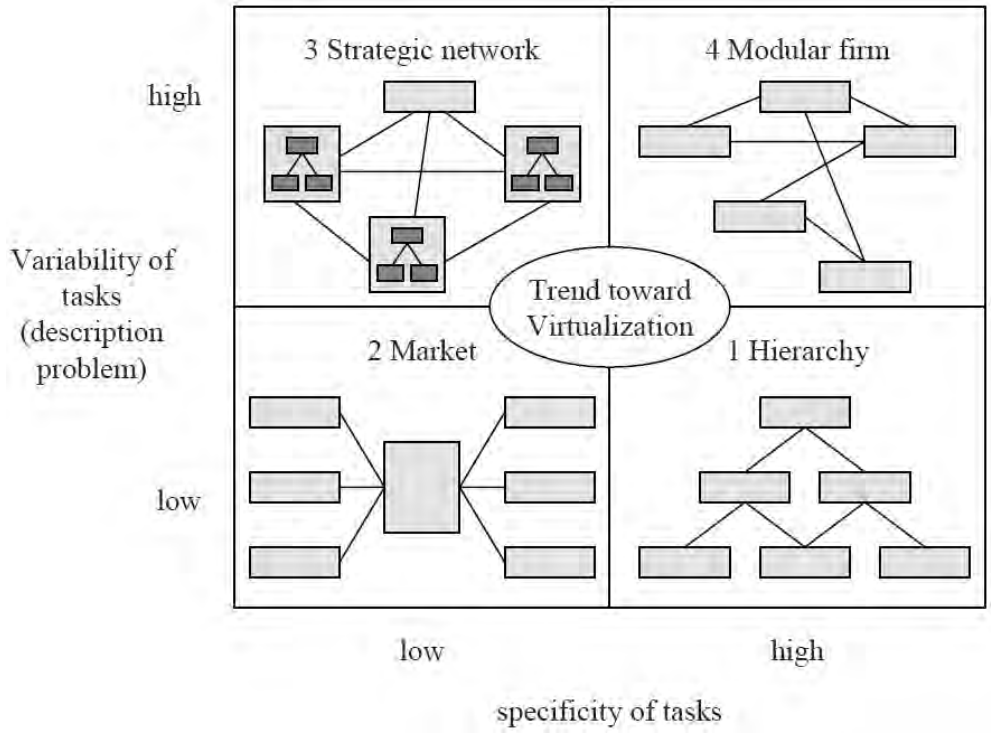

Figure 2.10: Organizational forms and macrostructures of information and communication systems [MG00b]

These factors need to be considered by the managers. It is easy to deduct interface problems exist if some subcontractors utilize different systems.

Chapter 3

Existing Solutions and their Problems

It is easy to recognize the complexity of Enterprise Information Systems in combination with interfaces between the increasing amounts of subcontractors in current digital firms.

The perfect non-proprietary solution is not yet available on the market. As a prerequisite for the doctoral thesis in this area, the existing solutions and their problems are faced. Existing papers and research conclusions are observed in order to to show the current issues.

Chapter 3.1 shows the current issues in German and Czech SMEs, followed by Chapter 3.2 which summarizes the main issues.

3.1 Current Issues

According to personal experience a variety of expertise from the field as mentioned in papers and articles, issues still exist even after implementation of modern tools in digital firms have proven successful.

First, some lists show the results of selected surveys, papers and dissertations.

The following list shows some of the mentioned main problems of an already realized project with a big provider of a proprietary solution [Bra09]:

- Confusion and a general lack of knowledge about the new system throughout the organization
- The production and inventory control department, as well as the help desk, and *IS (Information Systems)*[1] department were pummeled with a lot of questions that they did not have the capacity to answer
- A lack of tools for generating reports / the new system was not customized to the business
- Lack of quantitative measures to assess implementation progresses and the fulfillment of strategic benefits
- A lack of knowledge regarding the forecasting module decreased forecasting accuracy
- No back-up plans
- Unacceptable consultant turnover produced instability
- Data had been inaccurate, incomplete, overlooked or was not entered into the system causing many errors (garbage-in, garbage-out)
- Confidence in the system amongst internal and external customers was undermined
- Insufficient time and money necessary to successfully implement the project
- Management pushed for a quick transition to a new system to save money on current system software licenses

[1] Combination of hardware, software, infrastructure and trained personnel organized to facilitate planning, control, coordination, and decision making.

- Finger-pointing and blame shifting for poor system performance

A list of likely problems with an ERP system by Neville Turbit [Nev05]:

- The cost is likely to be underestimated
- The time and effort to implement is likely to be underestimated
- The resourcing from both the Business and *IT (Information Technology)*[2] is likely to be higher than anticipated
- The level of outside expertise required will be higher than anticipated
- The changes required to Business Processes will be higher than expected
- Scope control will be more difficult than expected
- There will never be enough training – particularly across different modules
- Most important of all, and the single biggest failure point for ERP implementations, is the need for *Change Management*[3]

Al-Hammad identified and assessed the interface problems among various parties by executing a survey with 102 companies which are contractors and/or subcontractors. 19 interface problems were identified and obtained by the survey and from review of literature, classified into four general categories (financial, contract and specifications, environmental and other common interface problems) [AH00].

[2] Set of tools, processes and methodologies (such as coding/programming, data communications, data conversion, storage and retrieval, systems analysis and design, systems control) and associated equipment employed to collect, process and present information. In broad terms, *IT* also includes office automation, multimedia and telecommunications.

[3] A structured approach to transitioning individuals, teams and organizations from a current state to a desired future state. It is an organizational process aimed at empowering employees to accept and embrace changes in their current business environment.

Financial Problems:

- Delay in progress payment by owner
- Accuracy of the project cost estimate
- Owner's low budget
- Price changes

Inadequate Contract and Specification:

- Insufficient details
- Insufficient specifications
- Violating conditions of the contract
- Poorly written contract
- Change order

Environmental Problems:

- Weather conditions
- Geological problems on site

Other common Interface Problems:

- Lack of communication between the parties
- Slowness of the owner in decision making
- Delay in completion of the project

- Lack of management supervision
- Skills and productivity of laborers
- Poor quality of work
- Poorly done planning and scheduling
- Unfamiliarity with local laws of related governmental agencies

47% of the participating companies declared that the *Lack of communication between the parties* (very) strongly affects the success of the project.

3.2 Summary of Key Issues

A summary of all main issues according to Enterprise Information Systems, combined with the previous mentioned authors and personal experience, is provided as follows in Figure 3.1. Previously listed items are combined and/or skipped (if not applicable or necessary) for that summary. Just main issues that can be applied to general facts are relevant for this point of view. All findings are linked to a Cause-and-Effect Diagram in Figure 3.4 in Chapter 3.2.5.

- *Technology*
  Data inaccuracy and incompleteness, no back-up plans for those situations
- *Information*
  Lack of communication between participating parties, because of missing clear responsibilities and task-allocation
- *Management*
  Insufficient time and money to successfully implement the tool because of underestimated costs

Lack of management supervision

Confusion and a general lack of knowledge / acceptance of the new system (by the management)

- *HR*[4]

  No Change Management

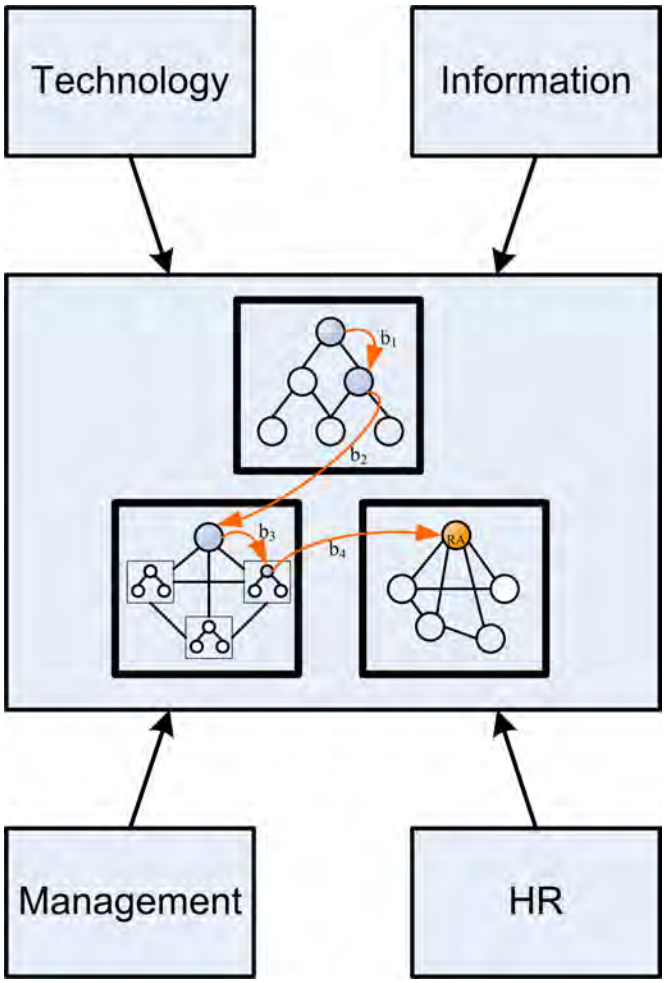

Figure 3.1: 4 Issues on a Mesh of Subcontractors

[4]Human Resource; The division of a company that is focused on activities relating to employees. These activities normally including recruiting and hiring of new employees, orientation and training of current employees, employee benefits, and retention.

The following Chapters describes the single Issues (Chapter 3.2.1 – 3.2.4).

3.2.1 Issue Technology

Data inaccuracy and incompleteness, no back-up plans for those situations:
As a prerequisite for our definition of digital firms (see Chapter 2.1.1), the issue of inaccuracy and incompleteness of data can be excluded. All needed data needs to be accurate and complete for all processes. That would be a knock-out criterion for a modern digital firm.

As implementations of tools have proven, companies and consultants still struggle with this issue. Furthermore, no back-up plans are designed for those critical situations which lead to tremendous issues.

3.2.2 Issue Information

Lack of communication between participating parties, because of missing clear responsibilities and task-allocation:

The lack of communication is even often present within teams which are located in an open office. If the participating parties are spread over different floors and teams – even when co-located – it can already be challenging. Modern digital firms which are global players with various subcontractors all over the world can have serious communication issues.

Tasks are shifted to each other and the responsibilities for certain processes can disappear. The allocation of the needed tasks, hence, can be challenging if synchronisation tools that link the Mesh of Subcontractors and Users are not implemented.

Rotating team members and flexible processes requiring consultants hinder the overall

composition. On top of all those issues shortages often lead to difficulties in training the new team members. The best experts cannot support the process if they do not have specified, accurate data.

On the other hand, too many tools block verbal interpersonal communication. Non-verbal language represents over 50% of our total message [Vin07]. Often, people are sending e-mails across a desk. Frequently, the written is prefered against the spoken communication. Even with an overall tool that controls all involved steps, a lack of verbal communication can lead to big issues as the direct reaction to certain details could impact further steps.

3.2.3 Issue Management

Insufficient time and money to successfully implement the tool because of underestimated costs:

The difference between budgeted costs and actual costs is a critical issue for most companies implementing ERP software packages. Over half (51.4%) of the total respondents indicated their actual costs were over budget, 40% were on budget and only 8.6% came in under budget as shown in Figure 3.2 [Con10][5].

Underestimated costs are a high risk potential. A started implementation almost cannot be stopped without big loss. Consultancies know very well about the proceedings and the dependency of their customers to the sold product. For that reason, a well-designed contract is highly important. Even so, additional costs are hard to avoid and should be in the customers' mind in advance.

[5]Panorama Constulting Group, an independent and vendor-neutral ERP consulting firm, developed the 2010 Enterprise Resource Planning (ERP) Vendor Analysis Report based on survey results from 1.600 organizations that have selected or implemented ERP within the last four years.

Generally, the costs are the reason for poorly using modern tools for SMEs, as they do not have enough money to purchase expensive licenses for every involved user.

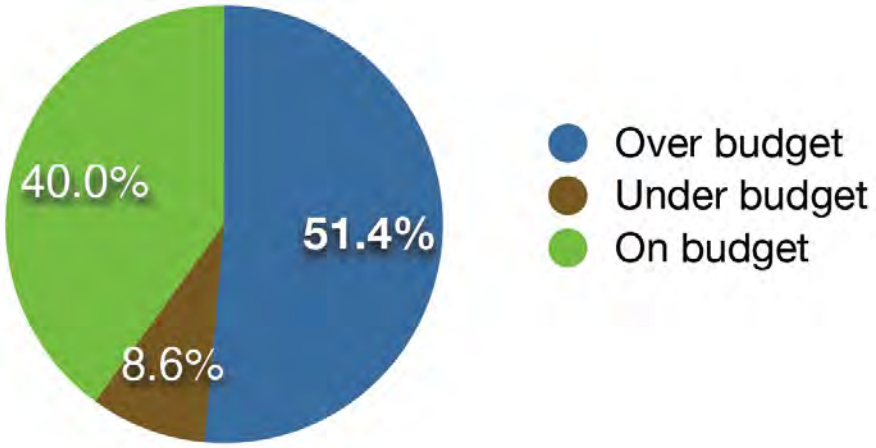

Figure 3.2: Software Implementations' Budget [Con10]

Lack of management supervision:

Management supervision is highly important for successful process completion. Especially if a complex *Mesh of Subcontractors* is involved into the entire product lifecycle, the general overview can quickly be lost.

Often, managers do not have the time to talk to their supervisors because of overloaded time schedules. A brief meeting with the management team can be a hard to accomplish. That is just one reason, why lack of management supervision leads to issues.

