The Quality of Organizations

A Communication-Based Measurement Approach

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Abstract

The goal of this research is to develop an understanding of what causes organizations and information systems to be "good" with regard to communication and coordination. This study (1) gives a theoretical explanation of how the processes of organizational adaptation work and (2) what is required for establishing and measuring the goodness of an organization with regard to communication and coordination. By leveraging concepts from cybernetics and philosophy of language, particularly the theoretical conceptualization of information systems as social systems and language communities, this research arrives at new insights. After discussing related work from systems theory, organization theory, cybernetics, and philosophy of language, a theoretical conceptualization of information systems as language communities is adopted. This provides the foundation for two exploratory field studies. Then a formal theory for explaining the adaptation of organizations via language and communication is presented. This includes measures for the goodness of organizations with regard to communication and coordination. Finally, propositions stemming from the theoretical model are tested using multiple case studies in six information system development projects in the financial services industry.

Keywords: Organizational analysis and design, law of requisite variety, self-organization, autopoiesis, social systems, information systems as language communities, organizational quality, organizational goodness.

Zusammenfassung

Zielsetzung der hier vorgestellten Forschung ist es, ein Verständnis für die Güte von Organisationen und Informationssystemen im Hinblick auf Kommunikation und Koordination zu entwickeln. Diese Studie gibt (1) eine theoretische Erklärung zur Funktionsweise organisatorischer Anpassungsprozesse und (2) Handlungsanleitungen zur Messung der Güte einer Organisation im Hinblick auf Kommunikation und Koordination. Dies geschieht durch die Nutzung von Konzepten der Kybernetik und der Sprachphilosophie, insbesondere der Formalisierung von Informationssystemen als soziale Systeme und Sprachgemeinschaften. Nach der Diskussion bestehender Ansätze in der Systemtheorie, der Organisationstheorie, der Kybernetik und der Sprachphilosophie wird die Konzeptualisierung von Informationssystemen als Sprachgemeinschaften übernommen. Diese bildet die Grundlage für zwei explorative Feldstudien. Im Anschluss wird eine Theorie zur Erklärung der Anpassung von Organisationen durch Sprache und Kommunikation vorgestellt. Dies beinhaltet Maße für die Güte von Organisationen im Hinblick auf Kommunikation und Koordination. Schließlich werden anhand dieses theoretischen Modells Hypothesen aufgestellt und in einer multiplen Fallstudie in sechs Informationssystementwicklungsprojekten in der Finanzdienstleistungsindustrie überprüft.

Schlüsselwörter: Organisatorische Analyse und Gestaltung, Gesetz der erforderlichen Varietät, Selbst-Organisation, Autopoiesis, soziale Systeme, Informationsysteme als Sprachgemeinschaften, organisatorische Qualität, organisatorische Güte.

For my family and friends.

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List of Abbreviations

ABC	Activity based costing
BCBS	Basel Committee on Banking Supervision
BI	Business Intelligence
Bn.	Billion
CC	Coordinatory Center
CCF	Credit Conversion Factor
CCP	Central Counterparty
CEO	Chief Executive Officer
CIO	Chief Information Officer
CO	Controlling
CPU	Central processing unit
DB	Data base / data bank
DRQ	Data request
DQM	Data quality management
DWH	Data warehouse
EAD	Exposure at Default
EP theory	Theory for explaining and predicting
ER	Entity-Relationship
ETL	Extraction, transformation and loading
EUR	Euro
FTE	Full time equivalent / employee
FTP	File Transfer Protocol
GB	Gigabyte
HG	Hazardous Goods Manager
IFRS	International Financial Reporting Standards
IRB	Internal Rating-based
IS	Information system
ISO	International Standard Organization
I-Space	Information space
IT	Information technology
ITD	IT development
KSA	Standardized approach (“Kreditrisiko-Standardansatz”)
LAVAT	Language-based variety adaptation theory
LGD	Loss Given Default
MRL	Maximum Residue Limit
NCA	National Credit Act
No.	Number
OM	Operation Manager

PD	Probability of Default
PWA	Risk Weighted Assets
SLA	Service level agreement
SM	Site Manager
TCP/IP	Transmission Control Protocol / Internet Protocol
TM	Transport Manager
TQM	Total quality management
Type EE	Generalizing from empirical statements to empirical statements
Type ET	Generalizing from empirical statements to theoretical statements
Type TE	Generalizing from theoretical statements to empirical statements
Type TT	Generalizing from theoretical statements to theoretical statements
VDT	Virtual Design Team
VSM	Viable System Model
VTA	Virtual Team Alliance
WM	Warehouse Manager
XML	Extended Markup Language
XSD	XML Schema Definition

List of Symbols

α	Complex critical language (re)action
$\alpha(t)$	Outside agent or controller of a machine
D	Data
$D(k)$	Variety for a particular behavior at scale k
E	Set of elements of a system
En	Environment of a system
$f(I, K, t)$	Translation process
$f(In \times S)$	Organization of a machine
$H(X)$	Entropy of a random variable X
I	Information
$I_{reciever}$	Information received by the receiver
I_{sender}	Information the sender wanted to transfer
$i(D, K, t)$	Interpretation process
In	Set of input or surrounding states of a machine
κ	Reaction of (re)construction
k	Scale of a task; the number of components that must act together
K	Pre-knowledge
$n(k)$	Number of different k-member fully coordinated groups to perform a task
N	Number of components of a system
m	Number of the possible actions or responses of each component of a system
M	Number of possible actions or responses that a system can take
p_i, $p(z_i)$	Probability of a variable or state z_i to occur
Φ	Set of all terminologies at schema level
φ	Reaction of terminological discourse
Ψ	Set of all pre-terminological languages
R	Set of relationships between elements of a system
S	(1) System, (2) set of states of a machine
t	Time (point)
T	Terminology at schema level
v	Variety of a component of a system
V	Variety of a system
$V(k)$	Variety as a function of scale k
x_i, z_i	State variable
$x_i(t)$, $z_i(t)$	State vector

1 Exposition

1.1 Motivation

What influences the quality of an organization with regard to communication and coordination? How should an organization structure and design itself and its information systems in order to cope with complexity? What *is* an organization? These questions are fundamental to understanding "organizational analysis and design" as a subject for information systems research and are the fulcrum of this thesis. An organizational design describes how an organization, such as a company or project, uses information and communication to coordinate its activities and accomplish its goals; it is the specification of configuration, complexity, formalization, centralization, incentives and coordination and control mechanism of an organization.[1] There are many important questions about organizational analysis and design and the employed processes that are relevant to organizational designers, researchers, educators, and managers. What makes a "good" organization? How can organizational analysis and design be taught better? Which characteristics of organizations make them most valuable? How is organizational design related to information technology (IT)? Is an organization purposefully planned or does it result from spontaneous collective behavior? Such questions are nearly endless in number, and the answers can be very difficult to pin down. However, the value in furthering the understanding of these issues is enormous. For instance, knowledge of key indicators of individual performance of a specific organization is crucial. When deciding which organizational setup to apply, managers attempt to determine which designs will perform well in their particular case and setting. Often, the deciding managers rely on high-level macro setups, standardization, and experience to predict prospective designs' abilities.[2] However, these measures are not adequate to gauge whether an organizational design will contribute to the success of a specific company.[3] For instance, empirical studies suggest that the adjustment costs incurred in integrating IT into a work system are due to hidden, slowly changing, firm characteristics and have an important effect on productivity.[4] Therefore it is an open question whether restructuring an organization's business processes and investing in IT are worth the costs of organizational change. Consequently, organizations have great stakes in the quality of their organizational design. It is the hope of this thesis that answers to these questions can guide researchers, practitioners and educators to achieve their individual goals.

The research that is presented in this dissertation has two related, but distinct goals. The first and primary goal is to give a theoretical explanation of what is required for establishing and measuring the goodness of an organization with regard to communication

[1] Burton & Obel (2005), pp. 45, 85.
[2] E. g., Carroll et al. (2006); Burton & Obel (2005).
[3] Donaldson (1996), p. 64.
[4] E. g., Brynjolfsson (1993); Brynjolfsson & Yang (1996); Brynjolfsson & Hitt (1998).

and coordination. This study believes that laying this formal foundation is critical. A clear understanding of the requirements involved in constructing and maintaining a system of communication will allow researchers to know when they should be surprised that such behavior exists, and when they should be surprised that it does not. The second, and more speculative goal is to use this theoretical explanation to begin to answer some questions about communication and language that this thesis feels are important. Why do humans communicate in coordinative situations? Why, when virtually every organization has a system of communication and human beings seem to be unique in their communicative abilities, is this not the focus of research? What is the relationship between organizational adaptation, self-organization and communication? Such questions represent both the motivation for the work in this dissertation, and the future directions that it is hoped to pursue as a result of it.

To arrive at more refined models for organizational analysis and diagnosis, this research has studied cybernetics and philosophy of language, particularly the theoretical models of information systems as social systems and language communities.[5] Consequently, this thesis has taken a different route than other research in this field, following the statements of Feyerabend that unconventional routes might yield new insights.[6] The research presented here is more modest and does not propose a revolutionary breakthrough, but hopes to arrive at a new insight by looking at an existing topic, using the body of knowledge from cybernetics, social systems theory and philosophy of language.

1.2 Problem Description

Coordination is a central term in different fields of study. Economists talk about the market and the hierarchy as alternative coordination devices.[7] Management scientists develop typologies of organizational configurations that are based on views on coordination mechanisms.[8] In this context, many researchers have voiced that the trade-offs among different organizational designs have changed in recent years. In particular, hierarchy, centralized control, and bureaucracy seem increasingly out of favor, and there is a shift from the centralized command-and-control organization to the decentralized information-based organization.[9] This thinking is of course strikingly different from the Taylorist tradition at the beginning of the 20th century.[10]

Malone & Crowston note that there has been a growing interest in recent years in questions about how the activities of complex systems such as markets, firms, and companies can be coordinated.[11] The question of how the widespread use of IT will change the ways people work together motivates the interest in coordination as "managing

[5] This thesis will mention only the leading papers and books.
[6] Feyerabend (1993), p. 120. Kuhn (1996) has also indicated that breakthroughs in theories can only be achieved by deviating from known paths.
[7] E. g., Coase (1937).
[8] E. g., Mintzberg (1979).
[9] E. g., Drucker (1988).
[10] E. g., Taylor (1911).
[11] Malone & Crowston (1994), p. 87.

dependencies between activities".[12] In general, this need for coordination arises from the existence of dependencies: if there is no interdependence, there is nothing to coordinate.[13] For instance, interdependencies arise due to the need for division of labor. Division of labor increases efficiency because of specialization, and increases the need for coordination. Another reason for the existence of dependencies can be drawn from the concept of bounded rationality: complex systems simply cannot be handled by a single manager's perspective, and therefore completely centralized control is simply not beneficial.[14] Consequently, Malone & Crowston claim, *group decision-making* and *communication* between people – the process whereby information is transferred from a sender to a receiver – are regarded as important in almost all instances of coordination:

> "*How, for instance, can actors establish a common language that allows them to communicate in the first place? This question of developing standards for communication is of crucial concern in designing computer networks in general and cooperative work-tools in particular. [...] A related set of questions arises when we are concerned about how a group of actors can come to have "common knowledge"; that is, they all know something and they also all know that they all know it.*"[15]

In parallel, there has been an increasing tendency in research to draw attention to the particular non-economic challenges posed by *complex systems*[16], and researchers increasingly pay attention to those ideas that are directly relevant to the social complexity created by and among disparate groups of people who together make up organizations.[17] As Nobel laureate John Mather said,

> "*I'm convinced that over half of the cost of a project is socially (contextually) determined.*"[18]

For instance, it has been known for complex information system development projects that coordination between the various stakeholders involved is a fundamental necessity, and successful communication between involved stakeholders is deemed to be one of the main drivers for information system development project success.[19] Previous research suggests that ineffective communication stems from many sources: differences in personality, differences in perceptions, attitudes, and values, differences in roles and functions, and differences in cognitive processing; these differences indicate that different stakeholders may bring to the situation different conceptual frameworks, which hinders mutual understanding and cooperation.[20]

[12] Malone & Crowston (1994), pp. 89-90.
[13] Malone & Crowston (1994), p. 90.
[14] E. g., Simon (1957).
[15] Malone & Crowston (1994), pp. 99 f.
[16] E. g., Allen & Varga (2006); Anderson (1999); Auyang (1998); Backlund (2002); Bar-Yam (1997); Benbya & McKelvey (2006); Braha & Bar-Yam (2007); Casti (1994); Courtney et al. (2008); Flood & Carson (1993); Jacucci, Hanseth & Lyytinen (2006); Kauffman (1995); Merali (2006); Simon (1996).
[17] Cooke-Davies et al. (2007), p. 50.
[18] Private correspondence with Terry Cooke-Davies reported in Cooke-Davies et al. (2007), p. 50.
[19] E. g., Gallivan & Keil (2003); Ko, Kirsch & King (2005); Ribbers & Schoo (2002); Joshi, Sarker & Sarker (2007); Vlaar, van Fenema & Tiwari (2008).
[20] Tan (1994), pp. 159-160.

The structured sharing and communication of relevant information is crucial to the overall success of any organization. Therefore, an important task of management is to design the communication within the organization in an effective way.[21] The imperative of this research is to develop an understanding of what causes organizations and information systems to be "good" with regard to communication and coordination. The question to be dealt with in this thesis is essentially one of construct validity, that is, what does "quality of organizations and information systems" refer to with regard to communication and coordination, and how can it be measured?

This thesis understands "quality" in the sense of "goodness".[22] Quality in this sense is an expression for the intuitively evaluated excellence or goodness, a definition which is inherently subjective: quality is any characteristic which may make an object good or bad, commendable or reprehensible.[23] Quality as *the degree of excellence* – how well a thing performs – is the most common approach to using the word in daily life, yet the most confusing one.[24] It is a function of effective design and may refer to tangible, intangible, and even transcendental characteristics of a thing; it is often difficult to define and measure because subjective judgment and perception play important roles in the estimation of quality.[25] Often, when organizational goodness has been understood as a degree of excellence, it has been equated with "performance" and "effectiveness" or "efficiency" and "productivity"; survey results suggest that the literature does not offer a consistent approach to the study of organizational goodness and that measurement is largely erratic.[26] According to Anupindi et al., *quality of design* refers to how well a thing's characteristics aim to meet one's requirements whereas *quality of conformance* refers to how closely the actual thing conforms to the chosen design specification; quality of design thus refers to *what* is promised while quality of conformance measures *how well* the promise is kept.[27] Consequently, quality may be defined broadly in terms of *the discrepancy between one's expectation of a thing's performance and one's actual experience of it's performance* – perceived bad quality results from an absence of expected characteristics.[28] Thus an inter-subjective definition of organizational quality or goodness with regard to communication and coordination requires some definition of expected characteristics and a measure for them, since an interaction between an organization's properties and the perceived goodness results in definition of explicit quality standards. Therefore this study searches for inter-subjective and characteristic patterns of good organizations. There is

[21] E. g., Boland & Tenkasi (1995).

[22] "Quality" is derived from Latin *qualitas*, a property or attribute that differentiates a thing. There is no unified definition for quality, since researchers explain it from different perspectives, and the definitional content of quality shifts. In its more modern sense, it is often understood as a degree or level of excellence. This understanding is closely related to concepts and techniques of quality management, for instance, ISO 9000 or quality improvement methods such as TQM and Six Sigma, e. g., Bhuiyan & Alam (2005); Sroufe & Curkovic (2008). The word "goodness" – meaning that which is pleasing or valuable or useful, the quality of being good – is deliberately chosen here instead of "quality".

[23] Martens & Martens (2001), pp. 37 f.

[24] Martens & Martens (2001), p. 39.

[25] Anupindi et al. (2006), p. 11.

[26] Shenhav, Alon & Shrum (1994), pp. 770 f.

[27] Anupindi et al. (2006), p. 245

[28] Anupindi et al. (2006), p. 245

a need for rigorous theories and approaches that researchers and practitioners can use as guidelines to understand and manage the goodness of organizations and information systems with regard to communication and coordination.

However, what *are* these interesting patterns and characterizing properties of organizations? Every organization such as a company, a non-profit agency, or a project is unique. Can common patterns be found at the level of the organization? Or is the object of interest more that of the organizations' members? There is not, on the one hand, the organization (at a higher level) and, on the other (at a lower level), action and interaction.[29] As Cooren claims, it is precisely through these interactions that something such as an organization or information system can come to exist and act: if one wants to see how an organization or information system functions, one needs to identify the ways by which things get organized through interactions.[30] According to Taylor et al., if that is the case, then the proper business of researchers is not the study of organization or information systems, using communication as data in the search for nonexistent laws, but *the study of communication itself.*[31] This directs scientific attention "upstream" to the origins of organization and information systems in coordination, communication and discourse, not "downstream" to the by-now reified structures that pass for the object of study.[32] That shifts the focus of organizational analysis and design from measuring and controlling the quality of structural characteristics of an organization or information system and its business processes to measuring and controlling the characteristics and capabilities of the individual actors of an organization and information system that communicate and coordinate in order to execute business processes. In the search for patterns and characteristic properties of good organizations and information systems with regard to communication and coordination, this thesis starts from a systems-theoretic perspective and develops a model of organizational participants' behavior. At its core, this model is about collective behavior. The model allows for two measures of quality or goodness – language community quality and speed of language adaptation. To match and predict collective communication and coordination behavior patterns may lead to more effective regulation and insight into organizational analysis and design.