The employees and subcontractors cannot do a satisfying job if the project manager does not have the needed information about the current status of the process or if the information is lost from top down or bottom up.

Hence, the lack of management supervision is bonded to the previously mentioned main issues. The result can lead to all kinds of sub-issues and snowball effects of failure.

Confusion and a general lack of knowledge / acceptance of the new system (by the management):

This general problem is well known in modern companies. Top managers do not want to accept new tools because of changes and the so-called 'running system'. The issues with the existing tools that should be replaced are often no-existent for top managers. They have assistants who manage their paperwork. They just have to execute very few tasks in the existing tools and are busy with other management jobs off the EIS. If they are voted down by the rest of the leading team, they often do not accept those tools and work against them. This makes it very hard for the employees to use the new systems. *Why shall we use the tool with all the problems in the first steps, if the boss is not using it either?* If they have one of the spoken top managers superordinate, it makes it very hard to get capital in terms of working hours to deal with the tool. The team starts avoiding the new system also and so forth.

Generally, the needed time to use the new tools efficiently is often underestimated by the management and the users. If the old system (even if there is no EIS implemented, every users 'generates' his/her own 'system', i.e. way to handle the daily work) is in use for several years, it is hard to switch to other proceedings. It takes a significant amount of time to include new processes and guidelines to follow. Experiential learning requires development and implementation.

3.2.4 Issue HR

No Change Management:

Employee resistance and a lack of proper training are key hindrances to organizational change [Lem07]. Change Management is the broad term for those issues. In order to realize changes it is important to have proper processes to complete the transformation smoothly. As shown in Figure 3.3, the success rate for specific change initiatives in

meant companies ranges between 19% and 46% [Smi07].

ERP implementations require changes in processes to meet the standardized software process. It is better to change some business, rather than customization of the tool; when organizations change business processes, Change Management experts are required because people resist change [Mut10].

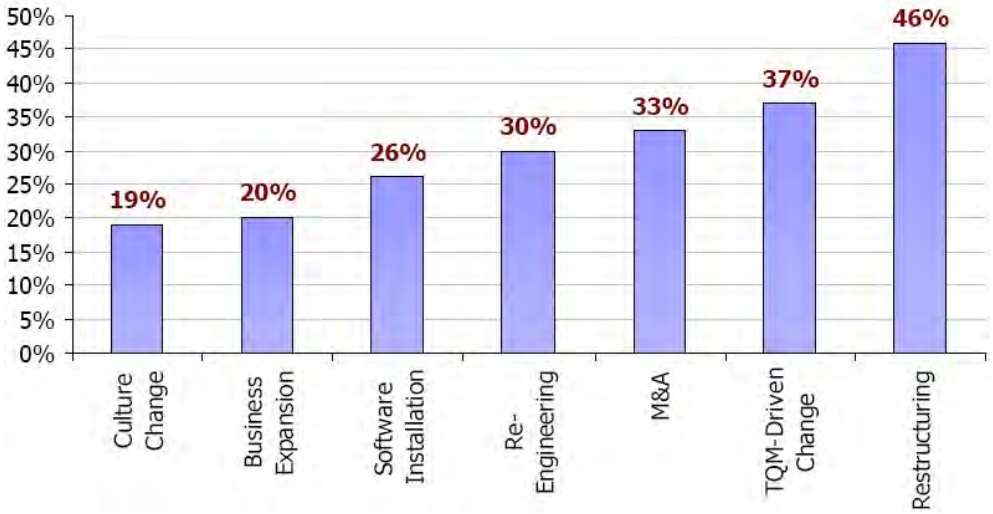

Figure 3.3: Success Rates for different Types of Organizational Change [Smi07]

3.2.5 Cause-and-Effect Diagram of Key Issues

All key issues are linked to an overall Cause-and-Effect diagram as follows.

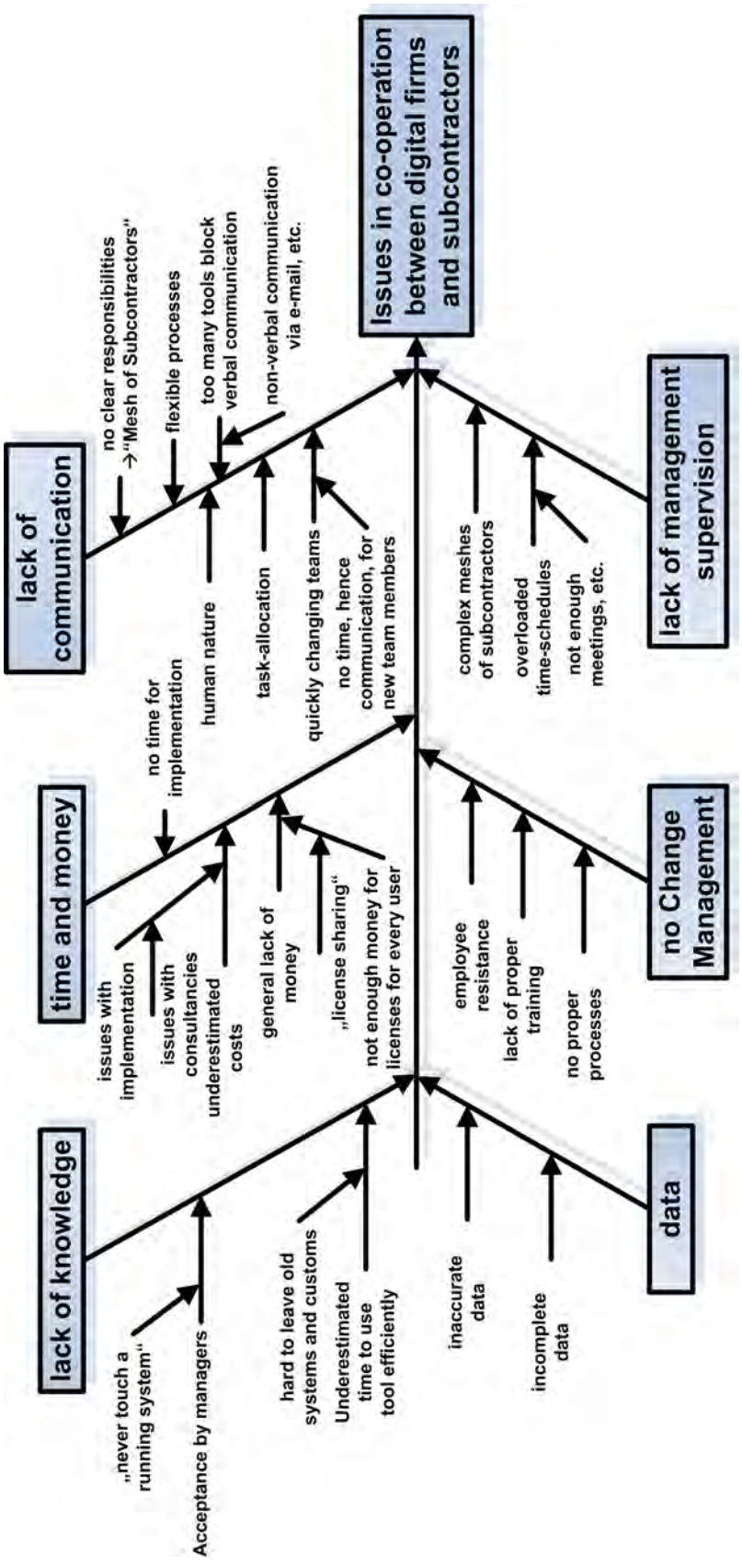

Figure 3.4: Cause-and-Effect Diagram

Chapter 4

Prerequisites for new Solutions based on Scientific Research

Chapter 3 showed the current issues of existing solutions on the market. The goal of this Chapter is to identify the key *Demands on new Solutions* (Chapter 4.1) in order to evaluate the existing problems in a *Mesh of Subcontractors* in Germany in Czech Republic. As a result of this research, the *Basic Framework* (Chapter 4.2) is deduced from those approaches. The acquired and developed perceptions are recapitulated in a *Summary* in Chapter 4.3.

4.1 Demands on new Solutions

First, the demands due to the existing problems with current tools are shown in Chapter 4.1.1. As a next step the demands, which are based on research results (Chapter 2.3), are extended and linked to the findings in Chapter 4.1.2.

4.1.1 Demands due to the existing Problems with current Tools

Chapter 3.2 provided a summary of main issues. Now, a new list of demands is created with the goal to solve every involved problem. As a next step, every item is discussed and explained.

- *Simple*
- *Affordable*
- *Implementable*
- *Non-Complex Communication*
- *Clear Responsibilities*
- *Unsophisticated Task-Allocation*
- *Quick Management*

4.1.1.1 Simple

One main issue of Chapter 3.2 is the *confusion and a general lack of knowledge / acceptance of the new system*.

Not every employee in digital firms is an enthusiastic software user. Because of frequently changing hardware, software, updates etc., a lot of users are over challenged. The older generation employees sometimes even struggle with typewriting. Complex *GUI*s[1] hamper the utilization on top of the other problems.

Frequent error messages are general issues that can lead the user to frustration. Often, the support of system administrational staff is essential.

[1] Graphical User Interface

Because current systems are struggling with that feature, a new tool needs to be *Simple*. Of course, complex systems which can control all company-internal processes are not too easy to handle and require certain training. If another new tool or module has to be used to enhance the co-operation with subcontractors and the flow of information, it is important that it can be worked through quickly and is self-explanatory.

To illustrate a standard situation as basis for the explanation, the flow of information is shown in Figure 4.1.

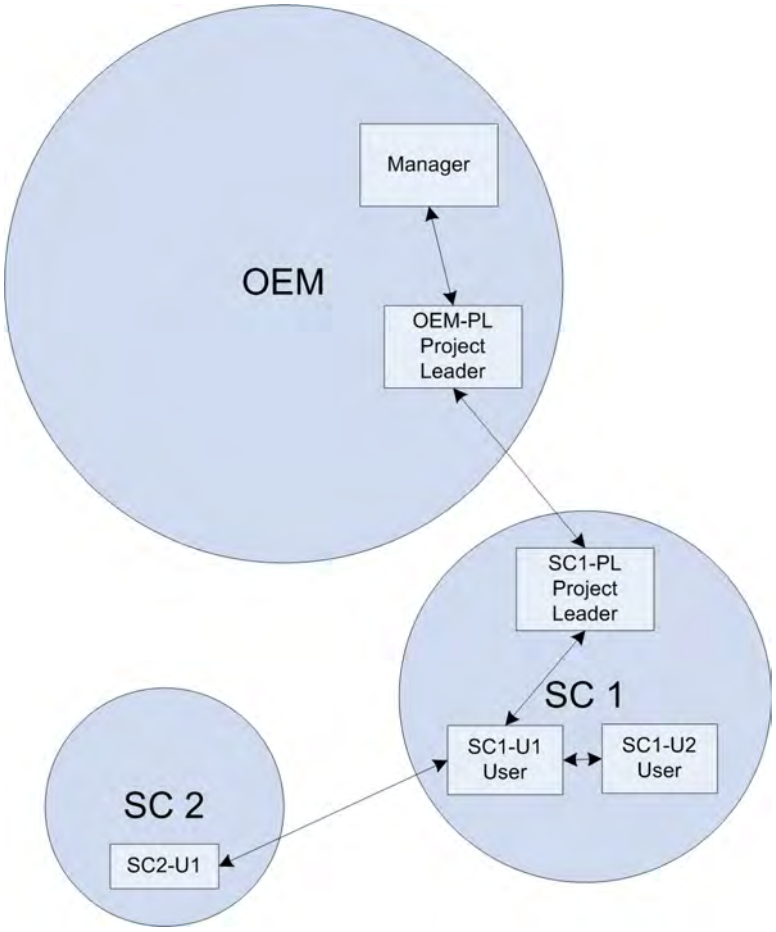

Figure 4.1: Flow of Information in a Sample-Process

Current state:

Usually, a manager of an OEM needs, for example, results on a certain problem in the assembly of a new product. His responsible project leader (abbr. OEM-PL) is working on various issues, hence assigns the task to the project leader (abbr. SC1-PL) of subcontractor 1 (abbr. SC1) as a specialist in this area. Furthermore, SC1-PL needs some legwork of his employee (abbr. SC1-U1) who has contact to other specialist in company 2 (abbr. SC2-U1).

Nowadays, the needed data is often pushed from one to another via e-mail or *FTP-Servers*[2], still. Mostly, no encryption is used as the users do neither have the specific knowledge about the process, nor the risks about data security. Another problem is that just the data is forwarded. I.e. every involved user has, for example, a dataset (abbr. DS) as a research result for the existing assembly problem. The DS has to be pushed from one to another back and forth various times for peer review and changes. The responsibility for the data is usually not clear, in a complex *Mesh of Subcontractors* in German and Czech SMEs. I.e. errors are not easy to recognize and the chance of getting confused is very high. *Which is the latest version of the DS?* That question pops up frequently and the confusion is high. Furthermore, that way of shifting data is very slow and highly susceptible to human mistakes.

Target state:

The usage of data exchange needs to be *Simple* and secure. It has to be obvious for every involved person which DS is the latest version and it has to be accessible easily.

[2] An FTP Server is a piece of software that is running on a computer and uses the File Transfer Protocol to store and share files. Remote computers can connect anonymously, if allowed, or with a user name and password in order to download files from this server using a piece of software called a FTP Client.

4.1.1.2 Affordable

Chapter 2.4.2 explained the difficile variations of cost models. Of course, cost-benefit equations need to be considered. If a new tool for the management of co-operation with subcontractors shall be deployed, it is important that it is *Affordable* in order to make it attractive. It makes just sense, if every involved user has his/her own account or license.

Current state:

Currently, if *EDI*[3] is managed by specialized tools, the usage is very expensive — and consequently often not affordable for SMEs with complex process structures. Furthermore, processes are supported, i.e. every task needs to be executed manually. That leads to slower process steps and that causes costs.

Because of the overpriced costs of the tools, the spoken firms frequently use just a single license for the entire involved team or even the overall company in order to save money. As responsibilities are bonded to various tasks and datasets, that approach makes no sense (compare Chapter 2.4.2). The *Mesh of Subcontractors* needs to stay flexible.

Target state:

An *Affordable* method to exchange data and manage co-operations would enhance the possibilities and save time, hence money.

The following demands, like a *Non-Complex Communication* and *Clear Responsibilities and an Unsophisticated Task-Allocation* are bonded to that target and equally important.

[3]Electronic Data Interchange

4.1.1.3 Implementable

One main issue of Chapter 3.2 was *insufficient time and money to successfully implement the tool because of underestimated costs*.

As shown in Figure 3.2, over half of the implementation costs are usually over budget.

Current state:

Complex Enterprise Information Systems which control all processes of digital firms are time and money intensive. The implementation can take years, dependent of the complexity of the processes and involved users, paperwork, interfaces and so on. The used hardware can already cause a lot of difficulties because of system requirements of modern tools. A high amount of companies in Germany and Czech Republic were founded decades ago and are still lead by the same person. The disadvantage in those firms is that the hardware is frequently out-dated.

If various subcontractors, employees of the contractor, freelancers etc. are involved, hard- and software compatibility can be a major issue.

Especially short-term relationships, which have to be established very quickly because of required expert-knowledge, are difficult to arrange. Implementation can slow down the overall process.

Target state:

In consequence of those perceptions, a system independent tool is required in order to solve those problems. Furthermore, it needs to be independent from *Operating Systems*[4].

[4]The program that, after being initially loaded into the computer by a boot program, manages all the other programs in a computer.

Hence, a web-based tool would be the fastest available solution without any implementation in the running-system.

4.1.1.4 Non-Complex Communication

Communication is a major issue in general (Chapter 3.2) as already broached in Chapter 4.1.1.1. Figure 4.1 shows a very simple *Mesh of Subcontractors* that includes several interfaces which should lead to the wanted results as part of a process.

Current state:

No matter which Enterprise Information System is in use, digital firms generally use quasi-standard e-mail software for any kind of information exchange and communication. Of course, several *Chat*[5]–tools are state of the art in modern companies, but do not replace verbal communication [Vin07].

Often, because of *Quality Management*[6], every exchange of information needs to be recorded somehow. Exchange of information needs to be obvious for every involved person. Exactly that is the weakness of regular e-mail and leads to difficult and time-intensive additional expenditure.

Target state:

The goal would be to establish a solution which is does not replace the current e-mail system. Own experience showed that it is a huge effort to establish extra tools for

[5] *Chat* can refer to any kind of communication over the Internet, but is primarily meant to refer to direct one-on-one *Chat* or text-based group *Chat*, using software tools. The expression *Chat* comes from the word chat which means 'informal conversation'.

[6] All management activities and functions involved in determination of quality policy and its implementation through means such as quality planning and quality assurance (including quality control).

communication. This is especially true if users and/or subcontractors are involved into various processes of a variety of different projects. If every contractor uses a different tool for communication issues are bound to occur.

For that reason, the goal is to include the communication into the new method. That sounds abstract. If an extra step, for example to save communications or to spread new information, is necessary, soon people will start to avoid the tool and use it thriftily. The snowball effect starts and soon new issues will occur. I.e. *Plug-ins*[7] to the standard e-mail software would solve that issue.

4.1.1.5 Clear Responsibilities

Another main issue in a complex *Mesh of Subcontractors* are *Clear Responsibilities*. Every involved company has its own hierarchy. The diverse responsibilities of integrated subcontractors are often not obvious and can lead to several problems. Often, employees without a leading position can be in charge for a subtask of a certain area.

Current state:

Hierarchies are not obvious and *Organizational Charts*[8] are often not updated as roles change. Complex processes can, furthermore, change responsibilities within the process.

Misunderstandings occur frequently, as tasks cannot be allocated correctly if the responsibilities are not cleared.

[7] A set of software components that adds specific capabilities to a larger software application. If supported, *Plug-Ins* enable customizing the functionality of an application.

[8] Visual representation of how a firm intends authority, responsibility and information to flow within its formal organizational structure.

Target state:

The overall responsibilities need to be allocated to any involved task. I.e. if a task is created it needs to be assigned to a person in charge which is then responsible until the task is completed. In addition, the Organizational Chart for each process must always be clear for everybody at any time.

4.1.1.6 Unsophisticated Task-Allocation

At a first glance, *Unsophisticated Task-Allocation* seems to be present any time. That impression appears be wrong after a short example of the current state.

Current state:

Involved team members shift tasks back and forth as a continuous process. Complex processes and products need the input of various experts in niche areas. Frequently, if an issue suddenly occurs, the advice of specialists is necessary. I.e. people which are deeply involved into the process or which are employed at the firm for years know where to ask for the needed information. As the number of short-term employment relationships is increasing and knowledge needs to be acquired short-dated, new employees and subcontractors need to be incorporated extremely quickly. That is still a big issue for nowadays companies in Germany and Czech Republic, as those firms are still not used to those procedures.

Target state:

Tasks, as part of processes always need to be 'owned' by somebody [BB10] in order to avoid mistakes. For that reason an *Unsophisticated Task-Allocation* is essential.

The previously mentioned problems can be solved by allocating tasks to users. I.e. everybody has a list of tasks to handle. If a task is processed by a variety of involved

team members, there must be always the 'Task-Owner' which leads the management of the single task. That leads to again to the *Clear Responsibilities*.

4.1.1.7 Quick Management

The *Lack of Management Supervision* is always present in the everyday work life. Frequently, managers and top managers are smothered with paperwork and obligations that their time schedule has no gaps. There is almost no time available to troubleshoot and interact with project leaders. Even small companies struggle with this issue.

Current state:

According to a lack of time and overview of the ongoing processes, managers often do not have the needed overview and insight. Another reason for lack of management is the increasing amount of involved people and data. A complex *Mesh of Subcontractors* is hard to manage. For this reason, the supervision of processes is getting ever more complicated. Subordinate staff have to deal with those situations which can lead to improvisation and hence, a loss of quality.

Target state:

Reports and evaluations are gaining more and more importance for leading personnel. The current state of the projects and processes needs to be present and easy to inspect.

Visualized processes, like a *Traffic Light Principle*[9] or *Status Bar*[10], for example, can easily indicate the current status of tasks and overall projects. This is one possibility to

[9] Method to visualize the status of a process. Green indicates that everything is all right, yellow indicates a moderate or partially critical situation and red indicates critical situations.

[10] An information area typically found at the bottom of windows in a *Graphical User Interface*. Its job is primarily to display information about the current state of its window, although some status bars have extra functionality.

support managers and leaders. A quick intervention is possible if responsibilities are clear.

4.1.2 Extended Demands due to Research Results

The following list from Chapter 2.3 is now extended according to the acquired results.

- *Flexible, Agile and Non–Monolithic Applications*
- *Adaptability*
- *Openness*
- *Data Access*
- *Up-to-dateability*
- *Responsibilities*
- *Task-Allocation*
- *Time Management, Time Schedule*

4.1.2.1 Flexible, Agile and Non–Monolithic Applications

As explained in Chapter 2.1.3.1, the need of quick changes and adjustments lead to flexible processes and a *Mesh of Subcontractors*.

Current state:

Monolithic solutions are critical and should be avoided for new tools [Hin05]. Mostly big providers offer allrounder tools that can be adopted, adjusted and reconfigured to the extremes. Consequently, customization is cost intensive (see Chapter 2.3). The

current hype towards *SOA*[11] (*Service-Oriented Architecture*) during the last years reflects the unavoidable necessity for flexibility.

Target state:

A solution that unifies those demands in terms of an independent tool which is easy to extend and adjust needs to be developed. For example, a web-based solution where additional methods can be enabled easily.

4.1.2.2 Adaptability

Adaptability in general should be a key feature for any tool because of frequent changes in modern firms.

Current state:

Frequently, German and Czech companies use obsolete tools as the running-system still works more or less. Usually, in terms of *Adaptability*, the limits are reached quickly. Unfortunately, there are still tools that need cost intensive customization if an adaption is needed. Those costs are likely to be underestimated.

Target state:

SOA is an approach that faces that issue. Basically, each tool should be adaptable on the long term to changes and other programs.

[11] A flexible set of design principles used during the phases of systems development and integration in computing. A system based on a *SOA* architecture will package functionality as a suite of interoperable services that can be used within multiple separate systems from several business domains.

4.1.2.3 Openness

Openness is bifid, i.e. that *Openness* to other Enterprise Information Systems, e.g. from competitors, is usually just possible by customization via interfaces. That is very cost intensive and highly critical, as the interfaces are not standardized. Communication and data exchange via a variety of proprietary tools is not easy to handle. Adjusted solutions which are often based on outdated operating systems and databases are not made for an easy communication with other tools. Beyond that, small subcontractors often do not have any EIS at all. They simply use an organized file structure on a server or hard disk drive and 'quasi-standard' file processing software. Basic versions of the used EIS are generally not available without an expensive extra license. I.e. the implementation of those data sets is not possible without big efforts.

Generally, *Openness* to 'quasi-standard' software tools and file types is fundamental and applied in almost every solution on the market.

Current state:

In complex processes where various firms, subcontractors etc. are involved, *Openness* cannot be solved quickly without problems. Every digital firm is using its 'own' EIS that is tailored to its demands. The needed interfaces can be a knock-out criterion.

Target state:

Exactly this issue is one reason for the need of new methods and tools to enhance the co-operation of companies and subcontractors. As quick changes etc. are necessary, those interfaces currently cannot be established easily. An independent open tool is required in order to meet that demand.

4.1.2.4 Data Safety

Large enterprises invest huge efforts into *Data Safety*. Expensive and complex tools are purchased with an effective encryption to protect sensitive data. Every employee is trained to use and apply those tools mandatory.

Unfortunately, SMEs frequently discount this issue because of extra costs and a general lack of knowledge of the consequences. Around 30,000 potential non-professional spies are active in Germany. Especially SMEs of innovative products, like the automotive supply and telecommunication industry are exposed [wal09].

Current state:

SMEs realize the lack of *Data Safety* a lot of times if it is too late. *Hacker*[12] attacks are increasing. In order to save money, SMEs frequently transfer data via unsecured environments or – on the other hand – via mail services, digitally saved on data storage devices (often without encryption), which is very slow and unreliable.

Target state:

Data Safety must be included into any data transfer of the new method that is available on the Internet or on servers. The service should be affordable and the level of encryption selectable, as not every data set is sensitive. This selection is reasonable because encryption takes time and additional passwords for decryption are annoying and not necessary for everything.

On top of that, data backups are necessary to solve issues in case of data loss according to damaged hardware.

[12] Skilled computer programmer who breaks (hacks) a password code or otherwise gains remote access to a protected computer system.

4.1.2.5 Data Access

By 2013, mobile phones will overtake PCs as the most common web access device worldwide. The total number of *PCs*[13] in use will reach 1.78 billion units in 2013. By 2013, the combined installed base of smartphones and browser-equipped enhanced phones will exceed 1.82 billion units and will be greater than the installed base for PCs thereafter [PH10].

Managers and project leaders especially travel around the globe for meetings and conferences. The needed information needs to be available from any location. *Smartphones*[14] with Internet connection provided the wireless access anywhere. Modern laptops have slots for *SIM*[15]-cards, hence wireless Internet access. This facilitates the manager's jobs extremely.

Current state:

Nowadays, mobile *Data Access* is daily business and state of the art but *Data Safety* remains an issue as explained previously. Another problem is that various outdated tools neither offer a mobile version nor mobile access to the required data.

Target state:

A modern tool needs to offer mobile *Data Access* in every dimension. 'Access, edit and manage' information is a basic requirement as well as the *Data Safety*.

[13] Personal Computer

[14] Mobile phone which includes functions similar to those found on personal computers. *Smartphones* provide a one-stop solution for information management, mobile calls, email sending, and Internet access.

[15] Subscriber Identity Module

4.1.2.6 Up-to-dateability

The situation is analog to the described *Mesh of Subcontractors* from Chapter 4.1.1.1 and Figure 4.1. Based on the constituted perceptions *Up-to-dateablity* is as important as a *Simple* tool.

Current state:

A majority of even large enterprises work with spreadsheet software (e.g. *Microsoft Excel*[16] as 'quasi-standard'). As those spreadsheets are not *multitasking*[17]-enabled, every user has to edit the file and store it, e.g. with an index on the filename. This leads to a high error rate in current companies. Usually one user is responsible to combine the edited files again. Complex spreadsheets with hundreds of line and columns, links between the sheets etc. are extremely difficult to manage. Issues, like overwritten cells are not easy to solve and lead to time-intensive corrections.

Target state:

Every involved project member needs to have access to the latest version of all needed files, combined with the previous requirements *Data Safety* and *Data Access*. In the case of various people sharing a single file another solution has to be found to solve this issue.

A shared usage of data, if changes on that certain dataset are required, is hard to handle. Hence, such undertakings should be avoided or removed.

[16] Software developed and manufactured by Microsoft Corporation that allows users to organize, format and calculate data with formulas using a spreadsheet system broken up by rows and columns.