1.3 Research Questions

To summarize the problem scope of this thesis: *what is the goodness or quality of an organization with regard to communication and coordination?* As organizations grow, they specialize, and the resulting division of labor leads to a buildup of organizational structures. This results in the need of communication for coordination. Efficient communication becomes a leverage to make business processes more effective.[33] For an organization of any given size consisting of agents or actors with a given degree of information-processing capability, the efficiency of the organization might vary with its structure; the limited processing capacity of individuals means that organizations that are able to intelligently

[29] Cooren (2006), p. 335.
[30] Cooren (2006), p. 335.
[31] Taylor et al. (1996), p. 31.
[32] Taylor et al. (1996), p. 31.
[33] E. g., Galbraith (1974); Tushman & Nadler (1978).

leverage their internal communications will have a competitive advantage.[34] In this thesis, "organization" and "information system" are treated as two sides of the same coin because an organization and its information structure are interlinked and cannot be treated separately.[35] The objective of this thesis is to identify and validate the patterns and characteristics that determine the goodness or quality of an organization or information system with regard to communication and coordination. In order to reach this goal the following research questions are addressed.

Research question 1 (RQ1): What criteria can be developed for "good organizations" with regard to communication and coordination?

Research question 2 (RQ2): How can the goodness (or quality) of an organization be measured with regard to communication and coordination?

Research question 3 (RQ3): What conditions influence organizational goodness (or quality) with regard to communication and coordination?

1.4 Structure of the Thesis

The research proceeded in four broad phases – literature review and analytical research, exploratory field studies, theory building and theory testing – and is summarized in Figure 1.1 alongside the structure of the thesis. This study follows a holistic multi-method approach. The philosophical underpinnings and the research position of this study are presented in *Chapter 2*. Stemming from this foundation, a framework for research and the general research methodology of this study are discussed. This thesis stands in the systemic tradition and adopts a modern, systemic view. However, due to its philosophical underpinnings, it is also a part of the symbolic-interpretive tradition.[36]

Chapter 3 discusses the related work from systems theory, organization theory, cybernetics, and the philosophy of language. This includes important concepts such as the systems view on organizations, complexity, variety and the law of requisite variety, autopoiesis, contingency theory, self-organization, and the importance of language for organizations. Stemming from this discussion, a theoretical conceptualization of information systems as language communities is adopted. This provides the foundation for the subsequent parts of the thesis.

Chapter 4 discusses exploratory field studies in form of an action case at a financial service provider and an action research study at a logistics provider. This provides a first exploration of how to measure the quality of a specific organization with regard to communication and coordination. For each field study, the applied research method is introduced and the case findings are discussed in detail. The empirical findings from the field studies are matched to the theoretical foundation of Chapter 3 in order to generate a first understanding of the problem scope in an empirical setting. Afterwards, general conclusions from the findings are drawn.

[34] E. g., DeCanio & Watkins (1998).
[35] E. g., Courtney et al. (2008); Lucas & Baroudi (1994). See Chapter 3.2.3.
[36] E. g., Berger & Luckmann (1966); Geertz (1973); Hatch (1997), pp. 34; 41-42.

In *Chapter 5*, following the literature discussion and findings from the exploratory field studies, a formal theory for explaining the adaptation of organizations is introduced. The formal model of the theory and its constructs are deducted from the theoretical foundation and the generalization of the exploratory findings. Moreover, propositions stemming from this theory are generated and presented. This includes measures for the goodness of organizations with regard to communication and coordination.

Chapter 6 tests the propositions stemming from the theoretical model, focusing on information system development projects in the financial services industry. Using multiple case studies, the projects are treated as a special case of organization where it is prudent to examine the propositions made.

Chapter 7 summarizes the results and limitations of this thesis and gives an outlook for further research.

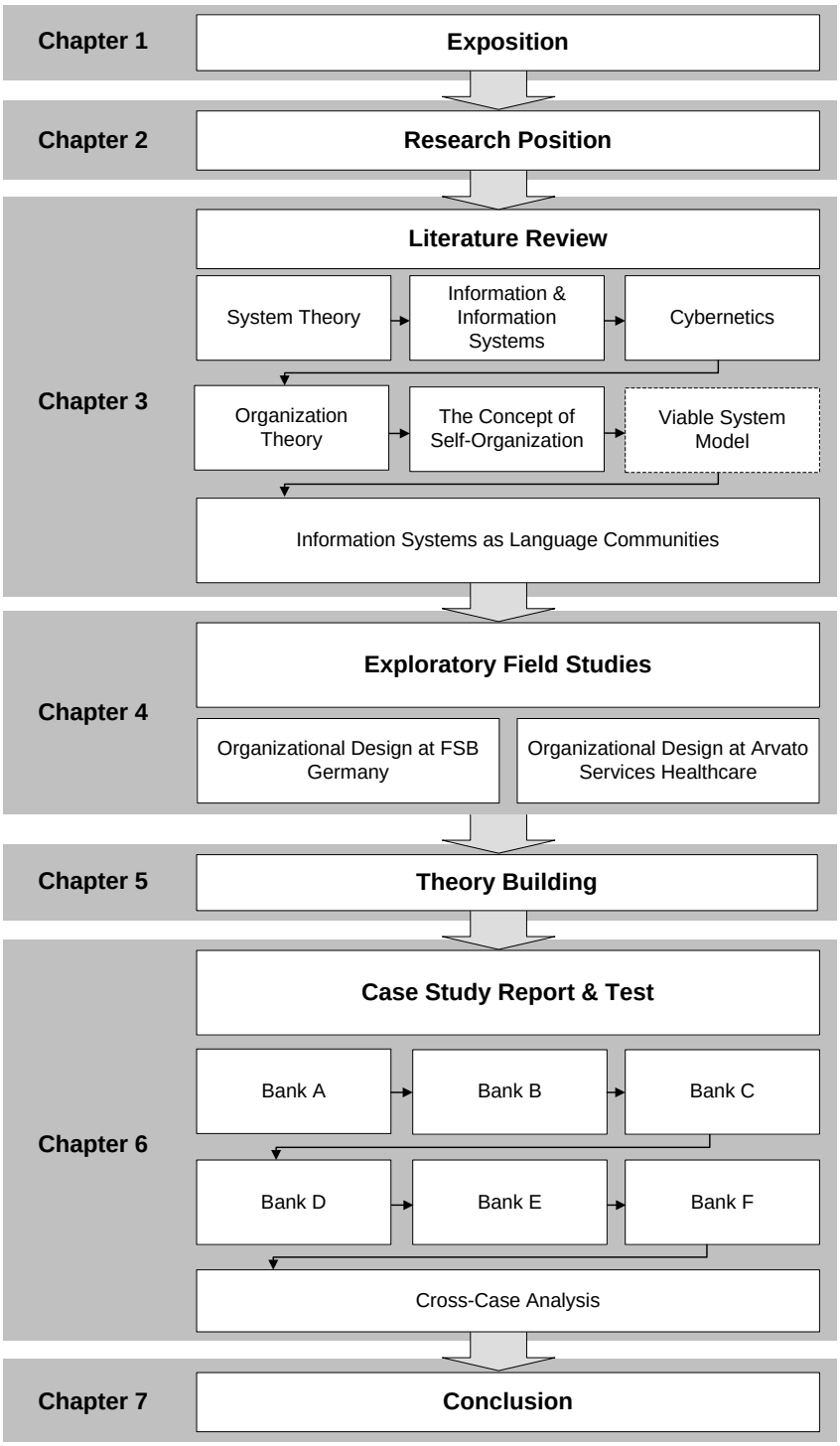


Figure 1.1: The Research Process and Structure of the Thesis

2 Research Position

Information systems research is a multiple-paradigm discipline which explores all processes and aspects of information systems from a mostly behavioral, or organizational perspective.[37] However, it also incorporates aspects from design science and software engineering.[38] Consequently, this study follows the *socio-technical approach to information systems*, which suggests that a fit is needed between the technical sub-system and the social sub-system which together make up an organization. The basic assumption of this approach is that the fit is achieved by a design process aiming at the joint optimization of the two sub-systems.[39] Therefore information systems research examines more than just the technological system, or just the social system, or even the two side by side; it investigates the phenomena that emerge when the two interact.[40]

The following chapter introduces the scientific position and research approach of this thesis which are adopted to study information systems and organizations. Chapter 2.1 discusses the philosophical presuppositions of this study and the consequences for the concept of causality. In Chapter 2.2 a framework for research is introduced which leads to the specific methodology adopted in this study. Chapter 2.3 discusses in short the distinction between behavioral and design science research and makes a brief statement about the choice of methods of this thesis for the subsequent chapters.

2.1 Philosophical Assumptions

The fact that epistemic values are necessary in science has never been doubted. Weber and many other proponents of the so-called value-freedom of science have argued again and again that science is not possible without such values.[41] Therefore every research approach is based on specific ontological and epistemological assumptions which define the researcher's position and choice of methodology.[42] *Ontology* comprises the foundational beliefs about the empirical or "real world" that researchers are investigating. *Epistemology* is the outline of the reasoning process by which researchers perform their empirical and logical work.[43] Worth noting is that the same ontology can lead to more than one epistemology: for instance, a positivist ontology can lead to the highly mathematical reasoning process seen in economics as well as to the qualitative reasoning process that framed Darwin's

[37] Morrison & George (1995), p. 80; Checkland & Holwell (1998), p. 98.
[38] Hevner et al. (2004), p. 77. See Chapter 2.3.
[39] E. g., Cherns (1976); Bostrom & Heinen (1977); Clegg (2000); Mumford (2003); Avgerou, Ciborra & Land (2004).
[40] Lee (2001).
[41] E. g., Weber (1917/1967); Weber (1921/1967); Albert (1976); Albert (1985); Albert (1993); Keuth (1989).
[42] See Lee (2004) and Myers (1997) for discussions in the context of information systems research.
[43] Lee (2004), pp. 5 f.

development of his theory of evolution.[44] Based on these assumptions, researchers have debated competing philosophical paradigms for research, in information systems research mostly represented by the two labels positivism and interpretivism.[45] There are other related distinctions which are commonly made. For instance, research methods have variously been classified as objective versus subjective[46], qualitative versus quantitative[47], or as critical versus uncritical[48]. Each of these philosophical positions favors the particular research methods that fit its own assumptions.[49] Although the differences and boundaries between research positions have ever been a cause for discussion and argument among information systems researchers, recent contributions argue for a conciliation and the acceptance of each others principle philosophical arguments as ontological and epistemological paradigms.[50] Therefore every research should make its philosophical presuppositions explicit.

Summarizing the philosophical assumptions of this study, it is assumed that an objective world exists (*ontological realism*), but that the cognition of this world is subjective or "private" (*epistemological subjectivism*).[51] Due to this subjectivity, cognition relies upon the (re-)construction of reality through (linguistic) action. Consequently, the general research approach of this study can be seen as belonging to the interpretive tradition. However, due to the assumption that an objective world – of whatever kind – does exist, this study posits a "weak" understanding of constructivism which allows the formulation of general propositions and hypotheses which can be inter-subjectively tested. To avoid confusion, it is pointed out that this understanding of interpretivism does not directly fit to traditional research frameworks due to its realistic position concerning the ontological question.[52] A framework proposed by Becker & Niehaves allows this study to make its assumptions with regard to ontology and epistemology more precise:[53]

- *What is the object of cognition?* This study stands in the tradition of *Kantianism*, which attempts to overcome the differences between ontological realism (a world exists independently of human cognition) and ontological idealism (the world is a construct depending on human consciousness). For Kant, both types of entities exist: entities that are independent from (so-called *noumena*) as well as entities that depend on human consciousness (so-called *phenomena*). Knowledge which can be acquired by an observer is restricted to phenomena; the "things in themselves" ("Das Ding an sich") are unknowable.[54]

[44] Lee (2004), p. 6.
[45] E. g., Jenkins (1985); Walsham (1995a); Walsham (1995b).
[46] E. g., Burrell & Morgan (1979), pp. 3 and 22.
[47] E. g., Straub, Gefen & Boudreau (2004).
[48] E. g., Alvesson & Deetz (2000), p. 24.
[49] Mingers (2004b), p. 373.
[50] Weber (2004), pp. iii-xii. As Lee (1991) shows, supposedly adverse positions can even be methodologically combined and integrated.
[51] Holten, Dreiling & Becker (2005), pp. 177 f.
[52] E. g., in the prominent framework proposed by Burrell & Morgan (1979), ontological realism is an aspect of the so-called objectivist approach to social sciences, whereas the subjective approach is defined by epistemological anti-positivism only, which clearly corresponds to this study's subjective epistemological position. See Burrell & Morgan (1979), p. 3.
[53] See Becker & Niehaves (2007), pp. 202-206, in the following.
[54] E. g., Kant (1999).

- *What is the relation between cognition and the object of cognition?* Following the statements with regard to the object of cognition, this study assumes a "weak" constructivist position, that is, cognition is subjective or "private" because the cognition of reality is interpreted by the researcher. The relationship between cognition and the object of cognition is determined by the subject.[55]

- *What is true cognition?* This refers to the extent to which "true" knowledge can really be obtained and how this can be verified. This study posits itself within the range of both the *correspondence theory of truth* – truth is a result of a correspondence which can be formulated as an equivalence between a statement and a fact – and the *semantic theory of truth* – truth depends on the condition that an object language and a meta-language can be differentiated. Therefore this study assumes that a fact can never finally be classified as true.[56]

- *Where does cognition originate?* Cognition can originate from the senses (a posteriori knowledge, empiricism) or from the intellect (a priori knowledge, rationalism). Again, following the statements made regarding the ontological and epistemological aspects, this study takes a conciliating position by adopting what Becker & Niehaves name *Kantianism*, which regards both experience and intellect as valid sources of cognition. Without empirical knowledge, no object would be given, and without intellect, the necessary categories for cognition would be missing.[57]

- *By what means can cognition be achieved?* This study assumes that both inductivism and deductivism do not exist in a pure form. For the derivation of the individual from the universal, one always has a specific kind of foreknowledge, and one cannot detach oneself from a specific context or both inductivism and deductivism completely.[58]

Table 2.1 summarizes this study's philosophical underpinnings. These philosophical assumptions also have an important effect on the perception of *causality*. The prerequisite in handling a large number of variables, as in traditional cause-effect-models, is that they can be identified. However, social systems such as large information systems and organizations, which are the kinds of system under discussion in this study, exhibit literally billions of variables; there is no rigorous means of knowing which "matter". The importance of a particular variable in a complex system is a question of degree, and a question of judgment and conventions. Moreover, the importance it has by any of these criteria will change from moment to moment.[59]

In the same manner Ashby warns of taking classical research methods from the natural sciences without scrutiny since they have two peculiarities.[60] Firstly, their systems are

[55] E. g., Lorenzen (1987).
[56] E. g., Tarski (1935); Popper (1979); Tarski (1983).
[57] E. g., Kant (1999); Becker & Niehaves (2007), p. 205. It is a matter of debate if the framework offered by Becker & Niehaves (2007) uses dimensions that really are orthogonal, e. g., because "Kantianism" is a category in both the dimension of "ontological aspect" and the dimension "origin of cognition" and the position taken in the first dimension determines the position in the second.
[58] E. g., Lee (2004); Lee (1991).
[59] Beer (1979), pp. 97 f. See also Taleb (2008) who argues that highly improbable variables are usually disregarded, but may have important and grave consequences.
[60] Ashby (1958), pp. 97 f.