[17] Running two or more programs at the same time on the same single-processor (single CPU) computer. This seemingly simultaneous processing is deceptive because the CPU is actually attending to only one program at any given moment.

Data needs to be stored on a central server, for example. Of course, *Data Safety*, as previously explained, is additionally important in this case, also. The damage of central servers can lead to a collateral damage for the entire project.

4.1.2.7 Responsibilities

That issue is analog to the basic demands in Chapter 4.1.1.5.

4.1.2.8 Task-Allocation

That issue is analog to the basic demands in Chapter 4.1.1.6.

4.1.2.9 Time Management, Time Schedule

Time Schedules involve a high risk potential. If *milestones*[18] in roadmaps are not met, a subprocess can emerge to a tremendous issue of the overall process. Often, project leaders do not communicate the overall *Time Schedules* to all team members. Subcontractors frequently get short-term delivery dates, just several days in advance of the milestone, to avoid time issues. The lack of time leads to careless mistakes often due to the poor project *Time Management*.

Current state:

Buffer management, based on the Theory of Constraints (TOC) by [Gol04] is a main feature in strategic alliances. Figure 4.2 explains the current situation which occurs

[18] A milestone is a scheduled event signifying the completion of a major deliverable or a set of related deliverables. A milestone has zero duration and no effort – there is no work associated with a milestone. It is a flag in the workplan to signify some other work has completed. Usually a milestone is used as a project checkpoint to validate how the project is progressing and revalidate work.

frequently within strategic alliances with different organizational forms in Germany and Czech Republic. Figure 4.3 shows an example of a corresponding time schedule of a sub-process.

Generally, the leading head of the overall project shifts the milestone to the subordinate project leader with a buffer b1. When external knowledge is acquired, the internal milestone to fulfill a certain goal is often shifted to the subcontractor with a specific buffer b2. If an internal team member would have the required knowledge, this buffer would be smaller as there would be no interface within the process steps and the corresponding EIS. Those subcontractors, of course, have hierarchies and organizational forms as described in [MG00a] within their companies also. I.e. the involved team lead shifts the task to the subordinate colleague, again, with a buffer b3. That leads to snowball effects that put the Responsible Actor (RA) under unnecessary pressure. That, on the other hand, leads to mistakes due to a lack of time. Certainly, main contractors do not worry about the externals' internal hierarchy and buffer management. The process needs to be reached within the predefined time frame. Frequently, errors need to be abolished through rectifications that were based on time issues.

Time Management is mostly reserved to the management level. A *Time Schedule* is created with certain milestones for the single project leaders. They created another 'internal' milestone for their team which is usually just several days in advance to ensure the delivery. This procedure is broken down to the subordinate management levels. The worst case is that, for example, a one-week milestone is a one-day job for the last subcontractor, as the superordinate levels need several steps within the process to edit the results.

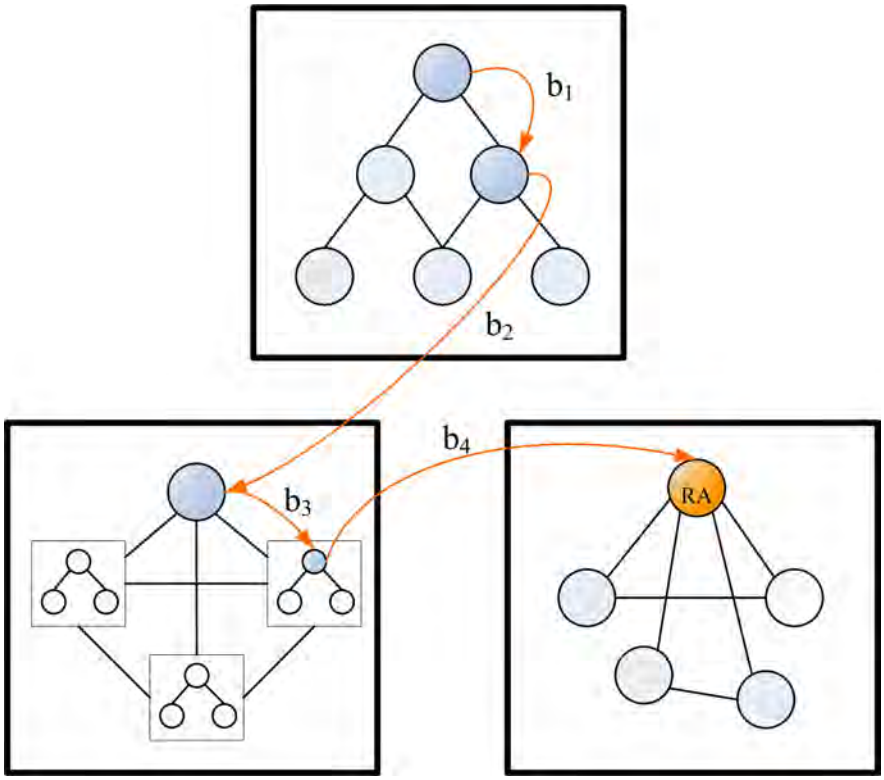

Figure 4.2: Management of Responsibilities in a Mesh of Subcontractors [BE11]

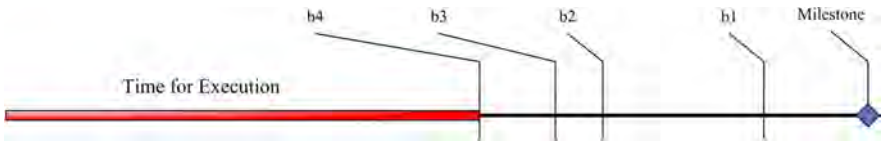

Figure 4.3: Time Schedule without Decision-Making [BE11]

Target state:

The importance that business processes of different organizations are correspondingly required to be integrated seamlessly to adapt to the continuously changing market. Combined with the opaqueness in a *Mesh of Subcontractors* an overall management of responsibilities as described in Chapter 4.1.1.5 to reduce buffers in order to save time seems to be hard to accomplish. Decision-Making algorithms help to support the overall process on a software basis as described in [BE11].

The involved project members are highlighted and need to be obvious for the entire alliance at any time, as shown in Figure 4.4. If a new task needs to be completed, a poll can be done by the leading head. Every involved team member acts as input in the multi-layer perceptron network. Depending on the level, the company, or the expertise of the single person, a specific factor can be weighted. After the calculation in the hidden layer(s), the tool shifts the task directly to the RA.

This team member is now directly responsible for the execution and completion of this milestone and has just buffer b1, hence more time to execute the task as shown in Figure 4.5.

The hierarchy is modularly adjusted. It is important to shift the responsibility, not just the single task, to the RA. The sub-tasks can be delegated to other colleagues, of course. Due to the advantage in time, those issues are scaled-down to a minimum.

The *Time Schedule* needs to be obvious for the entire team any time. This requirement leads to the possibility for a proper *Time Management*. Some milestones can be accomplished in shorter time. Those circumstances are generally not incorporated in the overall *Time Schedule* in Germany and Czech Republic, as the single steps are predefined at management level. I.e. if time remains, the team can work more accurate and 'slowly' and vice versa if the timeframe is to difficile.

A flexible *Time Schedule* that can be affected by any project member leads to a *Time Management* that reflects the entire process. Of course, if more time is needed, the Traffic Light Principle could be applied again to offer a perfect overview for the management level.

The new approach cannot avoid general errors, but should overcome opaqueness in a *Mesh of Subcontractors*. Hence, the executing expert for specific tasks and sub-tasks should be directly identified in order to avoid extra buffers, therefore provide more time.

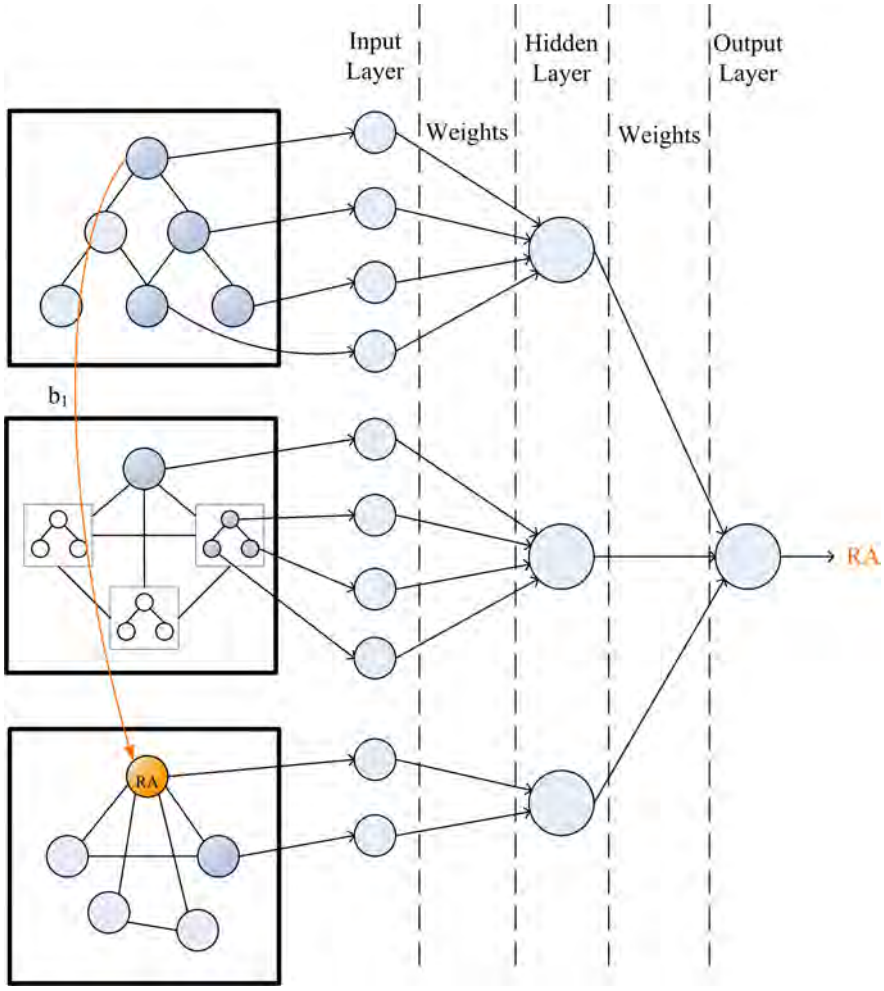

Figure 4.4: Management of Responsibilities in a Mesh of Subcontractors with Decision-Making [BE11]

Figure 4.5: Time Schedule with Decision-Making [BE11]

4.2 Basic Framework

The extended demand *Openness* (see Chapter 4.1.2.3) is one key requirement for the *Basic Framework*.

On top of that, a variety of operating systems (OS) are used in modern companies. This is highly dependent on the produced products. Frequently different OS are used, for example one in management to run text processing tools, another in production to control machines and assembly lines and a third one in *R&D*[19] for certain specialized tools.

For that reason, a solution has to be found that is compatible to all operating systems and *open* to other Enterprise Information Systems, as cost-intensive adjustments and interfaces are not possible in short-term subcontracting partnerships.

4.3 Summary

As evaluated in Chapter 4.1.1, there are a variety of demands even though existing perceptions of former research results exist. Still, digital firms in Germany and Czech Republic with a complex *Mesh of Subcontractors* struggle with a variety of issues and difficulties due to a lack of software solutions.

Chapter 4.1.2 provided the demands, due to the existing perceptions of former research results, applied on current issues. Still, a majority of tools cannot fulfill basic requirements for the exchange of information and involvement of subcontractors as frequently needed for the execution of proper processes.

Of course, various gadgets and tools provide niche products for single demands or overall solutions with a high level of customization needed. An all-encompassing

[19]Research And Development

tool that fulfills the demands of difficile responsibilities and connectivity is not yet available.

Figure 4.6 shows the summary of the new approach applied on the 4 key issues.

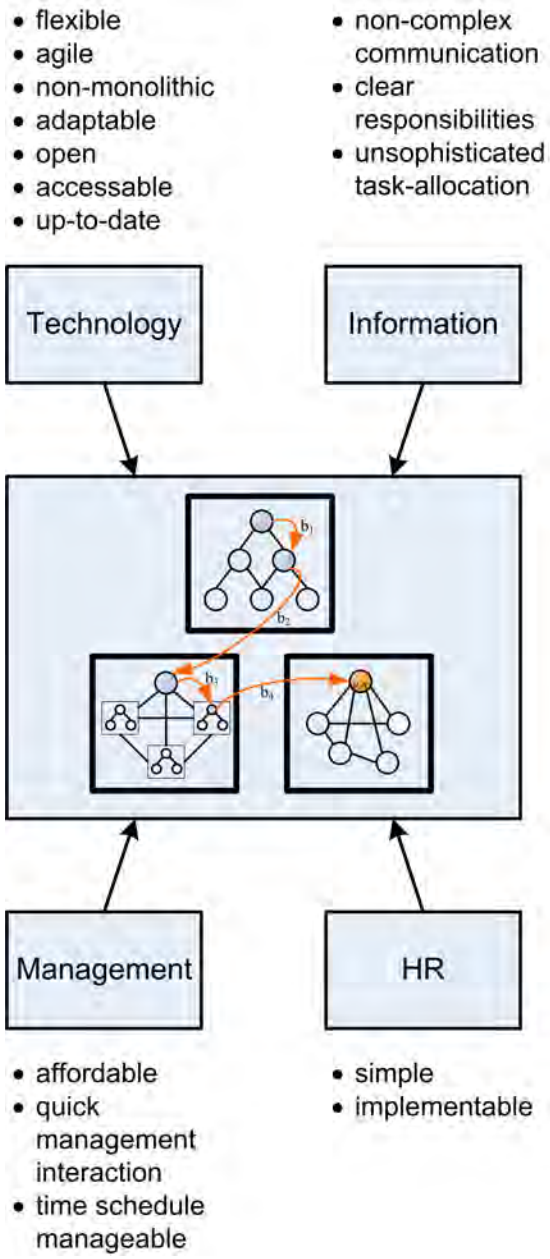

Figure 4.6: New Approach on 4 Issues of a Mesh of Subcontractors

Chapter 5

Proposal for Solution

Chapter 4 showed the prerequisites for new tools based on scientific research. The goal of this Chapter is to present the Proposal for Solution. The following Chapter 6 shows the new method in detail. Chapter 7 proofs the new method by a Case Study which finalizes the statements by showing the possible, non-possible conditions, risks and compares the method against web-based solutions.