Aspect	Characteristic		
Ontological aspect *Object of cognition*	Ontological realism	Ontological idealism	*Kantianism*
Epistemological aspect *Relationship between cognition and object of cognition*	Epistemological realism		*Constructivism*
Concept of truth *Essence of true cognition*	*Correspondence theory of truth*	Consensus theory of truth	*Semantic theory of truth*
Origin of cognition *Source of cognition*	Empiricism	Rationalism	*Kantianism*
Methodological aspect *Ways of emergence of cognition*	*Inductivism*	*Deductivism*	*Hermeneutic*

Source: adopted from Becker & Niehaves (2007), p. 8

Table 2.1: Position with Respect to Philosophy of Science

composed of parts that show an extreme degree of homogeneity: contrast the similarity between atoms of carbon with the dissimilarity between persons. Secondly, the systems studied by the natural scientists have nothing like the richness of internal interaction that the systems studied by the social sciences have.[61] Thirdly, in contrast to the natural sciences, social structures neither exist independently of the activities they govern, nor do they exist independently of the agents' conceptions, nor are they generally universal and independent of time and space.[62] In the systems of the natural sciences, the truth is often invariant with time; but methods from these sciences may be quite inappropriate in the systems of the social sciences such as sociology and economics, whose surrounding conditions are usually undergoing secular changes, so that the parameters to the system are undergoing changes – which is equivalent to saying that the systems are undergoing secular changes.[63]

Anderson argues among similar lines with regard to organization science: the behavior of complex systems is surprising and is hard to predict, because it is nonlinear, and simple "boxes-and-arrows-causal models" are inadequate for modeling systems with complex interconnections and feedback loops, even when nonlinear relations between dependent and independent variables are introduced by means of exponents, logarithms, or interaction terms.[64] Simply put, complex systems such as large information systems and organizations resist simple reductionist analyses, because interconnections and feedback loops preclude holding some sub-systems constant in order to study others in isolation, and complex phenomena usually have a *nonlinear causality*.[65] von Hayek adequately summarizes this point for research in social sciences:

[61] Ashby (1958), p. 97.
[62] Mingers (2004b), pp. 386-387.
[63] Ashby (1958), pp. 97 f.
[64] Anderson (1999), pp. 216 f. See also Daft & Lewin (1990); Casti (1994).
[65] Anderson (1999), p. 217.

> "*What we must get rid of is the naive superstition that the world must be so organized that it is possible by direct observation to discover simple regularities between all phenomena and that it this is a necessary presupposition for the application of the scientific method. What we have by now discovered about the organization of many complex structures should be sufficient to teach us that there is no reason to expect this, and that if we want to get ahead in these fields our aims will have to be somewhat different from what they are in the fields of simple phenomena.*"[66]

Since complexity is an important concept in this research, this study also questions the simple know-it-all validity of the cause-effect-concept for complex phenomena:

> "*It is two hundred years since the philosopher Hume made his profound criticisms of the very concept of causality; it has been strictly necessary to replace it ever since; yet our culture to this day continues to propagate the belief that 'every event has a cause'. Thus, when it comes to the management of very large systems, we still look for a unique cause of systemic failure – and this is not at all the appropriate methodology. Complicated systems fail because they are potentially unstable and because some concatenation of circumstances has made the potentiality actual. No unique event is the cause; and when we look for one it often seems that if the total system had been in a different state, that event would not have led to disaster.*"[67]

This study believes this critique of the simple application of the cause-effect-concept to complex systems such as information systems and organizations in general to be valid, which follows from the philosophical assumptions and is also reflected in the choice of methodology as argued hereafter.

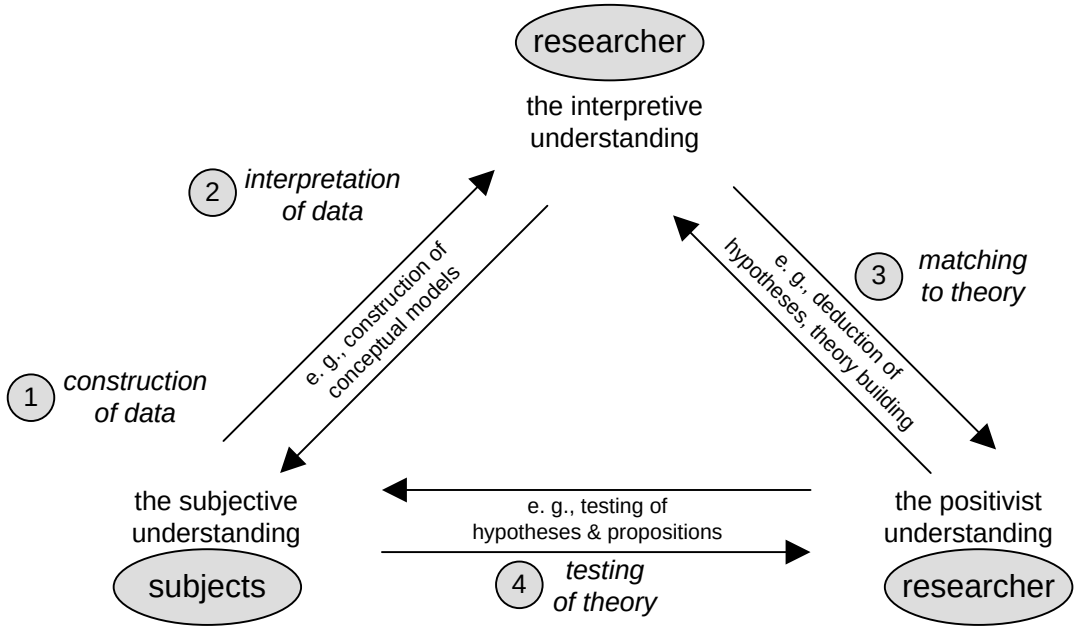
2.2 Research Methodology

Methodology refers to a specific manner in which researchers do empirical and logical work, and the same epistemology can have several methodologies, which in turn consist of different *methods*.[68] Information systems research is a meta-subject that spans many disciplines in the social sciences, in business, and in the natural sciences; it is also an applied discipline, not a pure science, and research methods must account for this duality.[69] Different philosophical positions not withstanding, given the richness and complexity of the real world, research methods best suited to the problem under consideration as well as the objectives of the researcher should be chosen. The over-riding concern of this study is that the research should be both relevant to practical problems and rigorous in its operationalization. This study believes that a methodology which allows to solve conflicts between interpretive and positivist approaches is required for this purpose, even though most scholars would argue that positivist and interpretive ontologies are contrary and conflicting.[70] In order to

[66] von Hayek (1967), p. 40.
[67] Beer (1979), p. 290.
[68] Lee (2004), pp. 6 f.
[69] Galliers & Land (1987), p. 901.
[70] Lee (2004), p. 7.

acquire an understanding of how people in information systems and organizations behave, researchers must participate in the daily life and decision processes belonging to specific information systems and organizations. To do these things without being involved would be impossible.

As a consequence, this study's research approach, or methodology, is characterized by four roles that the researcher adopts during the investigation. In accordance with a framework proposed by Lee, this approach allows to relate interpretive and positivist positions: after having created a *subjective understanding* of everyday meanings and common sense within observed organizations, which provides the basis for the *interpretive understanding*, the researcher creates a *positivist understanding* in order to explain the empirical reality – the explanation being a scientific theory which can be tested against the subjective meaning as recorded in the interpretive understanding.[71] This leads to an integrated framework for an interpretive and positivist understanding as illustrated in Figure 2.1. The four roles can be applied and embodied during known research methods. Engaging into the four roles allows the researcher to collect rich and meaningful data for answering research questions. In the following sections, the four roles are described in detail.



Source: adopted from Lee (1991), p. 351

Figure 2.1: Levels of Research

2.2.1 First Role: Construction of Data

As Popper acknowledges, the framing of any scientific question assumes some foreknowledge of what it is one wants to know.[72] Everybody exists "all along" within a subjective

[71] Lee (1991), pp. 351-354.
[72] Popper (1959), pp. 6-10.

understanding of the world, which is linguistically articulated.[73] The first role of the researcher refers to the *construction of data*, wherein the researcher acts as a participant and engages in observation of the world. For instance, the researcher conducts projects within an organization as an active partner in problem solving. In order to generate a mutual common sense understanding, researchers and other participants actively create a language community during these projects and create a joint attention frame.[74] They align their language constructs, terms and meaning of words in the specialized language or terminology of the domain in focus. Thus an inter-subjective understanding of the research domain is created. In doing so, the researcher gains access to observations in the research domain. Based on the observations, data can be collected and constructed. For instance, Holmqvist & Andersen refer to this in the description of their longitudinal field study in a car garage:

> "*Many of the important ongoings were not expressed but had to be supplemented by the mechanic: we had to learn the secrets of car repair in order to understand why sentences were uttered, and what they meant.*"[75]

Consequently, participation in actual activities and in a language community becomes a prerequisite for observation. Adopting a strategy akin to Langley, the researcher chooses to plunge deeply into the operational processes themselves, collecting fine grained quantitative and qualitative data.[76] She or he secures empirical material for the construction of data and its following interpretation, for instance, by collecting documentation, forms and print-outs, by observing operational processes and application systems, by conducting surveys, by asking and inquiring the subjects, and by taking field notes. As Eisenhardt argues, one key to useful field notes is to write down whatever impressions occur, that is, to react rather than to sift out what may seem important, because it is often difficult to know what will and will not be useful in the future.[77]

In general, if the researcher wants to find out what someone knows, she or he asks him or her, and observes her or his behavior.[78] However, adequate data cannot be produced from a record only of what people say, most especially it cannot be produced from a record only of what people say in artificial interviewing contexts removed from the scene of their ordinary cultural performances.[79] Therefore this is but a special case of ethnography since its domain of study, speech messages, is an integral part of a larger domain of socially interpretable acts and artifacts.[80] Along similar lines, Taylor proposes to build a body of organizational research that starts from an accumulation of solid *discourse-based, empirical studies* in order to undertake a much finer-meshed analysis of the data.[81]

[73] Kamlah & Lorenzen (1984), p. 5.
[74] Kamlah & Lorenzen (1984), p. 47; see Tomasello (1995) for a discussion on joint attention. For a more detailed discussion on the concept of language community, which is of paramount importance for the major arguments in this study, see also Chapter 3.7.2.
[75] Holmqvist & Andersen (1987), p. 330.
[76] Langley (1999), p. 691.
[77] Eisenhardt (1989), p. 539.
[78] Frake (1964) p. 133. See also Bortz & Döring (2006), pp. 236-289.
[79] Frake (1964) p. 133.
[80] Frake (1964) p. 132.
[81] Taylor (1995), p. 29.

2.2.2 Second Role: Interpretation of Data

The second role concerns the *interpretation of data*. The researcher needs to analyze and interpret the extracted data and observations. She or he makes statements about the research domain, which are based on her or his interpretation of the subjective understanding. Consequently, the researcher interprets the mutual agreement, the observations, and the statements in the specialized language or terminology of the domain in focus. This is in line with Lee & Baskerville's generalizing *from* empirical statements *to* other empirical statements (Type EE generalizability).[82] An observed event, action or situation is interpreted in its specific context and an interpretive description of the situation is created. A researcher must therefore repeatedly go from her or his own interpretive understanding to the subjective understanding and then back again to her or his own interpretive understanding, using the hermeneutic cycle.[83] The resulting understanding is the researcher's reading or interpretation of the first-level, common sense understanding. An important point is that a different reading or interpretation of what the organization means to the human subjects may lead to a different theoretical explanation for how the human subjects behave.[84]

2.2.3 Third Role: Matching to Theory

In the third role, a *matching to theory* takes place. Gregor suggests that theories in general can be categorized into five different types as summarized in Table 2.2. Generally, this study understands theory as a means for describing, explaining and predicting (*EP theory*) and also as a means for design and action (*design and action theory*).[85] An EP theory says what is, how, why, when, and what will be, and corresponds to commonly held views of theory in both the natural and social sciences. EP theory implies both understanding of underlying causes and prediction, as well as description of theoretical constructs and the relationships among them.[86] In contrast to an EP theory, a theory for design and action is about the principles of form and function, methods, and justificatory theoretical knowledge that are used in the development of information systems. Design theory and EP theory are strongly interrelated.[87]

However, in respect to this study's philosophical assumptions and the critical comments previously made with regard to the traditional view of the cause-effect-concept, this study advises to be aware of the limitations in identifying underlying causes for complex social phenomena, that is, only *patterns* might be observable. A pattern is a set of variables which are stable over a certain period of time; a social EP theory is then created by an observer acquiring insight into this pattern, and is not changed unless phenomena which they satisfy or obey are changed into phenomena of an entirely different type. By acquiring insight into a pattern of social behavior, elements of social behavior can be predicted, at least roughly

[82] Lee & Baskerville (2003), pp. 232 f.
[83] E. g., Butler (1998); Klein & Myers (1999), p. 71.
[84] Lee (1991), pp. 351-353.
[85] Gregor (2006), pp. 626-630.
[86] Gregor (2006), p. 626
[87] Gregor (2006), pp. 628 f.

Theory Type	Distinguishing Attributes
I. Analysis	Says what is. The theory does not extend beyond analysis and description. No causal relationships among phenomena are specified and no predictions made.
II. Explanation	Says what is, how, why, when, and where. The theory provides explanations but does not aim to predict with any precision. There are no testable propositions.
III. Prediction	Says what is and what will be. The theory provides predictions and has testable propositions but does not have well-developed justificatory causal explanations.
IV. Explanation and Prediction (EP)	Says what is, how, why, when, where, and what will be. Provides predictions and has both testable propositions and causal explanations.
V. Design and Action	Says how to do something. The theory gives explicit prescriptions (e. g., methods, techniques, principles of form and function) for constructing an artifact.

Source: Gregor (2006), p. 620

Table 2.2: A Taxonomy of Theory Types in Information Systems Research

and in a short-term perspective since social patterns are linked to specific societies in time and space.[88] As VON HAYEK argues:

> "*Those mainly concerned with simple phenomena are often inclined to think that where this is the case a theory is useless and that scientific procedure demands that we should find a theory of sufficient simplicity to enable us to derive from it predictions of particular events. [...] We are, however, interested not only in individual events which can be empirically tested. We are equally interested in the recurrence of abstract patterns as such; and the prediction that a pattern of a certain kind will appear in defined circumstances is a falsifiable (and therefore empirical) statement.*"[89]

All that is needed to know in order to make an EP theory applicable to a situation is, therefore, that the data possess certain general properties or belong to the class defined by the scope of the variables. Beyond this nothing needs to be known about their individual attributes so long as it is the aim only to derive the sort of pattern that will appear and not its particular manifestation.[90] For this reason theory in the field of social phenomena is confined to describing kinds of patterns which will appear if certain general conditions

[88] Johannessen & Olaisen (2005), p. 1571.

[89] von Hayek (1967), pp. 27 f. Similarly von Hayek (1967), p. 32, comments on Darwin's theory of evolution: "*The theory as such, as is true of all theories, describes merely a range of possibilities. In doing this it excludes other conceivable courses of events and thus can be falsified. Its empirical content consists in what it forbids. [...] The range of what is permitted by the theory is undeniable wide.*"

[90] von Hayek (1967), p. 28.

are satisfied, but can rarely, if ever, derive any predictions of specific phenomena from this knowledge.[91] However, predictions of a pattern are nevertheless both testable and valuable: since the theory tells the researcher under which general conditions a pattern of this sort will form itself, it will enable her or him to create such conditions and to observe whether a pattern of the kind predicted will appear.[92]

Usually, in the third role, researchers confront an EP theory with interpreted observations in order to deduct meaningful hypotheses. This theory can be a previously *existing theory* or a theory based largely on previously existing theoretical components (explanatory research, deductivism), which is then tested in order to falsify or corroborate it. However, the researcher can also construct a *new theory* based on her or his interpretive understanding (exploratory research, inductivism), which subsequently needs to be tested in further research. As such, Lee's framework can frame a single study, but also whole research programs. Thus a contribution to knowledge with theory of EP type involves either *theory testing* or *theory building*.[93] This distinction is in line with a framework for generalizability proposed by Lee & Baskerville and displayed in Figure 2.2:

- In *Type EE generalizability*, the researcher generalizes *from* empirical statements (as inputs to generalizing) *to* other empirical statements (as outputs of generalizing). Type EE reasoning involves generalizability in two ways: the generalizabilty of data to measurement, observation, or other description (such as a descriptive statistic or a thick description) and the generalizability of the resulting measurement, observation, or other description beyond the sample or domain from which the researcher has actually collected data (such as generalizing to the unsampled portion of the population or to the people in the corporation who were not interviewed). In either case, the product of the generalizing is a description (*interpretation*).[94] This corresponds to first and second role of the researcher.

- In *Type ET generalizability*, the researcher generalizes *from* empirical statements (as inputs to generalizing) *to* theoretical statements (as outputs of generalizing). Type ET reasoning also involves generalizability in two ways: the generalizability of measurements, observations, or other descriptions to an existing theory (*theory matching*) or new theory (*theory generation*), and the generalizability of the resulting theory beyond the sample or domain that the researcher observes (such as the unsampled portion of the population or the parts of the organization where the field worker has neither conducted interviews nor collected data in other ways).[95]

- *Type TE generalizability* is closely related to empirical testing and can involve applying the theory (as the major premise in a syllogism) to a set of initial conditions (i. e., the minor premise, consisting of empirical statements that describe the conditions observed in the experimental or field setting before the experimental treatment is administered), resulting in the conclusion (i. e., predictions, which are empirical

[91] von Hayek (1967), p. 35.
[92] von Hayek (1967), p. 36.
[93] Gregor (2006), p. 628.
[94] Lee & Baskerville (2003), pp. 232 f.
[95] Lee & Baskerville (2003), pp. 235 f.

statements describing what should be observed at the end of the experiment if the theory is true). The only way in which a researcher (or practitioner) may properly claim that the theory is indeed generalizable to the new setting would be for the theory to be actually tested and confirmed in the new setting. This would involve making a comparison between what the theory would describe as happening in the new setting and what is actually observed as happening in the new setting (*theory testing*).[96]

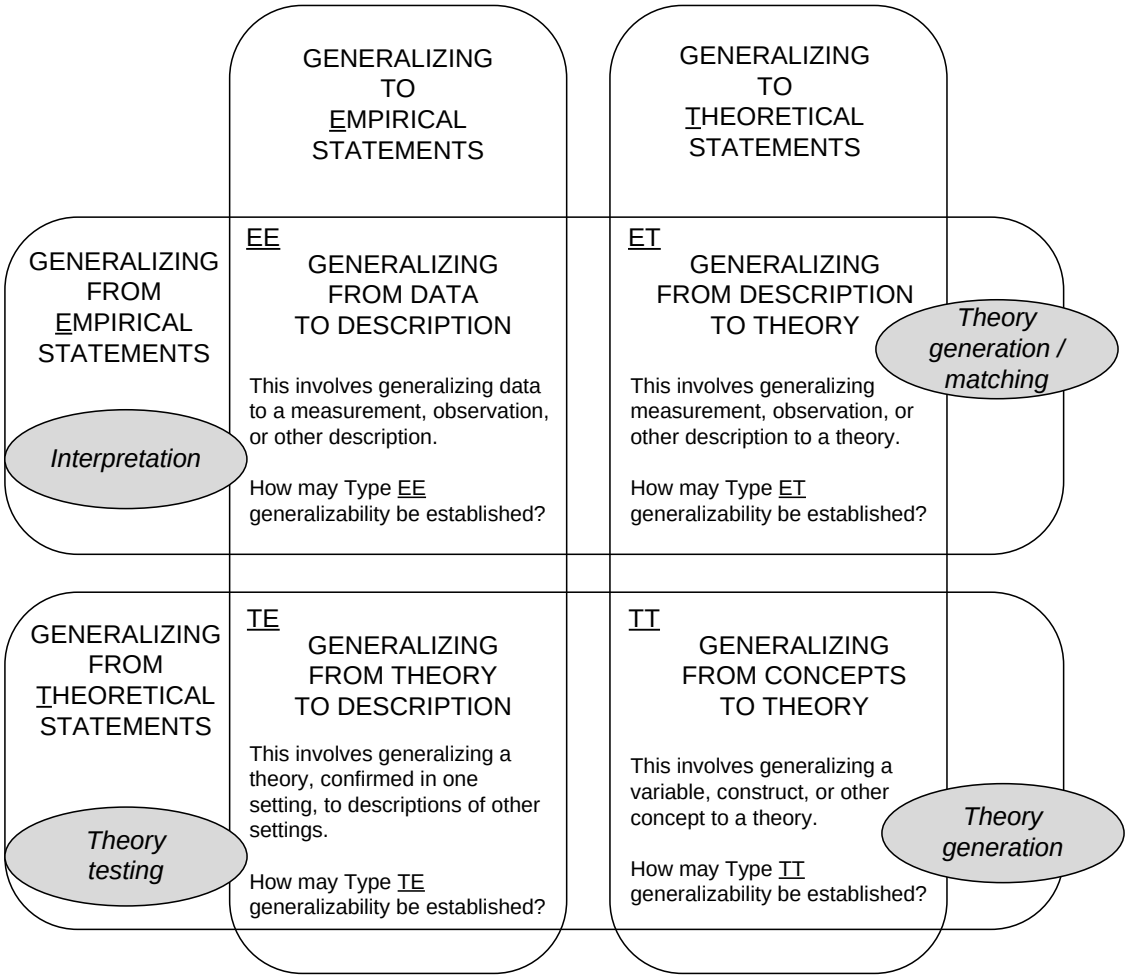
- In *Type TT generalizability* researchers generalize *from* theoretical propositions in the form of concepts (such as a variable, an a priori construct, or another concept) *to* the theoretical propositions that make up a theory (a set of logically consistent propositions that, pending the results of empirical testing, could qualify as a theory) (*theory generation*).[97]

In both cases of exploratory, theory building research and explanatory, theory testing research, the resulting positivist understanding is one that the researcher creates in order to explain the empirical reality that she or he is investigating, the explanation being a scientific theory consisting of *formal propositions*.[98] This is the third role of the researcher. Consequently, the researcher generalizes from the interpreted observations to a either a new or an existing theory (Type ET generalizability). From this generalizability concept stems the idea that one case may yield as much information as many cases. Science operates with conjectures and jumps to conclusions, even after a single observation, as long as the rules of hypothetico-deductive logic do apply and the emerging theory remains falsifiable and testable.[99] In information systems research, this means the (exploratory) inductive generation of a new theory, or the (explanatory) deduction of hypotheses based on existing theories about the information system or organization under examination in order to match the findings with a theory which is subsequently tested.

2.2.4 Fourth Role: Testing of Theory

As has been convincingly argued by others, induction is invalid as a method of scientific justification.[100] Theory can only be generated by induction, but not proved to be true. Accordingly, a scientific theory can never be proved but can constantly be disproved, or falsified. In reaction to this problem, Popper formulated *falsifiability of a theory* as the demarcation criterion for distinguishing science from non-science.[101] Popper's principle of falsifiability as the demarcation criterion derives from his critique of early logical positivist views of science, where empirical observations are seen to be enough to prove a theory. However, there are no reasons to believe that a theory is scientific only because data,

[96] Lee & Baskerville (2003), pp. 237.
[97] Lee & Baskerville (2003), pp. 238.
[98] Lee (1991), p. 351. Propositions are general, confutable statements with empirical content. They refer to an observable phenomenon that can be investigated empirically. If a proposition is connected to an empirical measurement instrument, it is called a hypothesis.
[99] Lee (1991), pp. 346 f.
[100] E. g., Lee (2004), p. 2; see Albert (1985) for a detailed discussion.
[101] Popper (1965).



Source: adopted from Lee & Baskerville (2003), p. 233

Figure 2.2: Four Types of Generalizing and Generalizability

no matter how much of it there is, confirm it: the theory "all swans are white" is not confirmed as always being true by observations of white swans, no matter how many white swans an observer reports.[102] Additionally, POPPER suggests that scientists should design experiments that aim to falsify the theory to the maximum effects.[103] Propositions making up a scientific theory need to satisfy four conditions: (1) they must exhibit internal logical consistency, (2) they must be empirically testable, (3) they must survive attempts at empirical testing (falsification), and (4) they must be at least as explanatory or predictive as any rival theory.[104] This scientific position is generally known as "critical rationalism".[105]

[102]Silva (2007), p. 257.
[103]Silva (2007), p. 257.
[104]Popper (1965), pp. 326-394.
[105]For a critique on the applicability of the resulting methodological rules of critical rationalism in empirical sciences see Keuth (1978), who concludes that critical rationalism is not more than an attitude of being critical with regard to theories.

To summarize, a social science theory must satisfy all the same logical and empirical requirements that a natural science theory satisfies (i. e., POPPER's four conditions), but must also account for the world of subjective meaning.[106] Moreover, a social theory need not be stated in terms of independent and dependent variables. It may be stated in the form of propositions not mentioning any variables, as long as the propositions (1) are logically consistent, (2) are empirically testable, (3) survive attempts at empirical testing, and (4) are at least as explanatory or predictive as the propositions comprising any rival theory.[107] This is the fourth role of the researcher where she or he engages in the *testing of a theory*. Many specific research methods can be used to investigate and test aspects of this EP theory type, including case studies, surveys, archival studies, experiments, simulations, the grounded theory approach, quasi-experiments, statistical analysis, and field studies.[108]

2.3 Research Methods

Normally, information systems research methods are chosen due to distinct worldviews based on certain epistemological and ontological assumptions. However, research methods cannot only be distinguished based on particular epistemological positions. HEVNER et al. and MARCH & SMITH introduce two other distinctions: *behavioral science research* and *design science research*. The former is understood as a "problem understanding paradigm", the latter as a "problem solving paradigm".[109] This refers to two distinct phases of a problem-oriented process, namely understanding and solving it.

Several endeavors have been made in order to conceptualize and apply design science in contrast to behavioral science.[110] Both are complementary parts of the information systems research cycle. Acquiring knowledge about information systems requires the application of both research paradigms. Theories are developed based on observation of information systems and IT usage in practice. These theories are intended primarily to explain and predict human behavior, information system function, and issues interrelated with both of these aspects. Through the process of falsification and testing, these theories are then considered to be either corroborated or falsified. They provide an understanding of the problem situation. This understanding constitutes the basis for designing *IT artifacts* that address a given problem situation. These IT artifacts are intended to be useful for problem solving and provide new impulses for theory development.[111] The goal of design science is utility; rather than producing general theoretical knowledge, design science research aims to create efficient artifacts. Therefore in contrast to behavioral science, design science research aims to provide four general outputs: (1) constructs, (2) models, (3) methods,

[106] Lee (2004), p. 9.
[107] Lee (2004), p. 9.
[108] Gregor (2006), p. 628.
[109] E. g. Simon (1996); March & Smith (1995); Hevner et al. (2004).
[110] E. g., Simon (1996); Nunamaker, Chen & Purdin (1991); Walls, Widmeyer & El Sawy (1992); March & Smith (1995); Hevner et al. (2004).
[111] See Orlikowski & Iacono (2001) and Benbasat & Zmud (2003) for comments on the IT artifact in general.

and (4) instantiations.[112] Hence, behavioral and design science can be considered as two complementary perspectives.[113]

This thesis is mainly concerned with behavioral science: understanding and explaining the goodness of organizations and information systems with regard to communication and coordination. Traditionally, behavioral information systems research has embraced positivism, and statistical methods adopted from the natural science are the instrument of choice.[114] However, according to Galliers & Land and their call for greater methodological diversity in information systems research, it is appropriate to apply a range of different methods, each with its own strengths and weaknesses.[115] Following the discussion of this thesis' philosophical assumptions, it can be argued that the creation of a subjective understanding is the weakest link in the process of scientific research. The creation of a mutual common sense understanding of the research domain essentially creates a boundary for research in the social sciences: only by using the detour of forming a subjective understanding and subsequently creating an interpretive understanding, does the investigation of the phenomena of complex social systems such as information systems and organizations become possible.

Scientific research is highly creative; however, it is not anything-goes arbitrariness.[116] Since the classical image of a clockwork universe is gone, the image of a clockwork science that claims to comprehend all the diversity by a single method and a single set of laws is equally untenable.[117] Taking this into consideration, this study makes use of a multitude of research methods instead of relying solely on one method for investigating the different aspects of organizations and information systems. In the following chapters, action cases and action research are used as methods for exploratory research, whereas interview-based multiple case study research is applied for explanatory research. Details on the methods and the application are given in the respective sections.[118]

However, this study also employed design science during an exploratory action case and followed the methodology as suggested by Vaishnavi & Kuechler for developing an IT artifact within an organization.[119] Since the development of this artifact is not the focus of this thesis, the description of this process is only briefly narrated and not described in detail.

[112] E. g., March & Smith (1995); Hevner et al. (2004); Gregor (2006), p. 628.
[113] See March & Smith (1995) and Hevner et al. (2004) for a more detailed discussion.
[114] Orlikowski & Baroudi (1991); Chen & Hirschheim (2004).
[115] Galliers & Land (1987), p. 901.
[116] Auyang (1998), p. 341.
[117] Auyang (1998), p. 341.
[118] See Yin (2003) for an general introduction to case study research. Lee (1989a) and Lee (1989b) give a general overview about the application of case study research to information systems; Braa & Vidgen (1999) introduce action cases, which incorporate aspects of action research, see Avison et al. (1999); Baskerville & Pries-Heje (1999); Baskerville & Wood-Harper (1996); Checkland & Holwell (1998); Davison, Martinsons & Kock (2004); Susman & Evered (1978).
[119] Vaishnavi & Kuechler (2008), pp. 19-22. See Chapter 4.1.

3 Literature Review

In this chapter the foundations that contribute to the topic of organizational and information systems analysis and design in the field of quality with regard to communication and coordination are discussed. The systems-theoretic view offers a framework for the analysis of organizations and information systems in whole or in parts. Within this study, theoretic concepts are used that are based on systems theory. Chapter 3.1 provides an overview of these fundamental principles. Chapter 3.2 discusses the fundamental concept of information and provides a definition of the term "information system" for this study. Afterwards, the interdisciplinary field of cybernetics is introduced in Chapter 3.3. Especially the concept of variety as a measure for complexity and the law of requisite variety are discussed in detail. Systems theory and cybernetics provide the general framework for this research. Chapter 3.4 gives an overview of traditional approaches in organization theory. Contingency approaches are described in detail, along with a critique of this traditional research understanding. Building on this critique, the perspective of organizations as complex adaptive systems is introduced, which is then linked to the cybernetic concept of self-organization in Chapter 3.5. Chapter 3.6 provides an excursion to the Viable System Model as a language for describing organizational structures which is later used in the exploratory studies for mapping the examined organizations. Finally, Chapter 3.7 shows the importance of language-based communication for organizations and introduces a formalization of information systems as language communities, which builds on the philosophy of language and provides a theoretical basis for the following exploratory empirical studies in Chapter 4 and the theoretical arguments in Chapter 5.

3.1 Systems Theory

3.1.1 Systems Theory & Organizations as Systems

The concepts of system and systemic thinking lie at the very heart of information systems research. In general, a *system* is a thing with interrelated parts, which affect each other and each part depends on the whole system. The idea of interrelated parts, or sub-systems, emphasizes that, while all systems can be analytically broken down, their essence can only be identified when the system is confronted as a whole. This implies that in order to comprehend a system, one must be willing to transcend the view of the individual parts to encounter the entire system, which has properties that are emergent through the relation of its parts.[120] Systems can be hierarchically nested, that is, the elements of a system can be other systems that form a hierarchy of *super-systems* and *sub-systems*. The not-understood big system is carved up into interacting sub-systems, of which behavioral

[120]Hatch (1997), p. 35.

questions are asked, which can result in useful statements about the big system itself.[121] More formally, a *system* S in its most general form is a set of entities, or *elements*, E and a set of *relationships* R between these elements. The *environment* En of a system is a set of elements which are not part of the system but are external to it.[122]

The identification of a system, its elements, and their relationships is dependent on an *observer*. That is, a system is not something given in nature, but a description of something, defined by perspective; therefore Ashby argues that a system is by definition not something objective, it is subjective and depending on the properties ascribed to it by the observer:

> "*[. . .] when we face the complex, the danger of ambiguity becomes acute. The New York conurbation, for instance, is seen very differently by the sociologist, the communications engineer, the historian, the economist, the utilities engineer. When they all point in its direction and say 'this system', they are, in fact, meaning very different things, and will soon fall into confusion if they argue about 'its' properties.*"[123]

Analogies, languages and models of systems are used to describe the world. Systems theory then allows different observers to speak in the same systemic language about a specific system that they have identified in order to create an inter-subjective agreement on the conventions ascribed to this system.[124] As a result systems can be classified according to different characteristics.[125] A popular distinction is often made in relation to the *boundary* of a system to its outside world. If relationships exist between the elements of a system and things external to it, that is, input and output relationships with its environment, a system is called an *open* system. In contrast, in a *closed* system, no relationships are found or made between the elements of the system and its environment.[126]

The *state* of a system is any set of relevant reoccurring properties of the system that can be recognized at a given point in time.[127] The dynamics of a system are determined by the rate of change of a system's states. A change in any environmental element can produce a change in the state of the system.[128] The totality of the space in which the change in states over time may move, the *line of behavior* for S, is termed the *state space*, which can be described by a state vector $x_i(t)$ as the value of the state variables x_i at time t. If the states of a system map on a one-to-one basis with their future states, the system is *deterministic*. In more complex cases the states of a system may map on a many-to-one or

[121] Beer (1965), p. 226.
[122] Ackoff (1971), p. 662
[123] Ashby (1963), p. 95. As Beer (1979), pp. 9-13, states, the recognition of a system and of its purpose is a highly subjective affair; purposes or even boundaries cannot simply be attributed to systems as if these were objective facts of nature.
[124] Beer (1966), pp. 242 ff.
[125] E. g., Ackoff (1971), pp. 662-667; Flood & Carson (1993), pp. 6-21.
[126] Flood & Carson (1993), p. 8. As von Hayek (1967), p. 27, has pointed out, this distinction is somewhat misleading and mostly theoretical since there are, strictly speaking, no closed systems within the universe.
[127] Ashby (1964), p. 25; Ackoff (1971), p. 662.
[128] Ackoff (1971), p. 662

one-to-many basis, and the system is indeterminate or *probabilistic*.[129] Furthermore, the whole is greater than the sum of its parts, that is, systems have *emergent properties*.[130]