5.1 Comprehensive Summaries

The following Chapters show comprehensive summaries that lead to the proposal for solution.

5.1.1 Comprehensive Summary of Key Facts

As elaborated in Chapter 3 and 4 a very complex situation has to be faced by a solution which can be easily applied within a very short period of time.

The necessity for shot-term interactions and collaborations within a *Mesh of Subcontractors* combined with a multitude of Enterprise Information Systems within the participating companies and the lack of financial resources for new overall tools leads to a need for a solution which is easy-to-apply.

The lack of time and the high amount of time-buffers turned out to be the biggest issue of the spoken short-term commitments in nowadays alliances.

5.1.2 Comprehensive Summary of Essential Demands

Due to the lack of time to set up a new system without to change the habits of the specific company-internal tools it pointed out to be essential to enhance the initial idea of a web-based solution. Chapter 6.2 explains that fact more specificly.

5.2 Proposal for Solution

Already in 2001 Michael Hammer showed up the necessity for a new way of cross-company interaction in his contribution *The Superefficient Company* [Ham01]. So did a lot of other collegues by linking processes together by the support of internet interfaces to reduce long adjustments.

In collaboration with Dietmar Nedbal from the Upper Austria University of Applied Sciences Steyr, such a web-based solution was proofed successful, but failed on short-term commitments as adjustments and interfaces have to be assimilated. Hence, a non-software-based method appeared to be the best solution.

In oder to find the new contribution on this cross-company issue, the existing solutions were analyzed. Existing tools properly provide internet-based possibilities to support strategic alliances. Existing solutions focus on long-term commitments. In this specific case, a short-term alliance has to be supported in order to gain an advantage on the

market. Those steps are shown in the following Figure 5.1.

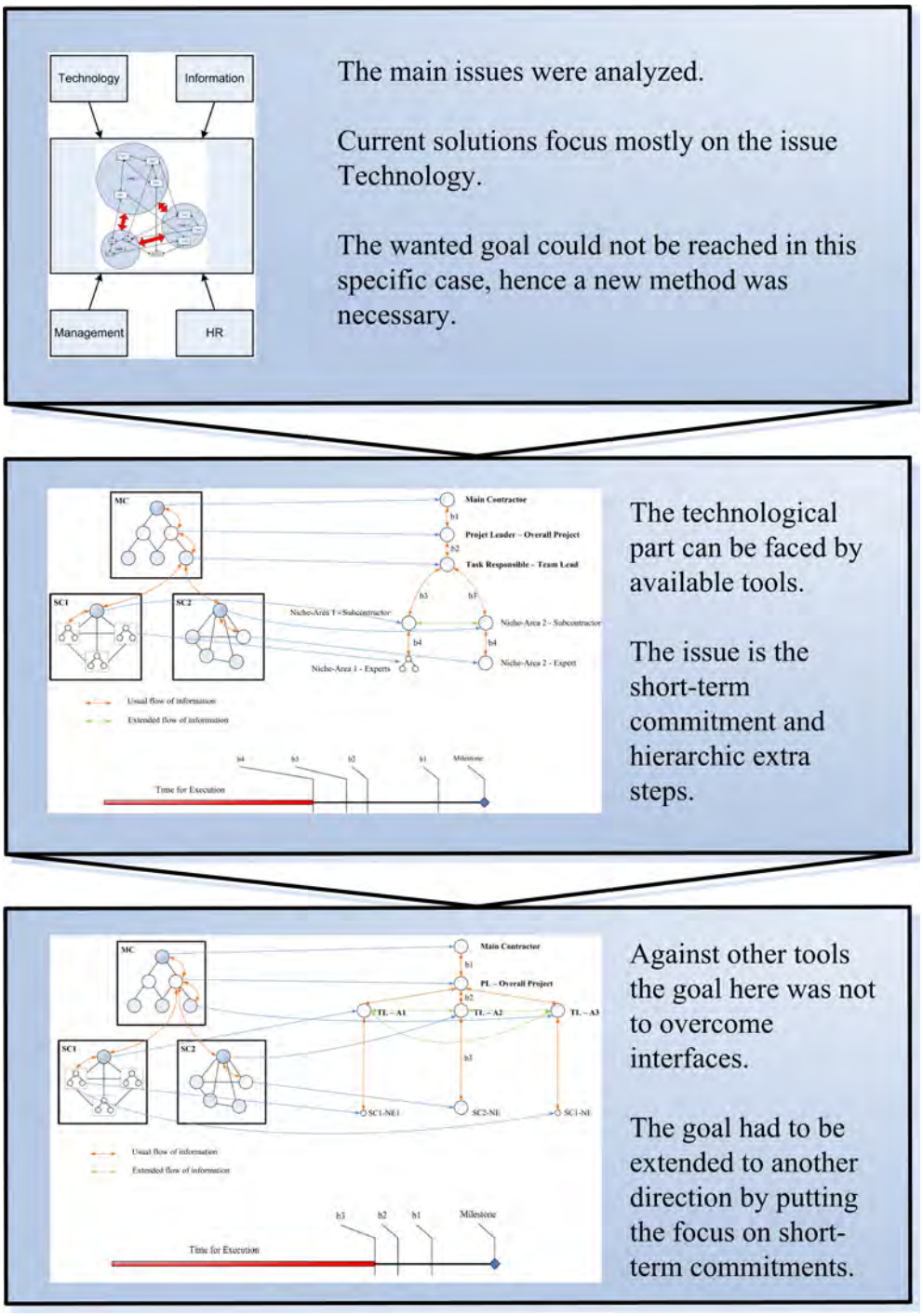

Figure 5.1: Proposal for Solution

Chapter 6.3 explains this approach, followed by a Case Study in Chapter 7.

It seemed to be necessary to set up a possibility for very short-term issues and interactions without big efforts and adjustments.

A method needs to be developed to support that alliances. Existing tools can be established during the project execution to take advance of them and to avoid previously mentioned long-term issues. The new method needs to be an initial aid for starting projects with a very strict time-schedule.

Chapter 6

Matrix-Method to Enhance the Co-Operation between Digital Firms and Subcontractors

Chapter 4 showed the prerequisites for new tools based on scientific research, followed by Chapter 5 with the proposal for solution. The goal of this Chapter is to present the output of the research, finalized in a theoretic method by the help of a matrix that shows the niche experts of every needed task. The new method is presented by a sample project. A Case Study finalizes the outcome of the method in Chapter 7.

6.1 Introduction

Due to the complexity and multitude of factors that lead to issues on short-term commitments within a *Mesh of Subcontractors*, the following situation was focused as a sample for the new method.

6.1.1 Initial Situation

The focus is on a strategic network of three companies. One small company is the main contractor (MC) that needs to fulfill a development of a new product within a certain amount of time.

Due to the complexity of the task, the need for external expertise is necessary. Two more companies (SC1 and SC2) are acquired to support the overall process. Every company has a different organisational form (compare Figure 2.10). The main contractor has a strict hierarchy, subcontractor 1 has a strategic network within the company and subcontractor 2 is organized as a modular firm.

Figure 6.1 shows the initial situation of the spoken *Mesh of Subcontractors*.

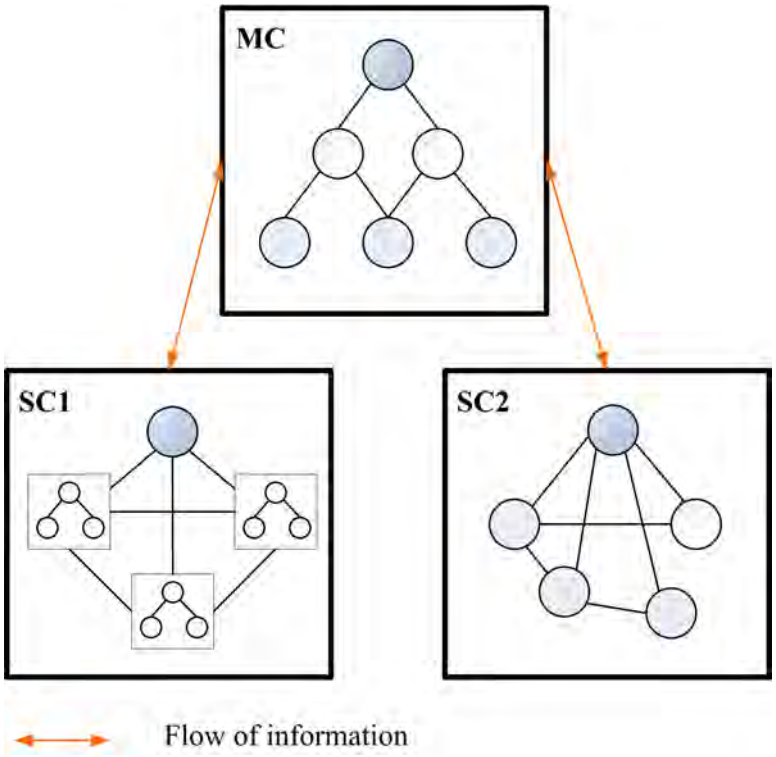

Figure 6.1: Initial Situation

6.1.2 Main Issues that hamper Success

As described in Chapter 3.2, there are four main issues in such networks. Those issues were analyzed and summarized in Chapter 4.3, Figure 4.6.

During case studies with various companies, the key issue *Information* pointed out to be the biggest problem, especially in short-term commitments.

6.1.3 Issue Main Contractor

Figure 6.2 shows the quasi-ideal situation within the company of the main contractor. As we can see, the exchange of information is usually restricted from one level of the hierarchy to another. The green arrows show information flows which are not frequently applied.

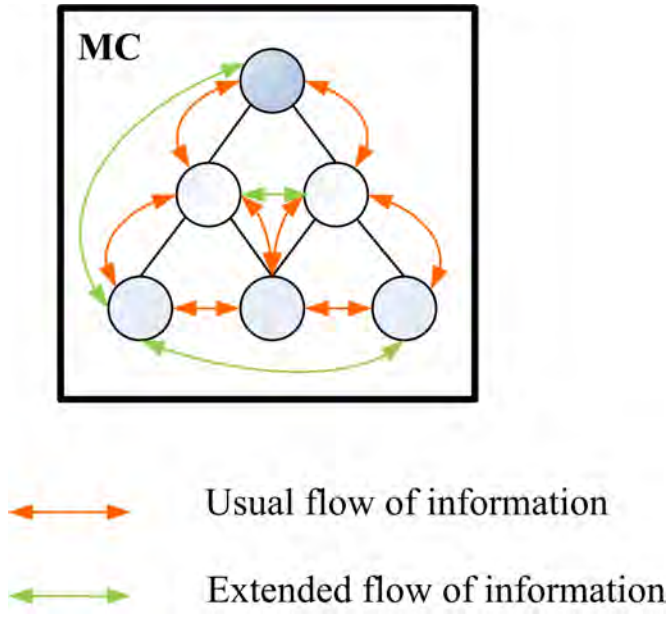

Figure 6.2: Initial Situation of Main Contractor

The issue here is that an employee from the lower level often struggles in exchanging information to a higher level or another department. Further more, team leaders and

personnel from management level do not have the needed time or insight to talk to their staff.

Another problem is that usually a team lead is responsible for the overall project. I.e., also for coordinating the involved subcontractors. All the information and responsibility mostly cannot be handled easily, especially when complex tasks have to be fulfilled. Further more, team leads frequently are responsible for more than one project, of course.

The task allocation is very simple-structured, as the upper levels shift it to the lower levels. Due to the high amount of information involved, that can lead to delays which have to be covered by lower levels.

6.1.4 Issue Subcontractor 1

Figure 6.3 shows the quasi-ideal situation within the company of SC1. The situation is close to the main contractors'. The difference is that there are departments with an own hierarchic structure. That situation slows down the overall process tremendously, as extra buffers are added to gain security for adjustments and control.

The additional issue here is that an extra border for information exchange is created by the departmental structure. Frequently, departments do not exchange their needed information as often as needed. It can take days and weeks until necessary data is shifted from one to another department.

Another problem is that usually a departmental lead is responsible for the overall project. I.e., also for coordinating the involved subcontractors. All the information and responsibility mostly cannot be handled easily, especially when complex tasks have to be fulfilled.

The task allocation is structured like the main contractors top-down. The departmental structure adds extra buffers to the system as the allocation can take days at every level.