The systemic important concept of *homeostasis* can be explained in terms of state space as well. Homeostatic systems are capable of maintaining a specific state space in a changing environment through internal adjustment, a *dynamic equilibrium*, with fluxes in and out. The identity of a homeostatic system may appear to be unchanged, but its elements at time t will be partially or totally replaced by time $t + s$, or in state vector representation, $x_i(t) \approx x_i(t + s)$.[131] It is an elementary property of all systems in equilibrium that they react so as to oppose disturbance; "adapted behavior" then is equivalent to "the behavior of a system is in equilibrium".[132] Thus, the environment is of special importance for every system: both contribute to the organization of the whole, both act dynamically on themselves and on the other, and any equilibrium must stabilize both.[133]

Building on this understanding, *general system theory* tried to pick out certain general phenomena in the empirical universe which are found in many different disciplines.[134] Boulding's *hierarchy of systems*, displayed in Table 3.1, is widely used to explain the major concepts of general system theory. The hierarchy begins with the simplest system and moves to greater complexity with each successive level in the hierarchy. Each level includes the characteristics of lower levels plus unique characteristics of their own level.[135] On the level of *humans*, the hierarchy connects the property of self-consciousness with language and symbolism. The capacity for speech and a much more elaborate image of time and relationship most clearly mark humans off from animals.[136] At the level of *social organizations*, the concern is one with content and meaning of messages.[137] It is not easy to separate clearly the human level from that of organizations because a human isolated from other humans is practically unknown. Most of todays theoretical concepts in the social sciences are still at level 1 to 5 of the hierarchy, although the subject matter clearly involves level 8, a level with an emphasis on communication and homeostasis.[138]

Grounded in general system theory, the *systems view of organizations* which is adopted in this thesis depicts organizations as a mechanism for transforming inputs such as raw materials via processes into outputs such as goods and services. The inputs are taken from the environment, and, for instance, the sales of goods and services produced by a company allow this organization to continue functioning.[139] Therefore *organizations* can be perceived as *socio-technical systems* that are goal-oriented, have a specific purpose, have relationships

[129] Ashby (1964), pp. 24-26; Flood & Carson (1993), p. 10. Moreover, there is need for a *general* method for ascertaining the state that a system is in, see Ashby (1963), p. 95.
[130] Flood & Carson (1993), p. 17; von Bertalanffy (1973), p. 18.
[131] Flood & Carson (1993), p. 12.
[132] Ashby (1947a), p. 47.
[133] Ashby (1947a), p. 56.
[134] E. g., von Bertalanffy (1973).
[135] Hatch (1997), p. 37.
[136] Boulding (1956), pp. 204 ff.
[137] Boulding (1956), p. 205.
[138] E. g., Boulding (1956), p. 207; Pondy (2005), p. 124.
[139] Hatch (1997), pp. 36 ff.

Level	Characteristics	Examples
1. Framework	Labels and terminology classification systems	anatomies, geographies, lists, indexes, catalogs
2. Clockwork	cyclical events simple with regular (or regulated) motions equilibria or states of balance	solar system, simple machines (clock), equilibrium systems of economics
3. Control	self-control feedback transmission of information	thermostat, homeostasis, auto pilot
4. Open (living)	self-maintenance throughput of material energetic input reproduction	cell, river, flame
5. Genetic	division of labor (cells) differentiated and mutually dependent parts growth follows “blue-print”	plant
6. Animal	mobility self-aware specialized sensory receptors highly developed nervous system knowledge structures (images)	dog, cat, elephant, whale or dolphin
7. Human	self-consciousness capacity to produce, absorb, and interpret symbols sense of passing time	homo sapiens
8. Social organization	value system meaning	businesses, governments
9. Transcendental	“inescapable unknowables”	metaphysics, aesthetics

Source: adopted from Hatch (1997), p. 36, based on Boulding (1956)

Table 3.1: Boulding’s Hierarchy of Systems

to outside entities (i. e., they are open systems), exhibit a significant complexity, and change their structure and organization over time (i. e., they are dynamic systems).[140]

3.1.2 Autopoietic Systems

Traditionally, systemic concepts have been explained in the classical, modernistic tradition of general system theory.[141] A relatively new development in systems theory, *autopoiesis*,

[140] In the following sections, the term *organization* is used as a synonym for the terms company, firm, and enterprise.

[141] Hatch (1997), p. 34.

contributed by Varela, Maturana & Uribe, has begun to influence the thinking of modernist organization theorists.[142] Autopoiesis as a biological theory was developed in order to explain the nature of living systems as opposed to non-living systems. An autopoietic system in its most general form means a self-producing system. For instance, a cell produces its own components that in turn produce it.[143] The autopoietic system produces, and is produced by, nothing other than itself.[144] Consequently, autopoietic systems do not primarily transform inputs into outputs, they transform themselves into themselves: the system uses its components as inputs to produce again its own components.[145]

Central to the concept of autopoiesis is the idea that the different elements of the system interact in such a way as to produce and reproduce the elements: through its elements, the system reproduces itself, and the elements of the system are not produced by something outside the system.[146] Therefore autopoietic systems are operatively closed because there are no operations entering the system from outside nor vice versa (operational closure). This, however, only implies a closure on the level of the operations of the system in that no operations can enter or leave the system. Nonetheless, autopoietic systems are also open systems because all autopoietic systems have contact with their environment (interactional openness). For instance, living cells depend on an exchange of energy and matter without which they could not exist. However, the autopoietic system determines when, through what channels, and what type of energy or matter is exchanged with the environment.[147] Consequently, autopoietic systems are *organizationally closed* but *structurally open* in that, while they internally are characterized by relations of self-production, they still have interactions and relations with their environment.[148] An autopoietic system is said to be *structurally coupled* to its environment (or to other systems in its environment) if its structures are in some way or other adjusted – embedded within – to the structures of the environment (or to systems in the environment), that is, if the structures of the system allow for reactions to important environmental events.[149] For instance, animals living on solid ground are structurally adapted to a different environment from those living in water: the former might have structures that rely on visual senses and perceptions as inputs, while the latter might also have structures that rely on sonic vibrations and perceptions.

Despite reservations expressed by Maturana & Varela about applying the theory of autopoietic systems from biology to other areas such as social systems[150], many researchers

[142] Hatch (1997), pp. 373 f.; for the original theory of autopoiesis in the context of living systems, see Varela, Maturana & Uribe (1974); Maturana & Varela (1979); Maturana (1980); Maturana & Varela (1987); Varela (1979); Varela (1981b); Varela (1981a); Varela (1984).

[143] Flood & Carson (1993), p. 19.

[144] Mingers (1995), p. 11.

[145] Varela, Maturana & Uribe (1974), p. 188; Mingers (2004a), p. 404.

[146] Seidl (2005), p. 22.

[147] Seidl (2005), p. 22.

[148] Mingers (2004a), p. 404. See also the comments on the difference between "organization" and "structure" in Chapter 3.4.3.

[149] Seidl (2005), p. 24.

[150] Maturana & Varela propose the use of the term *autonomy* instead of autopoiesis as the proper term for referring to the identity-preserving capability of social systems; autonomous systems strive to maintain their identity by subordinating all changes to the maintenance of their own organization as a given set of relations. See Maturana & Varela (1979), pp. 80-81.

have attempted to use it in the study of social systems.[151] One of the most prominent applications to social systems has been proposed by the German social systems theorist Niklas Luhmann.[152] According to Luhmann, organizations construct their own reality and this process of construction takes place in an unknown world, as every organization operates in a world that it cannot know. Therefore organizations are "being overtaxed by environmental complexity".[153] The unknown world is transformed through *uncertainty absorption* into – and replaced by – a known world.[154] The main component of these processes is *communications*.[155] Luhmann argues that all social systems are self-referential by nature, because all social processes are based in or carried by communication processes, and reflexivity in social systems requires communication about communication.[156] The self-referentiality implies a closed system with respect to communication or meaning – meaning is always determined inside the system – but does not negate that systems are open to their environments.[157] Luhmann claims that these reflexive and autopoietic processes, which determine meaning, will develop in social systems whenever a great need for structural change exists.[158]

However, Luhmann does not exactly specify the operators and mechanisms of these processes, and is criticized for only providing a very abstract and impoverished view of social interactions.[159] Therefore many organization and social theorists are still not convinced that autopoiesis as a theory can be transferred to organizations and social systems:

> "*Thus, the overall conclusion is one of agnosticism. Autopoiesis as a social theory has many attractions, and there may be very specific social situations [...] where it could be identified. But, in general, I do not believe that social autopoiesis has yet been demonstrated. Nevertheless, further research in this area is certainly to be encouraged.*"[160]

Amongst others, Mingers proposes the following two points as valid areas of inquiry:

- attempting to demonstrate empirically a self-constructing social system.
- developing further other theoretical ideas concerning the biological basis of observation, languaging, and embodied cognition. This leads to a particular view of interacting human agents at the individual level which could possibly be combined with modern complexity theory at the system level to produce an interesting new synthesis.[161]

[151] E. g., Luhmann (1995); Robb (1989); Zeleny (1981); Zeleny & Hufford (1992).
[152] E. g., Luhmann (1991); Luhmann (1995); Luhmann (2000); Luhmann (2005).
[153] Luhmann (2005), p. 99
[154] The concept of uncertainty absorption refers to the process that takes place when inferences are drawn from a body of evidence and the inferences are then communicated instead of the evidence itself. See March & Simon (1958), p. 165; Seidl (2005), pp. 40 f.
[155] Luhmann (1991), pp. 191 ff., 240; Luhmann (2000), pp. 59-62.
[156] Luhmann (1995), p. 450.
[157] Luhmann (1995), p. 37.
[158] Hatch (1997), p. 374.
[159] Mingers (2004a), p. 420; Mingers (2002), pp. 289 ff.
[160] Mingers (2004a), p. 421. See Kickert (1993), Mingers (1995), Kay (2001), Mingers (2002) and Bausch (2002) for other perspectives on this discussion.
[161] Mingers (2004a), p. 421.

The concept of autopoiesis, applied to organizations as social systems, has important implications for the understanding and conceptualization of information systems and organizations. This study tries to address the points of inquiry mentioned above in order to further explore the utility of autopoesis with regard to information systems and organizations.

3.1.3 Systems & Complexity

BOULDING's hierarchy shows that complexity is an important concept that is often associated with systems, and it deserves a more thorough introduction. In general, *complexity* is a multi-faceted term which has many possible meanings.[162] Traditionally, complexity has been thought of as a property of a system: a complex system is made up of a large number of parts that have many interactions.[163] However, research in complex systems has let to the perspective that it is more natural to see complexity not as a property of a system, but an emergent property of the relationships between elements of the system.[164] Likewise, there is a distinction between a system having many different parts – complexity of detail – and a system of dynamic complexity. A system has dynamic complexity when its parts have multiple possible modes of operation, and each part may be connected, according to need, to a different part.[165]

Complexity is a fundamentally *qualitative* concept, though several attempts have been made by various researchers to provide a more or less useful and general quantitative definition, such as algorithmic complexity or Kolmogorov complexity, computational complexity or logical depth, thermodynamic depth, and mutual information.[166] These are used, for instance, to design complexity measures in software engineering for the development of software systems.[167] Due to its qualitative nature, it is difficult to exactly determine and measure what constitutes the complexity of a system. Intuitively, one can make a connection between complexity and understanding. When something new is encountered, the objective usually is to understand it. This enables one to use, modify, control, or appreciate a thing. Understanding is achieved in a number of ways, through classification, description, and ultimately through the ability to predict behavior. Complexity is a measure of the inherent difficulty to achieve the desired understanding. Simply stated, the complexity of a system then is the *amount of information necessary to describe it.*[168] However, as with systems, this makes complexity also *subjective.* For instance, the brain is much simpler to a butcher than to a neurophysiologist, thus the complexity depends on the aspects considered.[169] Generally, since complexity is something perceived by an observer, the complexity of the

[162] E. g., Flood & Carson (1993); Klir (1985). As Rivkin (2001), p. 279, notes, the definition of the term complexity is the subject of vigorous, sometimes strident debate among advocates and skeptics, and he reports that researchers examining complexity employ up to 41 different definitions of the word.
[163] Simon (1996), p. 183.
[164] E. g., Bar-Yam (1997), pp. 703 ff.
[165] Courtney et al. (2008), p. 39.
[166] Backlund (2002), p. 30.
[167] E. g., McCabe & Butler (1989).
[168] Bar-Yam (1997), p. 703. Likewise, Ashby (1973), p. 1, proposes that the degree of complexity should be measured by the quantity of information required to describe the vital system.
[169] Ashby (1973), pp. 1 ff.

system being observed can be described as a measure of *the perceived effort that is required to understand and cope with the system.*[170]

3.2 Information & Information Systems

3.2.1 Information, Data & Knowledge

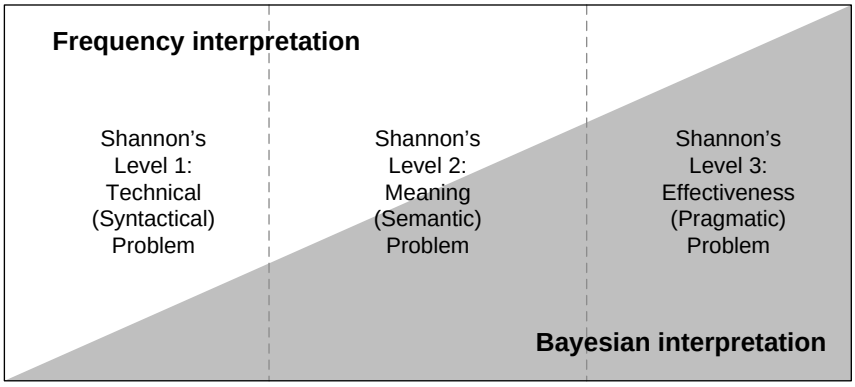
As seen in the previous section, the concept of *information* is important for describing systems and understanding their complexity. Furthermore, it is the second concept at the heart of information systems research. However, the terms data, information and knowledge are widely used in all scientific disciplines as well as in everyday life. Therefore, it is necessary to introduce clear and unambiguous definitions of these terms to ensure a consistent understanding in this thesis.

As the "lore of symbols", *semiotics* consists of three subordinate branches: syntactics, semantics and pragmatics.[171] From a semiotic perspective, information can either be defined in a syntactic, semantic, or pragmatic way.[172] *Syntactics* (or syntax) deals with relations of symbols to one-another. People who want to communicate by language need syntactical conventions in order to create a common understanding of interrelated symbols. The syntactical definition describes information as a sequence of characters.[173] *Semantics* deals with the relation of symbols to concepts. These conventions are necessary for language-based communication in order to address one object with the same symbol. The semantic definition describes information as a representation of an object, that is, information is a sequence of characters with a specific meaning. *Pragmatics* deals with the relation of symbols to their interpreters, and addresses the understanding of symbols to language users. The pragmatic definition stresses the purpose of information, that is, information has to be useful for taking decisions or activities.