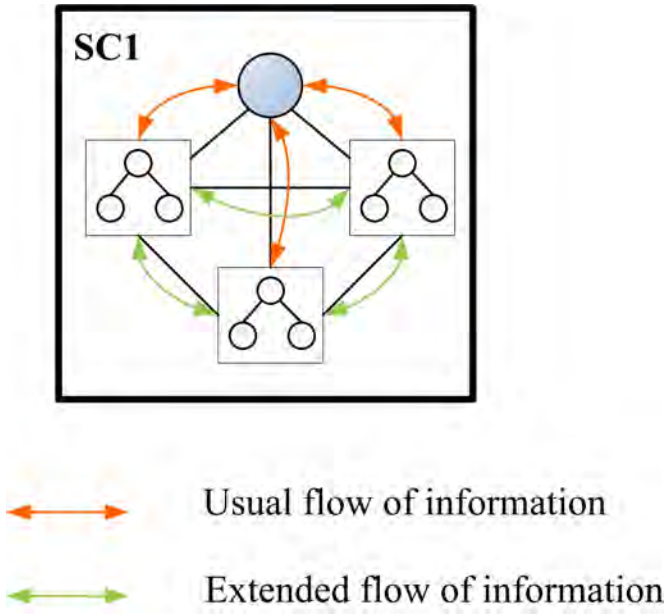

Figure 6.3: Initial Situation of Subcontractor 1

I.e. a quick reaction is very sophisticated.

6.1.5 Issue Subcontractor 2

Figure 6.4 shows the quasi-ideal situation within the company of the next subcontractor SC2. The situation is very different to the other strategic partners. The modular structure is very flexible and has almost no buffers as almost every involved employee exchanges information frequently.

The main advantage is that those companies can act and react just-in-time due to flat hierarchical structures. Usually the interaction is on cordial terms. That decreases the fear of contacting team leads and management levels. The flow of information is executed directly.

One problem is that generally the project lead is responsible for the overall project and the tasks are not always strictly shifted to niche experts. The amount of information for the leading staff is hard to handle. Furthermore the required exchange of information

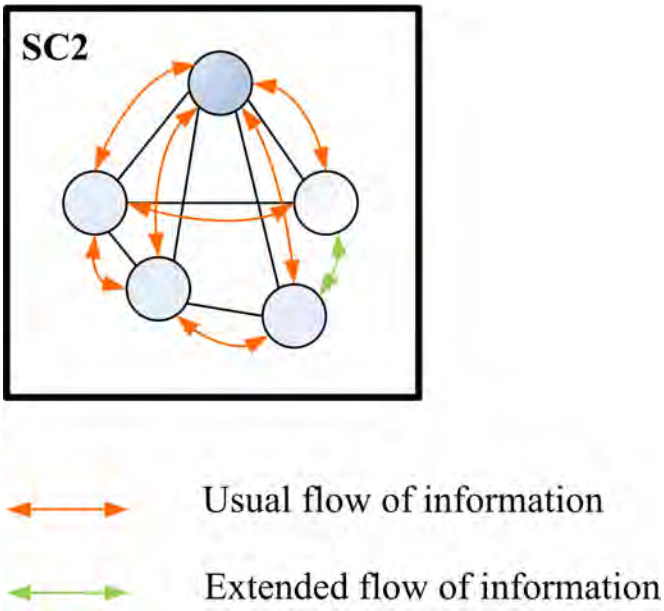

Figure 6.4: Initial Situation of Subcontractor 2

with the main contractor slow downs the process.

The task allocation is directly structured. Usually no extra buffers are necessary as the niche experts are directly responsible under the project lead. Even here, leading personnel shifts tasks to subordinates due to the overwhelming amount of work. That can lead to unnecessary extra buffers.

6.2 Starting Point

Due to the lack of time it seemed to be necessary to draw up a possibility to support such alliances by the help of a very simple and easy-to-apply solution.

Complex developments of tools did not seem to solve the issue as quickly as needed. The analysis of a web-based solution in co-operation with Dietmar Nedbal [BN12] as shown in Figure 6.5 was not useful for the needed fast solution.

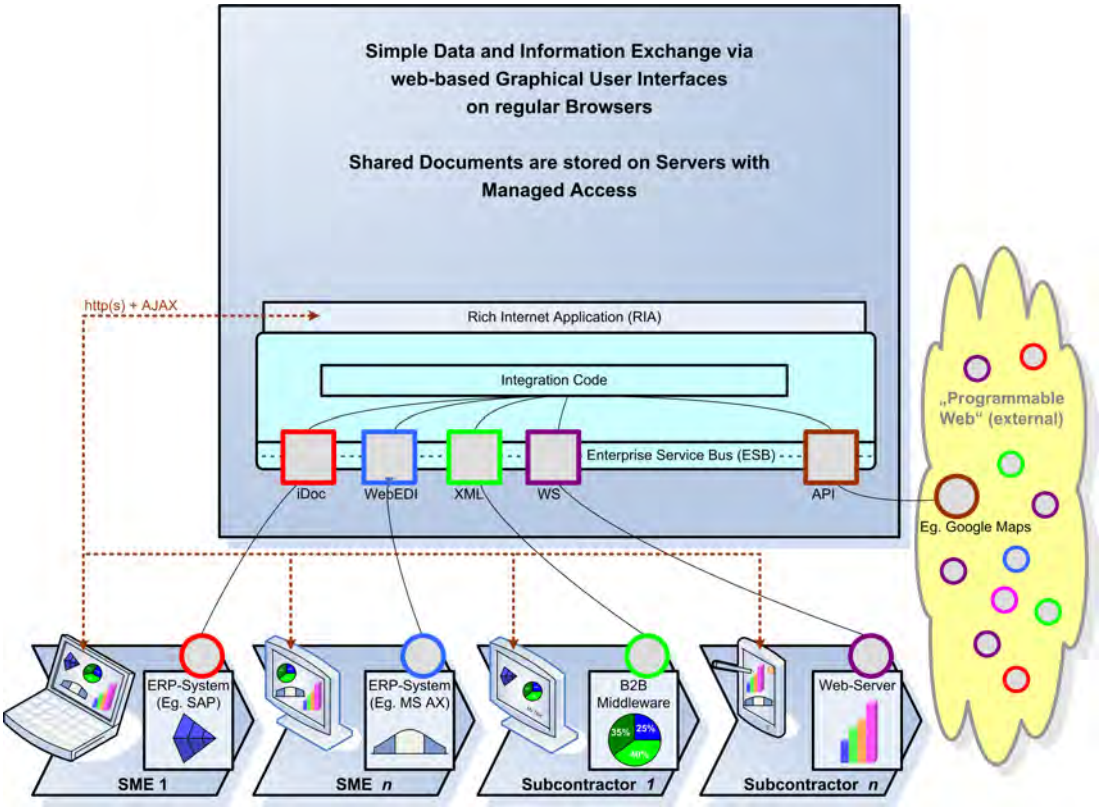

Figure 6.5: Software-Architecture for web-based solution [BN12]

The output of that research was very satisfying but not easy to implement. Hence, for that specific case of short-term commitments not useful.

For that reason, the flow of information had to be analyzed (Chapter 6.2.1), the main issues faced (Chapter 6.2.2) and – as a next step – transmitted into a new methodology to solve that issue (Chapter 6.3).

6.2.1 Flow of Information

After facing the previous mentioned situations within the companies the next step is to analyze the overall flow of information within the *Mesh of Subcontractors*. For that

reason one task was chosen to visualize the issue in general as shown in Figure 6.6.

Here, the MC is contracted to develop a new product, for example. The Project Leader (PL) is responsible for the overall execution of the end product within a certain amount of time. Buffer b1 is added.

As a next step, the Team Lead (TL) is assigned to be the Task Responsible. Buffer b2 is added.

The TL realizes the need for external experts and talks to the PL to assign SC1 and SC2 for niche areas. The PL handles the contracts with the *CEO*[1]s of the subcontractors. Of course, that takes a certain amount of time to negotiate. Due to necessary adjustments to the internal Enterprise Information System, etc. buffer b3 is required.

Finally, the TL is responsible again and tasks are shifted within the SCs similarly to the previously mentioned processes within the MC. Buffer b4 is added even before the initial task is at the executing experts' desk.

It is easy to recognize that – if more tasks have to be fulfilled for the final product – the amount of relationships can be very confusing and unclear. Hence, additional time buffers are added to obtain security even if a loss in quality is created due to the missing time for details.

[1]Chief Executive Officer

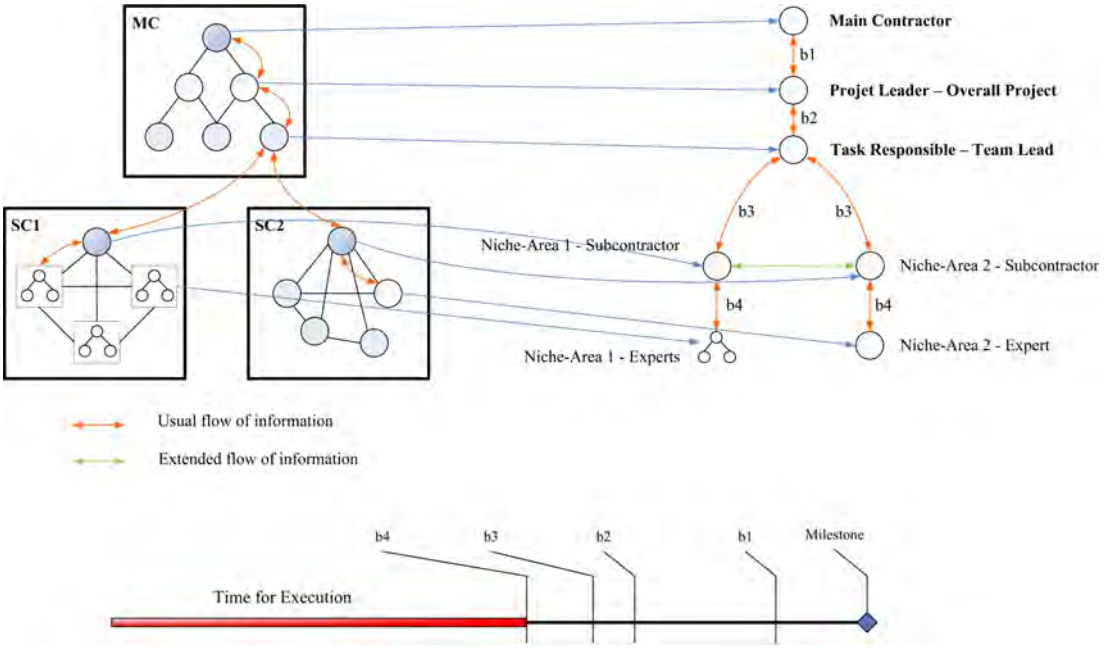

Figure 6.6: Flow of Information in Initial Situation

6.2.2 Facing Main Issues

The following list from Chapter 4.3 is now extended according to the acquired results from the previous chapters.

- *non-complex communication*

  Every company has its own e-mail system, like Microsoft Outlook, etc. Mostly contacts and calendars are managed through those tools also. As SMEs have various on-going projects simultaneously it makes no sense to replace those tools by another overall management solution. If every contractor uses a different tool for communication issues are bound to occur.

  For that reason, the goal was to include the used way of communication into the new method. If an extra step, for example to save communications or to spread

new information is necessary, soon people will start to avoid the tool and use it thriftily.

The main step is to overcome management levels. Especially European companies struggle with that obstacle. Frequently, the leading staff cannot realize issues as the subordinate employees are afraid of reporting those problems. Skipping a team lead within the hierarchy and directly talking to the managers frequently is a no-go.

Finally, the communication needs to stay simple. An extra tool for exchanging short-term information cannot be applied.

- *clear responsibilities*
  Currently, one project leader from the main contractor is responsible for the overall task. The coordination is segmented into sub-tasks that have to be accomplished. As a next step sub-tasks are shifted top-down. Buffers are added and the snowball-effect as previously described starts.

- *unsophisticated task-allocation*
  The task-allocation is basically faced directly. If a specific task has to be achieved, the overall task is shifted top-down to the next level. They shift it again to the next level or subcontractor and so on. Worst-case scenarios show that sometimes more than three team leads are involved for a single task.

6.3 Matrix-Method

Chapter 6.2 showed the starting point of the thesis. One part of the new Matrix-Method was already presented at MOPP2011 [BB11b]. New perceptions lead to an extension for the new method. Chapter 6.3.1 shows the required Matrix–Analysis as a first step. Then, Chapter 6.3.2 shows the time frame for the new hierarchies and responsibilities.

Chapter 6.3.3 finalizes the method by explaining the working environment. Chapter 6.3.4 summarizes the findings.

6.3.1 Matrix–Analysis

First, as shown in Figure 6.7 a Matrix Analysis is drawn up by the entire team to find the needed experts and possible connections for exchange. The needed areas as parts of the overall project are defined and every involved team member is weightened by a number within 1 (no experience) and 10 (expert).

That may also help for information exchange in general. Confusing hierarchies can be simplified by that approach.

Project: **Development of Product xyz**
Delivery-Date: **01.08.2012**

				SC1				SC2			
Experience: 1…10	MC	PL	TL	PL	TL	NE1	NE2	PL	TL	NE1	NE2
Area 1:	3	4	3	3	6	8	5	2	3	3	2
Area 2:	4	4	6	4	2	3	1	7	7	10	9
Area 3:	3	3	7	6	7	9	10	5	7	4	2
…											
Area n:											

MC: Main Contractor
PL: Project Leader
TL: Team Lead - Task Responsible
SC1: Subcontractor 1
SC1-PL: Subcontractor 1 - Project Leader
SC1-TL: Subcontractor 1 - Team Lead
SC1-NE1: Subcontractor 1 - Niche Expert 1
SC2: dto.

Figure 6.7: Matrix Analysis of Mesh of Subcontractors

That sample matrix highlights the experts for the Areas 1 – 3. An Area can be equated as sub-task. As a next step it is important to assign the Areas to the associated Team

Leads (TL) with the best experience, as shown in Figure 6.8.

One very important fact is that companies' boundaries do not influence the relations between the new hierarchy for the certain Area.