Classical *information theory* originated in an engineering tradition and concerns itself primarily with the challenge of information transmission rather than with problems of information content or meaning.[174] Information theory tries to maximize the fidelity of transmission at an acceptable cost – a technical (or syntactical) level problem (level 1). As Shannon took pains to point out, information theory is not particularly concerned with what the symbols actually *mean* – a semantic level problem (level 2) – or with whether a given message has the desired effect on a given message destination – an effectiveness level or pragmatic level problem (level 3).[175] These levels are displayed in Figure 3.1. Level 2 and level 3 are viewed as problems to be addressed by social scientists rather than engineers, and thus Shannon sought to offer a clear line of demarcation between information and knowledge. In order to provide a finite measure of the information potential of a given signal

[170] Backlund (2002), p. 31. See also Ranganathan & Campbell (2007), pp. 38 f.
[171] Morris (1971), pp. 22-43.
[172] It is not the aim of this thesis to provide a comprehensive discussion of different definitions and origins. For a detailed discussion of the term see Holten (1999), pp. 71-74, based on Bode (1997). For a similar discussion see Boisot & Canals (2004).
[173] E. g., as in classical information theory, see Shannon (1948).
[174] E. g., Shannon (1948); Shannon & Weaver (1949); MacKay (2003). See Boisot & Canals (2004), pp. 51 ff., for a thorough review.
[175] See Shannon (1948), pp. 379-423, 623-656.

or channel for engineering purposes, SHANNON had to ignore any particular interpretation process, and stop the analysis prior to including any consideration of what a sign or signal might be about.[176] Crucially, information theory takes the repertoire of symbols to be transmitted as given, and does not ask how the repertoire came into being, whence the distinctness of the symbol system came from, or whether the symbolic repertoire was established by prior convention or through a gradual process of discovery.[177] Thus what SHANNON called the level 2 or semantic problem – is the received message understood? – is not of concern for information theory. This depends on whether the receiver possessed the relevant *code*, for instance, some familiarity with the alphabet, the vocabulary and the syntactic rules of the English language, et cetera.[178]



Source: Boisot & Canals (2004), p. 54

Figure 3.1: Frequency and Bayesian Interpretations in Communication

Consequently there must be some redundancy with what is already known for information to be assessed: both sender and receiver must share the set of options that constitute information.[179] Referential information is not an intrinsic feature of any sign or signal, but a function of extrinsically imposed constraints. In different contexts and for different interpreters the same sign or signal may be taken to be about very different things.[180] Therefore information is both an objective term – the quantity of information that can potentially be carried by a given data set – and a subjective term – the amount of information that can be extracted in practice from the data set by a situated agent.[181] Information is relational with respect to the second of these terms. For instance, the English language contains an objective amount of information based on the relative frequency of appearance of letters of the alphabet and of certain types of words, such as articles and pronouns. In the objective view, information content is set by the ratio of actual to possible events: both the repertoire of possible events and their frequency are fixed *a priori*, so that the computation of information content is straightforward. Yet, as in example of the English language, as soon as one moves up to the level of sentences and paragraphs, the number of possible

[176] Deacon (2007), p. 137.
[177] Boisot & Canals (2004), p. 51.
[178] Boisot & Canals (2004), p. 53.
[179] Deacon (2007), p. 140. This is exactly why a shared language is so important, see also Chapter 3.7.
[180] Deacon (2007), pp. 141 f.
[181] Boisot & Canals (2004), p. 52.

sentence constructions moves to infinity. Thus the repertoire of possible sentences is now largely shaped by the circumstances in which any given sentence is likely to be uttered, that is, by its *context*, which *varies in the extent to which it is shared across individuals*. For instance, the discourse that might take place in a biology laboratory will be meaningful to a much smaller group of people than the one taking place on a television chat show. In sum, it is *shared context*, the generator of inter-subjective objectivity, that stops information content from moving to infinity and that renders discourse possible.[182] Consequently, the activity of extracting information from data constitutes an *interpretation of the data*. This involves an assignment of the data, encountered in a shared context, to existing categories according to some set of pre-established schemas or models that shape expectations. Thus, *data can only constitute information for an agent who is already knowledgeable*.[183]

According to Backlund, Langefors argues in a similar way.[184] His *infological equation* states that $I = i(D, K, t)$. I is the information produced from the data D and the pre-knowledge K, by the interpretation process i, during the time t. However, information is not only received by someone, but also created and transmitted by someone, expressable as $D = f(I, K, t)$, where D is the data produced from the information I, that is, what the sender wants to convey, and K is the pre-knowledge of the sender, during the time t, which is the time required to formulate the message, in the translation process f. Backlund concludes that unless the pre-knowledge of the sender and the pre-knowledge of the receiver are sufficiently overlapping, communication cannot be successful.[185] Then, the efficiency of the information transferring process can be measured as

$$\frac{|I_{reciever} \cap I_{sender}|}{|I_{sender}|}$$

where $I_{receiver}$ is the information received by the receiver, I_{sender} is the information that the sender wanted to transfer and $I_{receiver} \cap I_{sender}$ is the information that is common to $I_{receiver}$ and I_{sender}, that is, the part of the information that the sender wanted to communicate that was actually transferred.[186] Building on this, Backlund argues that it is hard to measure the success of communication on the semantic level. One would need to know what those from whom the information originated wanted to transfer, which cannot really be known, and how this was interpreted by the receiver, which cannot be known either. Even if both were asked, their answers would still have to be interpreted, and some information would be lost; even if they would use exactly the same words, there is no guarantee that they would attach exactly the same meaning to them. Perhaps estimates can be made, but even so, one must also keep in mind that this measure in itself is just an estimate.[187]

Following this argument, for the purpose of this study, information is defined from a semantic-pragmatic perspective as *the representation of an object in a particular language*

[182] Boisot & Canals (2004), pp. 52 f.
[183] Boisot & Canals (2004), p. 55.
[184] See Langefors (1995), p. 144, according to Backlund (2002), pp. 37 ff., in the following.
[185] Backlund (2002), p. 37.
[186] Backlund (2002), p. 37.
[187] Backlund (2002), p. 38.

with has a specific meaning and has an effect on organizational decisions or activities.[188] The purely syntactical definition of information is regarded as *data*. The merging of semantic and pragmatic definitions is important: to understand the sentence is not necessarily to understand the message; only prior *knowledge* will allow a contextual understanding of the message itself, and the message, in turn will carry information that will modify that knowledge. Therefore information and knowledge must also be distinguished from one another.[189] Then information, in effect, sets up a *relation* between data and a given individual. Only when what constitutes a significant regularity is established by *convention*, can information appear to be objective, in the sense of *inter-subjective*, within the community of individuals regulated by the convention.[190] Yet a tight coupling of information and knowledge, with knowledge becoming little more than processed information, is unrealistic, since different agents may still extract different knowledge from the same information.[191] To summarize, at level 3 in Figure 3.1 – the pragmatic problem – there is little scope for a pure frequency perspective on probabilities as in classical information theory, since conventions on this level are subjectively experienced and highly variable constraints, which lend themselves to a Bayesian interpretation of probabilities.[192] Information is always relational and context-dependent: individual human actors convert data into information guided by the possession of prior knowledge. This process consumes time, space, and energy and intelligent agents will be concerned to minimize their consumption of such resources.[193] Building on this, Boisot proposes the *Information Space (I-Space)* which places information in relation to the three dimensions of abstraction, codification, and diffusion.[194] The curve of Figure 3.2 in the I-Space shows that the more codified and abstract an item of information is, the more extensively it will diffuse within a target population within a given time frame. Codification and abstraction means standardization of terms that have meaning, which trades off communicative *effectiveness* for communicative *efficiency*. Codification and abstraction are mechanisms to deal with complexity, and agents in the I-Space process and exchange information with other agents using these mechanisms.[195]

[188] E. g., Bode (1997), p. 459; Teubner (1999), p. 17. In general, this thesis follows the definitions of Hoffmann (2008) in distinguishing between data, information, and knowledge.

[189] Boisot & Canals (2004), p. 44.

[190] Boisot & Canals (2004), p. 47.

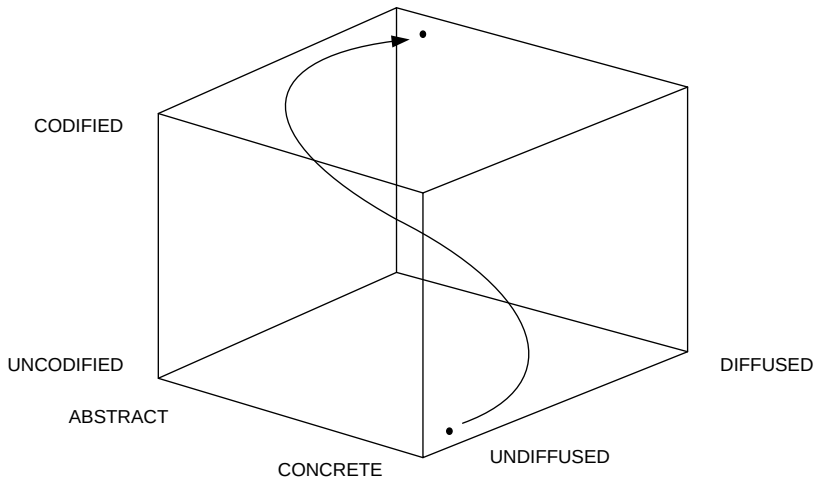
[191] Fransman (1998), p. 49.

[192] Bayesian interpretations of probabilities interpret probability as the subjective degree of belief in the truth of a proposition. See MacKay (2003), pp. 26, 48-56.

[193] Boisot & Li (2006), p. 225.

[194] Boisot (2006), p. 241. *Codification* creates categories in order to make clear and reliable distinctions between relevant states of the world that one can act upon, *abstraction* reduces the number of categories that one needs to draw upon when classifying phenomena. Codification and abstraction allow to respond to phenomena more discriminating and faster, however, this activities have set-up and operating costs. Moreover, articulation will be efficient only if the categories are distinct from each other (i. e., well codified) and few in number (i. e., abstract), see Boisot & Li (2006), pp. 226 ff. Furthermore, a growing body of evidence suggests that most knowledge is of the tacit, embodied kind, which will never be made explicit, see Boisot & Li (2006), p. 243.

[195] Boisot (2006), p. 242.



Source: Boisot (2006), p. 241

Figure 3.2: The Information Space (I-Space)

3.2.2 Information & Entropy

Information is closely related to *uncertainty* as measured in *entropy*.[196] Information reduces uncertainty. Entropy quantifies the uncertainty associated with a random variable, or the probability of a state z_i to occur. This gives a measure of how difficult it is to predict a single state of a system, with entropy $H(X)$ of a random variable X as

$$H(X) \;=\; \sum_{i=1}^{|Z|} p_i \times log_2(p_i),\; p_i \;=\; p(z_i) \;=\; P(X = z_i).$$

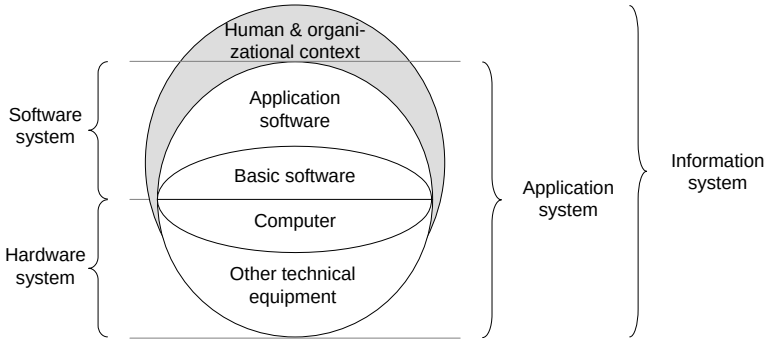
According to Ranganathan & Campbell, the term $log_2\ (\frac{1}{p_i})$, deducted from this formula, is often called the *surprisal factor*. Surprisal is the degree to which one is surprised to see a result. If the probability of an event is 1, there is zero surprise at seeing the result. As the probability gets smaller and smaller, the surprisal goes up. Hence, if the system may only be in a small number of states, each with relatively high probability, then the entropy is low and one is unlikely to be surprised very often. However, if the system can be in a large number of rare states, then the entropy or unpredictability is high. There are two ways in which unpredictability of a system can be reduced. One is by reducing the number of states that the system can be in. The other is by increasing the probability of a few "desired" states and reducing the probability of other states.[197] A broader interpretation makes H a parameter which measures the non-metric variability of any probability distribution: H has a value of zero when the probability is concentrated in a single category and is maximum when the probability is uniformly distributed over all categories.[198]

[196] Shannon (1948).
[197] Ranganathan & Campbell (2007), p. 39.
[198] Garner & McGill (1956), p. 219.

Following from the three semiotic levels of Figure 3.1, Boisot & Canals distinguish three different types of entropy: entropies 1 and 2 are to be found at Shannon's technical level and involve the erasure of differences between physical states (entropy 1) and symbols (entropy 2); entropy 3 is to be found at the semantic and effectiveness levels and involves the erasure of differences between possible contexts required for the interpretation of either states or symbols.[199] All three different entropies are variations of the formula above, where $|z_i|$ describes either the number of possible data states, the number of symbols in a repertoire, or the number of interpretative contexts that are compatible with a given set of states or symbols. Entropy 3 at the semantic level can occur because the receiver does not know the codes or what, specifically, they refer to (i. e., narrowly defined context). At the pragmatic level it can occur because the receiver does not know to embed the message as a whole into an appropriate context. Therefore Boisot & Canals argue that, strictly speaking, there is no such thing as common knowledge and there is common information only to a limited extent: only data can ever be completely common between agents.[200]

3.2.3 Information Systems

Stemming from the presentation of the concepts of system and information, the term "information system" can now be rigorously introduced. *Information technology* (IT) is all physical equipment, machines, and devices which are used for input, processing and handling, and output activities of *data*, or syntactical information. This mostly refers to computer hardware, software, and network resources. Thus IT includes communications technology.[201] This study defines an *information system* as a socio-technical system in a specific organizational context, which includes both technical and organizational sub-systems as illustrated in Figure 3.3.[202]



Source: adopted from Teubner (1999), p. 26

Figure 3.3: Shell Model of Information Systems

[199] Boisot & Canals (2004), p. 63. Entropy 1 has the effect of increasing entropy 2 and entropy 3. However, redundancy at the semantic and effectiveness levels can mitigate the effects of entropy 1.

[200] Boisot & Canals (2004), p. 63.

[201] Laudon & Laudon (2005), pp. 14 f.; Laudon & Laudon (2009), p. 15; Teubner (2004), p. 5.

[202] Laudon & Laudon (2005), pp. 8-13; Laudon & Laudon (2009), pp. 10-15; this is compatible with the general contemporary view of information systems in German *Wirtschaftsinformatik* (business informatics), e. g., Teubner (1999), pp. 26. f.; Ferstl & Sinz (2001), pp. 8 f.; Krcmar (2003), pp. 25 ff.; Becker et al. (2004), p. 33.

Consistently, Hirschheim, Klein & Lyytinen describe information systems as technically mediated social interaction systems aimed at creating, sharing and interpreting a wide variety of meanings.[203] The *technical sub-system* includes an application system with all IT equipment for solving an organizational task. The *social sub-system* is composed of humans in an organizational setting as users of the application system, with allocation of responsibilities for specific tasks. Consequently, information systems deal with semantic and pragmatic information and not with syntactic information only: the technical system is used to process data and the social system processes semantic and pragmatic information based on this data.

Whereas a more technical view on information systems was prevalent during the early days of IT due to the relative costs of the technical components, today the social dimension is more likely to cause problems since overall, the technology is reliable and well tried.[204] Therefore it is unwise to think of an information system as necessarily a computer-based system but far better to think of it as an organization: IT is only able to play a limited role in an organization by capturing, storing, forwarding, and processing the signals; organized human behavior depends on a far richer form of communication than any machinery can account for.[205] Similarly, Allen & Varga suggest that evolution in complex systems such as organizations is driven most strongly by individuals, and that information systems co-evolve through these individuals' interactions with other agents.[206] An information system is not the IT alone, but the system that emerges from the mutually transformational interactions between the IT and the organization, the result of an IT enabling an organization, as much as an information system is the result of an organization enabling an IT.[207]

In accordance with Land, this study sees information systems primarily as *social systems*, and disciplines relevant to the study of information systems include organizational theory, computer science, semiotics, and cognitive psychology:

> "*[...] an information system is a social system, which has embedded in it information technology. The extent to which information technology plays a part is increasingly rapidly. But this does not prevent the overall system from being a social system, and it is not possible to design a robust, effective information system incorporating significant amounts of the technology without treating it as a social system.*"[208]

Moreover, organizations and their information systems are growing mostly inextricable, and all large organizations are fully committed to their information systems as infrastructure.[209] This study follows Lucas & Baroudi in their argument that for any organization the tasks of technology design and organization design become ever more closely intertwined, and that (1) *the design of IT is the design of organizations* and that (2) *organizational designers should take advantage of the IT-enabled variables for designing organizations.*[210]

[203] Hirschheim, Klein & Lyytinen (1995), p. 13.
[204] Avison & Fitzgerald (1995), p. 6.
[205] Stamper et al. (2000), p. 15.
[206] Allen & Varga (2006), p. 229.
[207] Lee (2004), pp. 11 f.
[208] Land (1985), p. 215. See Lee (2004) for a similar point of view.
[209] Courtney et al. (2008), p. 43.
[210] Lucas & Baroudi (1994), p. 22.

In other words, one cannot safely distinguish between the engineering of an IT system and the development of the organization.[211] This has consequences for the goal of this study: the goodness of an organization is synonymous to the goodness of its information systems.

The interaction between IT and organization is very complex and influenced by many mediating factors, including the organization's structure, standard operating procedures, politics, culture, environment and management decisions.[212] Consequently, one of the main problems for an organization in achieving viability is the complexity and uncertainty exhibited by itself and its environment.[213] When an organization or information system is not complex, events and outcomes are well-understood, and management can follow standard procedures to regulate the business processes, resolve problems and improve efficiency. But an increase in complexity renders it relatively difficult to establish rules, procedures and predetermined responses to potential problems.[214] Moreover, complexity causes increased numbers of exceptions and deviations. However, reducing complexity is not always achievable or even desirable: complexity is a necessary feature of organizations because it may be needed it in order to respond to the complex reality of a specific environment.[215] Then how should an organization structure and design itself and its information systems in order to cope with complexity? Is there a relationship between complexity and quality with regard to communication and coordination? What is the goodness of a complex system? As a consequence, complexity becomes a subject for information systems research.[216]

3.3 Cybernetics

Complex systems such as information systems and organizations are by no means a new phenomenon and there are periods in which there are bursts of interest in studying complex systems.[217] For instance, large and complex systems – big systems – are the topic of cybernetics.[218] Cybernetics, as a truly interdisciplinary perspective, offers a large body of knowledge for dealing with these issues. This study proposes to built on this existing knowledge for dealing with questions concerning the quality of complex systems such as organizations and information systems with regard to communication and coordination.

[211] Snowdon & Kawalek (2003), p. 1026. Following this discussion, it is important to note that the notion of the concept "information system" is twofold for the purpose of this study. The members of an information system's development team *are* an information system. The purpose of this information system is to design a *different* information system. See Boland & Tenkasi (1995), pp. 195-196, and Brelage (2006), pp. 38-39, for similar views.

[212] Laudon & Laudon (2005), p. 77; Laudon & Laudon (2009), pp. 13 f.

[213] Jackson (1989), p. 413.

[214] E. g., Daft & Macintosh (1981).

[215] E. g., Simon (1996), pp. 1-24.

[216] This has been acknowledged by recent special issues of information systems research journals, which took a first step in recognizing complexity and related notions such as uncertainty, emergence, self-organization, chaos, or adaptive systems as important issues, e. g., Jacucci, Hanseth & Lyytinen (2006) and Merali & McKelvey (2006).

[217] Simon (1996), pp. 169 f.

[218] Beer (1965), p. 223.

3.3.1 General Principles

The Greek word *kybernetes* means the art of steersmanship and was used in ancient Greece to refer both to the piloting of a vessel and to the steering of the "ship of state". In the twentieth century, recognition and attention of the nature of control processes in all fields of study coined the rise of *cybernetics* as a science – not as a discipline, since along with general system theory, cybernetics is fundamentally interdisciplinary systemic thinking.[219] Cybernetics concerns itself with the essential unity of problems surrounding communication and control in machines and biological systems.[220] For achieving *control* over a system in the sense of cybernetics, the current state of a system is compared to the desired state and any discrepancy between the two states triggers an adjustment. A typical example for this kind of control is a thermostat.[221]

Cybernetics shows that the idea of *negative feedback* is crucial for understanding control. Negative feedback ensures self-regulation for complex systems and a feedback control system is characterized by its closed-loop structure. Negative feedback processes transmit information about any divergence of behavior from a preset goal (the negative feedback), and take corrective action on the basis of this information to bring the behavior back toward the goal. Likewise, communication is important since to control the actions of a machine or individual, one has to communicate with it. If control involves the communication of information, information as introduced in Chapter 3.2.1 is a central part of cybernetics.[222]

Moreover, according to cybernetics, complex systems cannot be easily examined in order to discover what processes are responsible for system behavior: the way not to proceed is by reductionist analyst. Instead, such systems must be seen as a *black box*.[223] The reductionist analysis of the separate parts of a complex system will not help in the analysis of interactions of the whole. Instead, the complex system is treated essentially as a whole of which only the inputs and outputs are observable. Nonetheless, a measure is needed in order to deal with complexity.

3.3.2 Variety & the Law of Requisite Variety

The Concept of Variety

The cybernetic concept of variety proposes a solution for the problem of measurement of complexity. *Variety* as a measure for complexity defines the number of manifestations or patterns of behavior, the possible distinguishable states of a system.[224] Thus variety is related to entropy[225], but more general in its applicability, since the frequency of the state

[219] Jackson (2000), p. 67.

[220] Wiener established the famous definition of cybernetics with his seminary book published in 1948 and titled *Cybernetics – or Control and Communication in the Animal and the Machine*. See Wiener (1948). Prominent cybernetic works include Ashby (1964); Forrester (1961); Beer (1966) and von Foerster (1981).

[221] Hatch (1997), p. 328.

[222] Jackson (2000), pp. 68 ff.

[223] Jackson (2000), pp. 69 f.; Ashby (1964), pp. 86-117.

[224] Ashby (1964), pp. 124-126; Beer (1981), p. 41.

[225] See Chapter 3.2.2.

is not important.[226] In relation to a set of distinguishable elements of a system, variety means either (1) the number of distinct elements, or (2) the logarithm to the base 2 of this number. Measured in logarithmic form, the unit of variety is the bit.[227]

According to Beer, if the variety of anything is its number of distinguishable elements or states, then the following statements can be made about variety's relation to information and uncertainty:[228]

- If more information about the elements – the parts of a thing – and their relations is added, the variety goes up. Simply put, for every class of information added, the number of possible connections increases. The relations of the elements may take on many values, for instance, an element A is element B's father, or A maybe taller, richer, older than B et cetera. To specify what is actually happening, a greater amount of uncertainty must be removed with each class of information added.[229]

- In case of dynamic systems, the elements will be distinguishable states of the system instead of mere elements. Every conceptual step of an observer which enriches the nature of a system under study increases the information about it, increases the uncertainty informing it, and proliferates its variety.[230]

- If a situation has a variety of 1024 choices, or 10 bits, the only advantage in knowing this number is to be able to say that it will take ten binary ("yes/no") decisions to eliminate the uncertainty implicit in that variety – because $1024 = 2^{10}$.[231] Thus *uncertainty is function of variety* and a decision, which reduces uncertainty, is the selection of one possible state from all the others.[232]

- The distinction between "yes" and "no", 0 and 1, is *the elemental decision* for the control of a system.[233] Every decision with n logical variables has an n-dimensional decision space. This variety of a decision situation presents the number of integral alternatives; the decision space is the totality of these alternatives. Then the variety of a decision also gives the uncertainty which has to be removed in searching for the completed specification of the decision situation.[234]

Beer gives the example of a simple managerial decision for illustrating this: one has eight products and eight machines; each product can be made on each machine. Then a decision might be to determine which of the products should be made on which machine: a two-dimensional problem with a variety of eight in each dimension, resulting in a variety of 64 alternatives, of which one has to be selected – the decision of this situation involves

[226] In the case of complex systems such as biological or social systems which are seldom isolated long enough, or completely enough, for relative frequencies to have a stationary limit, the more "primitive" concept of variety will have to be used instead of probability, see Ashby (1958).
[227] Ashby (1964), p. 126.
[228] Beer (1966), pp. 247 ff.; Beer (1981), pp. 212-230.
[229] Beer (1966), pp. 249-251.
[230] Beer (1966), pp. 251-252.
[231] Beer (1981), p. 45.
[232] Beer (1981), p. 212.
[233] Beer (1981), p. 44.
[234] Beer (1965), p. 229.

variety reduction from 64 to one.[235] So the relation between complexity of a system and the information required to understand a system is also reflected in variety as a measure of complexity.

However, if different observers of the system distinguish the states or elements differently, then they will come to different measures of the variety of the system. As such, like complexity, variety is not an intrinsic property of the system, but rather depends on (1) how the observer defines the system[236], and (2) on what scale she or he observes the system.[237] Scale denotes *the observer's distance from the system*; depending on how close or far removed the observer is, a system may have differing levels of variety. Bar-Yam gives a good example of this by considering our planet: at one scale of observation it is a simple dot – a planet moving predictably along its orbit; yet, observed at greater detail (a smaller scale) its complexity increases dramatically: the movement of the atmosphere and the oceans, plants and wildlife, cities, human beings, et cetera.[238] Thus, variety cannot be recorded as a single quantity or quality, which again underscores the subjectivity of complexity and the point of view of the observer. In principle, once one has agreed on *conventions* for the states one is interested in, it is thus possible to count all possible states of a system. If this is not directly possible, comparisons can be made ("something has more or less variety than another thing") or ordinal scaling can be applied ("this product is the fifth most variable").[239] Consequently, things that are different in nature can be compared with regard to their complexity by using variety as a measure.[240]

Requisite Variety and its Implications for Organizations as Systems

Ashby's *law of requisite variety* is a prominent theory[241] building on the concept of variety, and it is an important driver for the design of complexity reduction: *only variety can destroy variety.*[242] In order to be effective, a control system must be at least as complex and have as many potential behavior patterns as the system to be regulated. Ashby gives a simple but illustrative example of its application:

> "*[i]f a fencer faces an opponent who has various modes of attack available, the fencer must be provided with at least an equal number of modes of defence if the outcome is to have the single value: attacked parried.*"[243]

The law of requisite variety forms a challenge for the control of complex systems because in order to make a system responsive to change, management needs to possess as much variety as the system itself exhibits. With systems that exhibit massive variety, such as

[235] Beer (1981), p. 212.
[236] Ashby (1964), p. 125; Beer (1966), pp. 246-253.
[237] E. g., Bar-Yam (2004).
[238] Bar-Yam (2007), p. 4.
[239] Beer (1985), p. 22.
[240] Beer (1979), pp. 32-33.
[241] The law of requisite variety as a theory is referenced by several organizational and information systems researchers, e. g., Tushman & Nadler (1978); Daft & Lengel (1986); Gregor (2006), p. 628; Mumford (1998), p. 263.
[242] Ashby (1964), p. 207.
[243] Ashby (1958), p. 88.

social systems, only reducing the environmental variety or increasing the management's own variety enables one to cope with this.[244]

A restatement of the law is the so-called *Conant-Ashby theorem*. According to Conant & Ashby, model-making is compulsory for the cybernetic control of a system: success in regulation implies that beforehand, a sufficiently similar model must have been built.[245] Therefore the relation between regulation and modeling (making a digital, analogue, mathematical or other model) might in fact be a *necessary* part of regulation.[246] Conant & Ashby show that in most cases success in regulation implies that a sufficient similar model must have been built, whether it was done explicitly, or simply developed as the regulator was improved. Thus, every good regulator of a system must be a model of that system. From this arises the concept of management as a kind of mathematical regulator, or controller, that is responsible for homeostasis, that is, the property of a system to regulate its internal variety to maintain a stable, constant state.[247] In short, the regulator has to be capable of generating a variety equivalent to the variety of the system that has to be regulated or the regulator will fail.[248] Therefore the potential use of variety as a measure for complexity is not the naive use of *counting* states, but of *matching* state generators.[249]

Following this, the variety of stimuli impinging upon a system must be countered by the variety of responses that the system can muster.[250] According to Boisot & MacMillan, some variety only constitutes noise for the system, and therefore calls for no response by the system save that of filtering it out. A system that is incapable of filtering out noise from the set of stimuli that it responds to is condemned to dissipating its scarce resources unproductively as it overreacts by attempting to respond to every opportunity or threat, real or imagined. For Boisot & MacMillan, variety reduction then becomes necessary in order to filter out stimuli that do not constitute information and do not give rise to actionable beliefs, that is, to a form of knowledge – knowledge in the sense of a set of beliefs and contextual understanding of this information.[251] Therefore, the law of requisite variety is a call to action, and knowledge is an essential ingredient of effective action.

However, as Boisot & MacMillan argue, it is not so clear what is likely to constitute *sufficient* knowledge to take action: for instance, how do the different types of belief that an agent is willing to act upon relate to each other? And how do they increase in certainty? Furthermore, intelligent action is action that can handle variety adaptively within a given

[244] Jackson (2000), p. 73.

[245] E. g., Conant & Ashby (1970).

[246] Conant & Ashby (1970), p. 90.

[247] E. g., Ashby (1964), pp. 195-272; Beer (1981), pp. 25-72. See Chapter 3.1.1. Such a regulator or controller is named a *homeostat*. A homeostat generates *ultrastability*; ultrastable systems can reach totally different positions of equilibrium whenever circumstances change radically. See Ashby (1964), pp. 82-85.

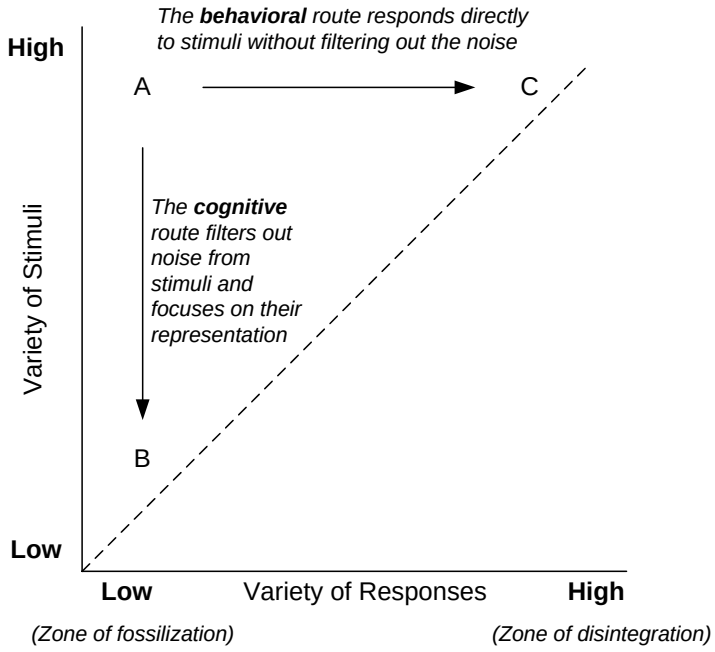
[248] Beer (1979), p. 89.

[249] Beer (1979), p. 87.

[250] Boisot & MacMillan (2004) p. 507. For organizations, this assertion rests on the premise that individuals' ability to make effective decisions for the organization is limited primarily by the quality and variety of information available to them. Indeed, organizations may react ineffectively to changes in their environment if they do not possess sufficient information about those changes, see Gray (2000).

[251] Boisot & MacMillan (2004) p. 507. Knowledge in this sense comprises a set of beliefs which informs decisions by agents to take actions in a specific context that consume the agent's (scarce) resources, see Boisot & MacMillan (2004), p. 506, and Chapter 3.2.1.

time frame – *requisite* variety has a time dimension.[252] How much variety is actually requisite variety is not clearly specifiable; not every instance of variety calls for a response, as Boisot & MacMillan illustrate by Figure 3.4. The vertical axis of the diagram measures the variety of the stimuli to which a system is subjected. The horizontal axis measures the variety of the responses available to the system. Boisot & MacMillan argue that the law of requisite variety locates adaptive responses on or below the diagonal in the diagram, that is, the variety of a response at least matches the variety of the stimulus that provoked it; the variety of responses equals or is greater than the variety of stimuli.[253] For instance, a fencer has to have more or at least as many modes of defence (responses) as the opponent has modes of attack (stimuli).



Source: adopted from Boisot & MacMillan (2004), p. 516

Figure 3.4: Illustration of Ashby's Law of Requisite Variety

Furthermore, Boisot & MacMillan claim that in a regime of high variety stimuli, the sheer variety of responses that appears to be required might well lead to the disintegration of the system. At the other extreme, a system with little or no variety in its responses eventually fossilizes or gets selected out.[254] Living systems endowed with cognitive capacities, however, have successfully evolved responses to *representations* triggered by the stimuli rather than to the stimuli themselves, that is, they draw on prior knowledge of the stimuli – using their contextual pre-knowledge and understanding of a situation – to filter out those elements of stimulus variety that constitute noise – meaningless data which cannot be interpreted according to some contextual pre-knowledge. Consequently, according to Boisot & MacMillan, living systems concentrate their response on the much smaller

[252] Boisot & MacMillan (2004) p. 507.
[253] Boisot & MacMillan (2004) p. 516.
[254] Boisot & MacMillan (2004) p. 516.

variety of information-bearing stimuli that remain. Line AB in Figure 3.4 implies this *cognitive strategy*. The cognitive strategy reduces the variety of the response called for by reducing the number of stimuli that it actually needs to respond through a filtering and interpretive process.[255] The system does not attempt to trace the whole chain of causes and effects in all its richness, but attempts only to relate controllable causes with ultimate effects.[256] In contrast, the horizontal line AC does attempt to match the variety of a given set of stimuli on a one-to-one basis with a given set of responses – a *behavioral strategy*.[257]

In its original form, the law of requisite variety does not consider the components of a system and how they must act together to perform a task to respond effectively. Bar-Yam presents a generalization of the law of requisite variety which makes the further assumption that a system is composed of a number of *components* N – the parts or sub-systems of a system, for instance, the people of an organization – and that these components can be combined to perform specific tasks.[258] The number of *possible actions* M or responses that the system can take is not more than the product of the possible actions or responses of each part, $m^N, M \leq m^N$. For instance, in social systems, if the components of a system are people, then a task may require a certain (minimum) number of people acting together; *the number of components that must act together* is a measure of the *scale* k of the task.[259] Scale is a distinct property from the necessary variety to perform a task. The total *variety* V *of a set of independent components* is the sum of the variety of the components,

$$V = Nv = log(M).$$

According to Bar-Yam, scale and variety constrain each other and what a system of a certain number of components can do: because coordination restricts the possible states and lines of behavior of the components and thus reduces variety[260], the same number of components cannot both have a large variety and a large scale, though various trade-offs are possible. From this follows a generalization of the law of requisite variety which states that *at every scale the variety necessary to meet the tasks, at that scale, must be larger for the system than the task requirements*, self-consistently defined as a necessary variety at each scale.[261] For a particular behavior – a scheme of coordination of the components – the variety at scale k is $D(k) = vn(k)$, with $n(k)$ the number of different k-member fully

[255] Boisot & MacMillan (2004), pp. 516 f. Luhmann argues in a similar way: in case of social systems such as organizations, the environment is usually always more complex than the system itself; social systems lack requisite variety that enables them to react to every state of the environment, that is, to establish a point-for-point correspondence between system and environment. Luhmann concludes that a social system's inferiority in complexity must be counter-balanced by strategies of *selection*. See Luhmann (1995), p. 25.