Project: **Development of Product xyz**
Delivery-Date: **01.08.2012**

				SC1				SC2			
Experience: 1…10	MC	PL	TL	PL	TL	NE1	NE2	PL	TL	NE1	NE2
Area 1:	3	4	3	3	6	8	5	2	3	3	2
Area 2:	4	4	6	4	2	3	1	7	7	10	9
Area 3:	3	3	7	6	7	9	10	5	7	4	2
…											
Area n:											

MC: Main Contractor
PL: Project Leader
TL: Team Lead - Task Responsible
SC1: Subcontractor 1
SC1-PL: Subcontractor 1 - Project Leader
SC1-TL: Subcontractor 1 - Team Lead
SC1-NE1: Subcontractor 1 - Niche Expert 1
SC2: dto.

Figure 6.8: Matrix Analysis of Mesh of Subcontractors – Election of Team Leads

A new project-related hierarchy is created as shown in Figure 6.9. The main difference to Figure 6.6 is that the conventional, rigid hierarchy is exchanged through a flexible, company-overlapping project-related hierarchy. Time-buffers b3 and b4 are joined together, i.e. one level of hierarchy is completely deleted.

The three self-sustaining companies join together and create a *new* alliance within the *Mesh of Subcontractors*.

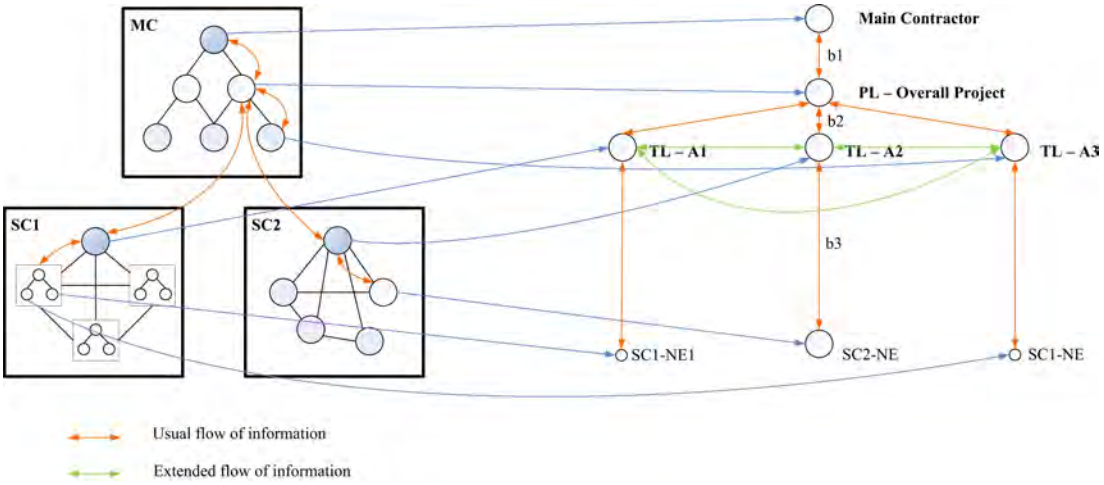

Figure 6.9: New project-related hierarchy within Mesh of Subcontractors

6.3.2 Matrix–Timeframe

By analyzing Figure 6.9 and Figure 6.6 it is easy to recognize that one buffer can be skipped at all. On top of that it is proofed that the other buffers can be minimized as the team gets to know each other better and starts to contact team members from the alliance in order to obtain information more frequently. The level of trust raises and the restraint against information exchange decreases.

A new timeframe can be generated as depicted in Figure 6.10.

Figure 6.10: New project-related overall timeframe

The team members need to get used to this new situation and therefore the overall process can be accelerated if teams join together more frequently for diverse projects, of course.

6.3.3 Work Environment based on Coworking Situations

The importance of information flows and the organizational structure is gaining importance in the information society. *Coworking*[2] models get more important and SMEs can learn from that trend towards information exchange an working environments [MBB12].

The mentioned working environment working with *RIAs*[3] (compare Chapter 6.2) can just be applied in complex systems on long-term [BN12].

Frequently, coworking environments share data by web-based tools like *Google Docs*[4], *Dropbox*[5] or other common *filesharing*[6] tools.

Data security and data protection is an important fact which has to be considered individually. Secure file servers can be supported by *VPNs*[7]. A key of naming the files should be used by every team member in order to avoid outdated information.

---

[2]Coworking is a style of work which involves a shared working environment, sometimes an office, yet independent activity. Unlike in a typical office environment, those coworking are usually not employed by the same organization. Typically it is attractive to work-at-home professionals, independent contractors, or people who travel frequently who end up working in relative isolation. Coworking is the social gathering of a group of people, who are still working independently, but who share values, and who are interested in the synergy that can happen from working with talented people in the same space.

[3]Rich Internet Application

[4]Free, web-based office suite and data storage service offered by Google. It allows users to create and edit documents online while collaborating in real-time with other users.

[5]Web-based file hosting service operated by Dropbox, Inc. that uses networked storage to enable users to store and share files and folders with others across the Internet using file synchronization.

[6]Process of direct or indirect data sharing on a computer network with various levels of access privilege.

[7]A private network that is configured within a public network (a carrier's network or the Internet) in order to take advantage of the economies of scale and management facilities of large networks. VPNs are widely used by enterprises to create wide area networks (WANs) that span large geographic areas, to provide site-to-site connections to branch offices and to allow mobile users to dial up their company LANs.

6.3.4 Summary

After the management-level, project leaders, and team members get used to the new hierarchies and cross-spanning network, everybody con benefit both occupationally and personally from this new method.

Teams are working closer together, the exchange of information increases and, nevertheless, goals can be reached more quickly.

If the initial situation in Figure 6.6 before, and the new project-related situation in Figure 6.9 is analyzed by the *Transaction Cost Theory*[8], an advantage in time, hence money can be determined.

In this case, time is the crucial factor of the overall success. For this reason each buffer can be set to a certain expenditure of time, e.g. b1 = 5, b2 = 10, b3 = 30, and b4 = 60 minutes. That would lead to an advantage in time of 42,2% in Task 1 and 9,5% in Task 2. As a lot of soft factors, like the willingness and trust in each other is highly important in such new situations, it is very hard to calculate practical percentages that can be applied for each case strictly.

[8]TCT; A theory accounting for the actual cost of outsourcing production of products or services including transaction costs, contracting costs, coordination costs, and search costs. The inclusion of all costs are considered when making a decision and not just the market prices.

Chapter 7

Case Study

Chapter 6 showed the new *Matrix-Method* to solve the issues from a *Mesh of Subcontractors*. The new method was tested within a real project to proof its functionality. Chapter 7.1 presents the Case Study which was divided into two parts – the first part as a classic way of subcontracting and the second part with the new *Matrix Method*. Chapter 7.2 summarizes the Case Study. Possible and non-possible conditions, risks, and comparison against other solutions are constituted.

7.1 Case Description

In December 2011 a SME with 28 employees had the goal to design an engineering system with the need for specialized experts in electrical, mechanical and supply engineering. The deadline for the delivery was set to May 14th 2012. The SME has a hierarchical organizational form and no specific EIS. This company acts as the *Main Contractor* (MC).

As the SME was not able to reach the goal without external support, a small company

was acquired to support with expertise in electrical engineering. This company has 7 employees and a modular organizational form and *RIB Office* as EIS. This company acts as *Subcontractor 1* (SC1).

SC1 recommended a Freelancer for the supply engineering part of the overall project. After all, the MC contracted the Freelancer (SC2) after 2 more weeks. SC2 had no EIS in use.

By end of January the *Mesh of Subcontractors* was set up. The geographical distance between all companies was about 300 kilometers each. Hence, frequent meetings were not possible.

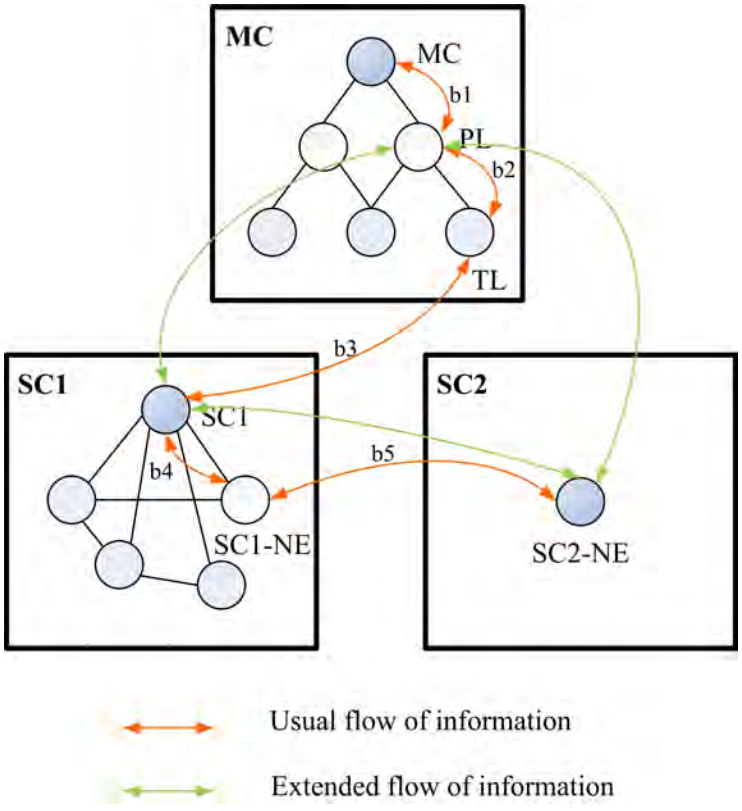

Figure 7.1: Mesh of Subcontractors within Case Study Situation

7.1.1 First Part – Classic Way

As the MC did not know the new business partners, the level of control was very high. The exchange of data was done by email transfer via MS Outlook.

Basically, the chain of buffers was
MC – PL – TL – SC1 – SC1-NE – SC2-NE
as shown in Figure 7.2.

Every steps contained a time-buffer. It turned out to be the wrong way to handle the tasks. The flow of information was basically top-down or bottom-up. The first milestones were delayed or fulfilled just-in-time and a few times with a delay of 10-30%.

7.1.2 Second Part – Change to Matrix-Method

At the end of March, the Matrix Analysis was executed and a simple *Dropbox* data exchange set up to face outdated information issues.

The Niche Experts (TL, SC1-NE, SC2-NE) were directly assigned to PL. Every expert got the same buffer, hence buffers 3, 4, and 5 were abolished.

7.1.3 Outcome

It clearly pointed out to work properly. The PL had a higher workload to execute due to the increase in coordination and information control between the participating new team members. SC1 had less work, but was in frequent contact for information exchange with the PL. The Niche Experts reported a more accurate level of details. All milestones were met in advance of the set milestones.

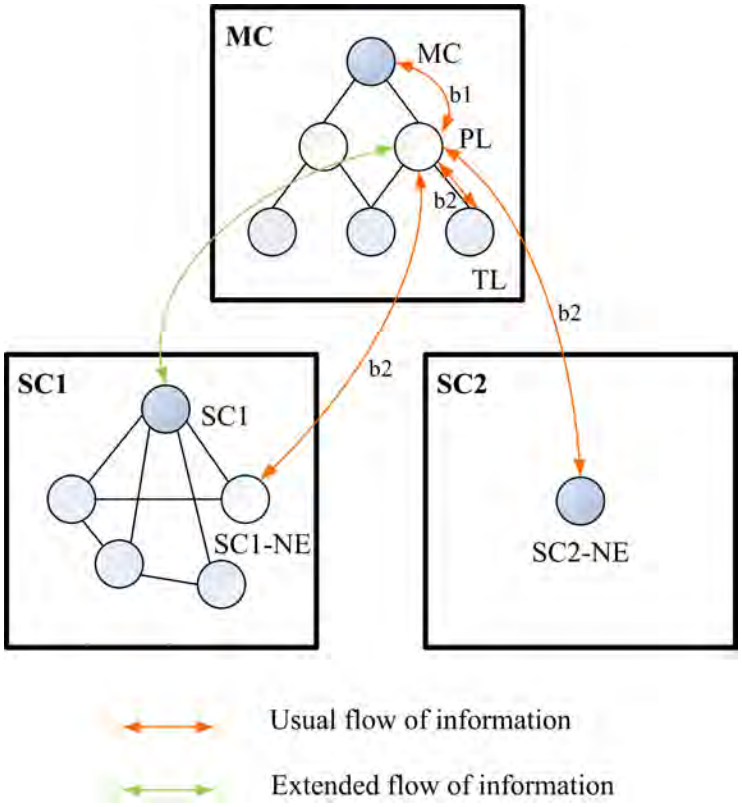

Figure 7.2: Mesh of Subcontractors within Case Study Situation after *Matrix Method*

7.2 Results

As a final result it can be determined that the *Matrix Method* worked very well under the mentioned conditions.

7.2.1 Possible Conditions

As proofed in the Case Study, the new *Matrix Method* works properly under the following conditions:

If all partners of the *Mesh of Subcontractors*...

- do not have too sophisticated EIS and are ready to exchange data with external

partners (maybe off the regular quality management).

- have an open hierarchical organizational form where the hierarchies are flat and/or modular.
- trust each other and are open-minded to work for non-internal supervisors.

7.2.2 Non-Possible Conditions

Other cases where the goal was to apply the new method did not work or may not work under the following conditions:

If a company of the *Mesh of Subcontractors*...

- has a sophisticated, proprietary EIS, were every task is pre-defined, the willingness to join such ways of information and data exchange is very low.
- has a very stiff hierarchical organizational form, employees tend not to be flexible enough to join an overall team and work for another supervisor than the company-internal.
- has a fear of exchanging data and show externals how internal processes are executed, overall teams are not possible to establish.

7.2.3 Risks

The main risk that appeared was inaccurate data. This issue was faced by the *Dropbox* solution. Other available tools specialize on those risks by providing professional solutions. In this case that was not necessary and the chosen simple way to face the issue was sufficient for the short-term commitment and milestone.

Another risk is that employees stuck on previous company-internal hierarchies, even after the new team is set up. Supervisors which are not anymore responsible for their staff – still they can be supervisors for other, parallel projects – have to focus on that risk and push their employees to ask and consult their new overall project lead.

7.2.4 Comparison against Web-Based Solutions

The advantages against a previously tested web-based solution as shown in Figure 6.5 were among other things:

- almost no costs (just the workload to set up the new hierarchies and teams)
- easy to set up within a very short period of time
- no software adjustments
- no interfaces
- no implementation costs

The disadvantages against a previously tested web-based solution as shown in Figure 6.5 were among other things:

- risk of inaccurate data
- data access can be non-secure without professional additional tool

Chapter 8

Completion of Objectives and Future Prospects

Chapter 8.1 contains the *Completion of Objectives* followed by *Future Prospects* in Chapter 8.2.

8.1 Completion of Objectives

All objectives of chapter 1.2 have been reached. The following register shows all objectives combined with the appropriate chapters in which they have been fulfilled.

The goal of this Dissertation was, to

1. provide an explanation of the used expressions (Chapter 2.1) and
2. explain the current challenges and issues of companies (Chapters 2.2 – 2.4),
3. show existing solutions and their problems in Germany and Czech Republic (Chapter 3),

4. show the prerequisites for new tools based on scientific research (Chapter 4)
5. explain the new proposal for solution (Chapter 5)
6. link the previous items with each other (Chapter 6) in a new theoretical method to solve the mentioned issues and
7. proof the concept by a case study (Chapter 7) and
8. complete those steps for defending this doctoral thesis (Chapter 7.2).

All tasks have been completed and evaluated in detail. Conclusions have been developed by analyzing current issues, basic requirements and research results.

8.2 Future Prospects

The results of the Dissertation, based on former perceptions combined with the latest research results and the current state of the art of software solutions in current German and Czech digital firms solved buffer issues in short-term strategic alliances.

During the research and case studies it pointed out to be necessary to make self-sustaining companies join together and create a *new* alliance within the Mesh of Subcontractors. New software-based tools were not necessary as the relationships are too short-term to set them up and handle the necessary adjustments.

Conventional, rigid hierarchies were exchanged through a flexible, company-overlapping project-related network. Time-buffers were joined together, i.e. one or more levels of hierarchy were completely deleted. Thus, a benefit in time and quality was created.

As shown in Figure 5.1 there are alrealy a multitude of solutions on the market that ease cross-company processes on a strategic long-term basis which are not useful for that

specific case. That approach hat to be modified to the needed short-term commitments for this specific cases. As we have seen, trust is one of the key factors. If an alliance of small and medium companies have to interact together to gain an advantage against competitors the quality of the end results can be increased significantly by reducing hierarchies and applying little gadgets that are free of interfaces and (mostl) free of costs. A measurable adantage in time, hence a faster time-to-market or an incrased quality can be reached, which was proofen in the case study.

Future studies can be executed by setting the focus on the non-possible conditions from Chapter 7.2.2. The willingness has to be overcome, trust has to be established. Future research can search for extensions for bigger companies that have an proprietary EIS in use.

Bibliography

[ABC92] Andersson, Blenker, and Christensen. *Industriens brug af underleverandører*. Industri- og Handelssryrelsen, 1992.

[AC98] Andersson and Christensen. *Den globale udfordring – Danske underleverandorers internationalisering*. Eksportfremmeradet, 1998.

[AH00] Al-Hammad. *Common Interface Problems among Various Construction Parties*. Journal of Performance of Constructed Facilities, volume 14, issue 2, pages 71-74 edition, 2000.

[ALM95] Adelsberger, Lazansky, and Marik. *Information Management in Computer Integrated Manufacturing*. Springer, 1995.

[Ans10] Answers.com. *Describe the qualities of a digital firm?* Answers.com, 2010. wiki.answers.com/Q/Describe_the_qualities_of_a_digital_firm.

[Bax10] Baxter. *Key Issues in ERP System Implementation*. University of St. Andrews, 2010. www.st-andrews.ac.uk.

[BB10] Burnickl and Basl. *Enterprise Information Systems – The Management of Data, Information and Responsibilities in European SMEs*. University of West Bohemia, Pilsen, 2010.

[BB11a] Burnickl and Basl. *Enhancing Data Exchange and Management Supervision in a complex Mesh of Subcontractors – A theoretic Approach*

to counter Interface Issues in Micro-, Small-, and Medium-Sized Enterprises. not published yet, 2011.

[BB11b] Burnickl and Basl. *SME-Issue in Optimizing Time Buffers in a Mesh of Subcontractors*. MOPP 2011, Modelling and Optimization of Business Processes, 2011.

[BE10] Burnickl and Edl. *A Strategic Approach for Successful Sustainable European Products concerning the Support of Information during the whole Product Lifecycle*. University of West Bohemia, Pilsen, 2010.

[BE11] Burnickl and Edl. *Decision-Making as a Key Feature in Overall Responsibility Management within a Mesh of Subcontractors*. not published yet, 2011.

[Ber97] Berry. *SME Competitiveness: The Power of Networking and Subcontracting*. American Development Bank, Washington, D.C., 1997.

[BN12] Burnickl and Nedbal. *Enhance Efficacy by Time-Management and Buffer-Reduction as Key Features of a web-based Tool within a Mesh of Subcontractors*. Conf-IRM, International Conference on Information Resources Management, 2012.

[Bra09] Bramorski. *A Case Study of ERP Implementation Issues*. University of Wisconsin, 2009. http://wisc.edu/.

[CJL02] Chung, Jackson, and Laseter. *Why Outsourcing Is In?* Operating Strategies, Strategy and Business, issue 28 edition, 2002.

[Com97] European Communities. *New industrial subcontracting in Europe*. 1997. europa.eu.int/comm/enterprise/entrepreneurship/supply/pdf/newindstten.pdf.

[Con10] Panorama Consutling. *2010 ERP Report*. Panorama Constulting Group, 2010. http://panorama-consulting.com/resource-center/2010-er-vendor-analysis/.

[dl06a] Ministere de l'Economie. *La Sous-Traitance Industrielle en Chiffres*. 2006. www.industrie.gouv.fr/sessi/publications/dossiers_sect/pdf/midest2006.pdf.

[dl06b] Ministere de l'Economie. *La Sous-Traitance Industrielle en Chiffres*. 2006. www.industrie.gouv.fr/sessi/publications/dossiers_sect/pdf/midest_2007.pdf.

[Dun93] Dunning. *Multinational Enterprises and the Global Economy*. Addison-Wesley, 1993.

[ea08] Liu et al. *Challenges and opportunities in collaborative business process management: Overview of recent advances and introduction to the special issue*. Inf Syst Front 11:201-209, 2008.

[EIM09] EIM. *EU SMEs and Subcontracting*. EIM Business & Policy Research, Brussels, final report edition, 2009.

[ER97] Esposito and Raffa. *The Trend of Italian Subcontracting System*. 6th International Annual IPSERA Conference, Naples, 1997.

[Fil07] Filip. *International Journal of Computers, Communications and Control*. CCC Publications, Agora University, volume 2, nr. 1 edition, 2007.

[Gol04] Goldratt. *The Goal: A Process of Ongoing Improvement*. North River Press, 2004.

[GSdCS97] Garrigós-Soliva, de Crombrugghe, and Sarrión. *Practical Case Studies on Industrial Subcontracting and Partnership*. United Nations Industrial Development Organisation, 1997.

[Ham01] Hammer. *The Superefficient Company*. Harvard Business Review, September-Issue, 2001.

[HAP10] Hestermann, Anderson, and Pang. *Magic Quadrant for Midmarket and Tier 2-Oriented ERP for Product-Centric Companies*. Gartner RAS Core Research Note G00163386, 2010. ,

[Hay02] Hayashi. *The Role of Subcontracting in SME Development in Indonesia: Micro-Level Evidence from the Metalworking and Machinery Industry*. Journal of Asian Economics, volume 13, issue 1 edition, 2002.

[Hin05] Hinrichs. *Datenqualitätsmanagement heute und morgen*. 3. DGIQ – Deutsche Gesellschaft für Informations- und Datenqualität e.V., 2005. www.dgiq.de.

[HP09] Houwerzijl and Peters. *Liability in Subcontracting Processes in the European Construction Sector*. Radboud University, Nijmegen, Netherlands, 2009.

[Hur06] Hurbean. *Business Intelligence: Applications, Trends, and Strategies*. Analele Stiintifice ale Universitatii 'Alexandru Ioan Cuza' din Iasi - Stiinte Economice, vo. 52-53 edition, 2006.

[KP88] Krüger and Pfeiffer. *Strategische Ausrichtung, organisatorische Gestaltung und Auswirkungen des Informations-Management*. Information Management, no. 3 edition, 1988.

[Kri10] Krigsman. *ERP failure: New research and statistics*. Enterprise Irregulars, 2010. http://www.enterpriseirregulars.com/11871/erp-failure-new-research-and-statistics/.

[Leh91] Lehtinen. *Subcontracting Systems in the 1990s*. SITRA, no. 114 edition, 1991.

[Leh01] Lehtinen. *Changing Subcontracting – A Study on the Evolution of Supply Chains and Subcontractors*. University of Oulu – Department of Industrial Engineering, 2001.

[Lem07] Lemmex. *Managing Change in Organizations: It's Management's Responsibility*. Global Knowledge Training LLC., 2007.

[LL06] Laudon and Laudon. *Management Information Systems: Managing the Digital Firm*. Prentice Hall, 9^{th} edition, 2006.

[MBB12] Mauri, Burnickl, and Basl. *Modelization of the Information Flow between Companies and Sub-Contractors. Management of innovation through the perspective of the Global Cognitive Theory.* not published yet, 2012.

[MG00a] Martens and Griese. *Integrierte Informationsverarbeitung – Planungs- und Kontrollsysteme in der Industrie*. Gabler Verlag, 2000.

[MG00b] Mertens and Griese. *Integrierte Informationsverarbeitung, Vol. 2, Planungs- und Kontrollsysteme in der Industrie*. Wiesbaden: Gabler, 8th edition edition, 2000.

[Mor03] Morcos. *International Subcontracting versus Delocalisatino*. United Nations Industrial Development Organisation (UNIDO), 2003.

[Mut10] Mutt. *ERP Implementation and Change Management*. 2010. www.associatedcontent.com.

[Nev05] Neville. *ERP Implementation – The Traps*. The Project Perfect White Paper Collection, 2005. www.projectperfect.com.au/info_erp_imp.php.

[OEC07] OECD. *Enhancing the Role of SMEs in Global Value Chains – Background Report*. 2007. www.oecd.org/dataoecd/27/43/38900592.pdf.

[OK10] Olson and Kesharwani. *Enterprise Information Systems – Contemporary Trends and Issues*. University of Nebraska–Lincoln, Indira Gandhi National Open University, 2010.

[PH10] Pettey and Holly. *Gartner Highlights Key Predictions for IT Organizations and Users in 2010 and Beyond*. Gartner, inc., 2010. www.gartner.com/it/page.jsp?id=1278413.

[Pic79] Picot. *Rationalisierung im Verwaltungsbereich als betriebswirtschaftliches Problem*. Zeitschrift für Betriebswirtschaft, 1979.

[Pic87] Picot. *Buerokommunikation, Leitsaetze für den Anwender*. Hallbergmoos: CW-Publikationen, 3rd edition edition, 1987.

[PRW08] Picot, Reichwald, and Wigand. *Information, Organization and Management*. Springer, 2008.

[RW99] Reichwald and Wiegand. *Informationsmanagement*. Vahlens Kompendium der Betriebswirtschaftslehre, Vol. 2, Munich: Vahlen, 4th edition edition, 1999.

[Sar10] Sarkar. *Managing the Digital Firm*. Santa Rosa Junior College, Computer & Information Sciences, 2010. http://www.santarosa.edu/ ssarkar/.

[SDMK98] Stuart, Deckert, McCutcheon, and Kunst. *A leveraged learning network*. Sloan Management Review 34(4), p 81-94, 1998.

[Smi07] Smith. *Success rates for different types of organizational change*. Wiley Periodicals, Inc., volume 41, issue 1, pages 26-33 edition, 2007.

[Sys08] Cincom Systems. *A practical Guide to evaluating ERP Systems and Vendors*. Cincom Systems, Inc., form cmus0901005-00 10/08 edition, 2008. http://www.cincom.com.

[Ver99] Verra. *Global Sourcing*. Nijenrode Research Paper Series, Centre for Supply Chain Management, 1999.

[Vin07] Vintean. *Non Verbal Communication in Business Life*. MPRA Munich Personal RePEc Archive, 2007. http://mpra.ub.uni-muenchen.de/6732/.

[wal09] wal. *Spionage aus dem Osten alarmiert Geheimdienst*. Spiegel Online, 2009. www.spiegel.de/wirtschaft/unternehmen/0,1518,669019,00.html.

[WG05] Wallgren and Granlund. *A Subcontractor's Dilemma – Two Case Studies of Subcontractors' Internationalisation*. Jönköping International Business School, 2005.

[ZBP06] Zarnekow, Brenner, and Pilgram. *Integrated Information Management*. Springer, 2006.