[256] Ashby (1958), pp. 90-99.

[257] Ashby argues in a similar way in the case of an "error-controlled" regulator; a regulation which is difficult to design when it is controlled by error may be easier to design if it is controlled not by the error but by what gives rise to the error, see Ashby (1958).

[258] Bar-Yam (2004), p. 37.

[259] Bar-Yam (2004), p. 38. "Scale of a task" is related to scale as previously introduced as the observer's distance from the system. Of course, scale of a task is subjective and depends on the observer who defines the components that are considered.

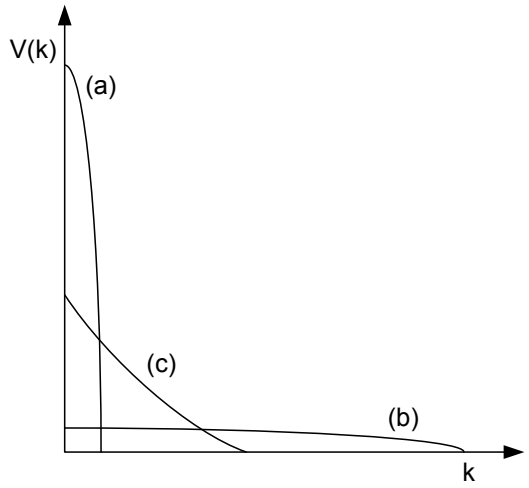
[260] E. g., Ashby (1962), pp. 257-258.

[261] Bar-Yam (2004), p. 38.

coordinated groups to perform the task. Then the same number, N, of components, can perform a task of scale N, with variety equal to that of one component, or a task of scale one with variety N times as great:[262]

$$Nv = \sum kD(k) = \sum_{k=1}^{N} V(k).$$

Then the total variety of the system is $V(1)$, and this equation describes the existence of a trade-off between variety at different scales. Increasing the variety at one scale, by changing the organizational form, must come at the expense of variety at other scales.[263] Figure 3.5 illustrates this constraint on variety $V(k)$ as a function of scale k.



Source: Bar-Yam (2004), p. 39

Figure 3.5: Schematic Illustration of Variety as a Function of Scale

A system with the highest possible fine-scale variety corresponds to a system with independent elements (curve a). When all elements are coherent, the system has the largest-scale behavior but the same low value of variety at all scales (curve b). Most complex systems have increasing variety as the scale decreases due to coordination at various scales (curve c).[264] According to Bar-Yam, this leads to the generalization of the law of requisite variety with regard to different scales, which

> "*[...] is directly relevant to the analysis of coordination mechanisms of an organization, biological or social. Specifically, how such coordination mechanisms are well or ill suited to the tasks being performed. Given the constraint imposed by the number of components, a successful organization has as a coordination mechanism that ensures that the groups are coordinated at the relevant scale of tasks to be performed.*"[265]

[262] Bar-Yam (2004), p. 38.
[263] Bar-Yam (2004), pp. 38 f.
[264] Bar-Yam (2004), p. 39.
[265] Bar-Yam (2004), p. 40.

In considering this generalization, it is possible to state that for a system to be successful or effective, it must be able to coordinate the right number of components to serve each task, and its coordination mechanisms must allow independence and dependence between components.[266] Tasks that are numerous and repetitive are large-scale whereas tasks that are numerous and variable are fine-scale or highly complex.[267] In social systems, the essential problem in each case is determining the number of individuals necessary to perform specific tasks, and therefore the *coordination* necessary between the individuals involved.[268] *Communication* increases coordination, which reduces variety of the whole system and particularly at a fine scale: when individuals are independent, they may perform many different possible tasks (high variety); when they are coordinated, they only perform a few possible tasks (low variety).[269] Therefore Bar-Yam claims that the issue of independence versus dependence, or decentralization versus centralization, results in a trade-off of variety versus scale.[270]

As a consequence, the law of requisite variety suggests a relationship between variety and the goodness of an organization with regard to communication and coordination; requisite variety has important implications for an organization as a system.[271] What this suggests is that measurement of variety, even if it can be done only approximately, will tell the investigator where a complex system such as an organization or information systems falls in relation to its limitation.[272] In this, this study follows Backlund's call to explore the usefulness of variety as a measure for complexity when applied to organizations and information systems.[273]

Critique on the Concept of Variety

It appears to be reasonable to test the use of variety as a measure for the complexity of organizations and information systems. But several charges have been put forward against the use of variety as a measure:[274]

- it is a "poor measure" inappropriate for scientific work[275],
- it is "unexceptional" in its implications[276], and
- it operates only at the syntactic level.[277]

The first argument that observer-dependent measures are not adequate for scientific work carries little weight when, as with organizations as social systems and following the

[266]Bar-Yam (2004), p. 41.
[267]Bar-Yam (2006), p. 459.
[268]Bar-Yam (2004), p. 41.
[269]See similar remarks on conditionality and constraint by Ashby (1962), pp. 257-258.
[270]Bar-Yam (2004), p. 41.
[271]Ashby (1962), pp. 273-274.
[272]Ashby (1958), pp. 83-99.
[273]Backlund (2002), p. 40.
[274]See Flood & Carson (1993), pp. 87-90; Jackson (2000), pp. 172-177, 207.
[275]Rivett (1977), p. 37.
[276]E. g., Checkland (1980).
[277]E. g., Ulrich (1981).

epistemological position of this thesis, such measures are the only proper ones available.[278] The second charge can be countered by pointing to other "unexceptional" principles with great consequences like the fundamental laws of classical physics, for instance, the second law of thermodynamics. In control terms, the law of requisite variety means that, in order for all the variety present in a regulator to be transmitted to the system S, the communication channel linking the regulator to S must be capable of transmitting the full variety of the regulator.[279] When stated in such terms, the law seems obvious and trivial; its utility arises in the context of design evaluation. Even if a system is ideally designed, if it does not have enough actions that it can take, its overall effectiveness is limited.[280] In effect, the law of requisite variety imposes an upper bound on the information that can be transmitted from a sender (the input) to a receiver (the output).[281] Most severe seems to be Ulrich's attack on variety as existing on a pure syntactic level. He argues that variety as the number of distinguishable states of a system operates only at the syntactic level, which is solely concerned with whether a message is well formed or not, in the sense of readability and syntactic information or data. Consequently, variety ignores the meaning and significance of messages for the receiver.[282] This argument falls short considering the approach presented here, and the validity of this claim is explored later in this research.[283]

3.4 Organization Theory

Having postulated a close relationship and connectedness between organizations and information systems and having looked at earlier traditions for dealing with complex systems, is is now reasonable to examine concepts and theories from traditional and contemporary organization theory before proceeding further in order to leverage this knowledge base for the analysis and measurement of organizational quality with regard to communication and coordination.

3.4.1 Contingency Theory Approaches to Organization Theory

Like complexity, the term "organization" covers a multiplicity of meanings.[284] It is interesting to notice that while March & Simon use the word "organizations" as the title for their seminal book, they do not give a formal definition.[285] Weick uses "organizing" instead, a process description: something is being organized or somebody organizes something.[286] One of the dominant approaches to the study of organizations is *contingency theory*, and until today is remains the core explanatory theory of organizational structure.[287] Contingency theory sees organizations as a series of independent sub-systems and rests on the conclusions

[278] Flood & Carson (1993), p. 88.
[279] Casti (1985), p. 455.
[280] Bar-Yam (2004), p. 37.
[281] Casti (1985), p. 459.
[282] Ulrich (1981), pp. 33-59.
[283] See Chapter 4.1.
[284] Ashby (1962), p. 255.
[285] March & Simon (1958).
[286] Weick (1979), p. 3.
[287] Donaldson (1996), p. 69.

drawn from various empirical studies, generally adopting a positivist research approach.[288] The design of organizations is widely held to be a fundamental management task in contingency theory:

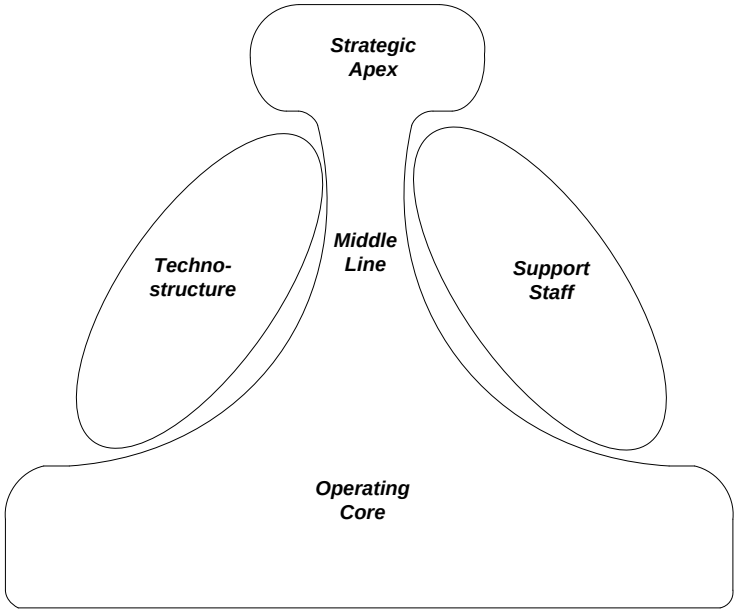
> "*Every organized human activity [...] gives rise to two fundamental and opposing requirements: the division of labor into various tasks to be performed and the coordination of these tasks to accomplish the activity. The structure of an organization can be defined simply as the sum total of the ways in which it divides its labor into distinct tasks and then achieves coordination among them.*"[289]

This description of the design task is appealing because it is simple; however, in reality, there are a large number of ways to divide labor and to coordinate tasks in the organization.[290] The complexity of reality may be quite too much for deliberately designing an organization in such a rational sense. However, traditional organization theory just sees this as one of the central tasks of management. For instance, according to GALBRAITH, the organization can follow one or some combination of four strategies: (1) creation of slack resources, (2) creation of self-contained tasks, (3) investment in vertical information systems, and (4) creation of lateral relationships.[291] He argues that if the organization is faced with greater uncertainty due to technological change, higher performance standards due to increased competition, or if it diversifies its product line to reduce dependence, the amount of information processing is increased, and the organization must adopt at least one of the four strategies when faced with greater uncertainty.[292] Basically, this conception is fundamentally *anthropomorphic*: it depicts organizations as single beings or entities.

In the same tradition MINTZBERG catalogs the elements of organizational structuring – which, according to him, show a curious tendency to appear in five's – and suggests a typology of five basic configurations: simple structure, machine bureaucracy, professional bureaucracy, divisionalized form, and adhocracy.[293] The elements of these five configurations include (1) five basic parts of the organization – the operating core, strategic apex, middle line, technostructure, and support staff (see Figure 3.6); (2) five basic mechanisms of coordination – mutual adjustment, direct supervision, and the standardization of work processes, outputs, and skills; (3) the design parameters – job specialization, behavior formalization, training and indoctrination, unit grouping, unit size, action planning and performance control systems, liaison devices (such as integrating managers, teams, task forces, and matrix structure), vertical decentralization (delegation to line managers), and horizontal decentralization (power sharing by nonmanagers); and (4) the contingency factors – age and size, technical system, environment, and power.[294] Accordingly, an effective organization will favor some sort of these configurations as it searches for harmony in its internal processes and consonance with its environment, with some organizations

[288] Jackson (2000), p. 116.
[289] Mintzberg (1979), p. 2. See also March & Simon (1958); Thompson (2003); Silverman (1971); Galbraith (1977).
[290] Lucas & Baroudi (1994), p. 9.
[291] Galbraith (1974), pp. 30-36.
[292] Galbraith (1974), p. 35.
[293] Mintzberg (1980), pp. 322-339.
[294] Mintzberg (1980), pp. 322-339.

inevitably driven to hybrid structures as they react to contradictory pressures or while they effect a transition from one configuration to another.[295] MINTZBERG claims that this typology of five can serve as a diagnostic tool in organizational design.[296] Again, this is a rather vivid example of the organization pictured as an anthropomorphic entity.



Source: Mintzberg (1980), p. 324

Figure 3.6: The Five Basic Parts of the Organization

Complimentary to this design understanding are contingency theory's findings, which analyzed organizations in a series of mostly positivist empirical studies. These findings suggest that as organizations grow, they differentiate, and specialized areas evolve to deal with particular tasks or environments. As these specialized units develop, each generates its own idiosyncratic norms, values, time frame, and coding schemes to permit effective processing of information. Thus, not only will different organizations have a mismatch in coding schemes, but differentiated subunits within the same organization will likely also have contrasting languages and coding schemes.[297] These inherent conceptual and linguistic differences act as a communication boundary hindering the free flow of information, and one way to deal with the difficulties of communicating across organizational boundaries is to develop special boundary roles. This suggests that individuals filling these roles are capable of translating contrasting coding schemes and therefore of acting as boundary spanners between the work unit and external information areas.[298] One of an organization's subunits will be more effective when its communication structure matches the uncertainty which the subunit faces in executing its work. This is not to suggest that uncertainty causes

[295] Mintzberg (1980), p. 322.
[296] Mintzberg (1980), p. 322.
[297] Tushman (1977), p. 590.
[298] Tushman (1977), p. 591.

communication structure, but that high-performing subunits will match their structure to meet the information demands of their work.[299]

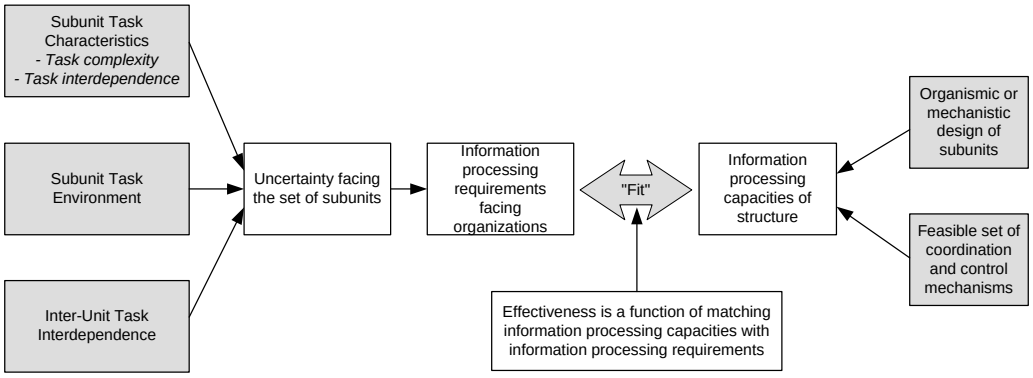
But a study conducted by Tushman in research and development projects found that contrary to the expectations, there was no overall effect of environmental variability on intra-project communication. However, under changing environmental conditions, then high performing research projects attended to their substantial information processing requirements with intense and decentralized patterns of *intra-unit* communication (within projects).[300] Moreover, for high performing projects, *extra-unit* communication (between projects) decreased. Tushman proposes that extra-project communication decreases under turbulent environmental conditions because environmental variability is not seen as a source of uncertainty to be dealt with directly, but rather as a source of information overload or threat.[301] He suggests that due to the mismatch in coding schemes between differentiated areas and the accentuation of this mismatch under turbulent environmental conditions, communication with external areas is not distributed evenly but takes place through a limited set of individuals able to translate between several coding schemes.[302] These boundary spanning individuals link their subunits to external areas and serve to buffer their more locally oriented colleagues from environmental turbulence. In further support for these ideas, Tushman in another study found that boundary spanning individuals existed to span laboratory, organization, and extra-organizational boundaries. To deal with the increased need for and the greater difficulty of communicating with external areas under turbulent environmental conditions, he also found that high performing projects facing changing environments had significantly more boundary spanning individuals than did high performing projects facing stable environments. These differences were not found for low performing projects.[303]

In this context Van De Ven, Delbecq & Koenig suggest that three predominant modes are frequently used to coordinate work activities within an organization: coordination by programming is exercised through an impersonal mode, while feedback or mutual adjustments occur through either personal (vertical or horizontal) channels or group (scheduled or unscheduled) meetings.[304] As tasks increase in uncertainty, mutual work adjustments through horizontal communication channels and group meetings are used in lieu of coordination through hierarchy and impersonal programming.[305] Van De Ven, Delbecq & Koenig's findings indicate (but do not demonstrate) that the tradeoffs or negative relationships between impersonal coordination and horizontal and group mechanisms are "explained" by task uncertainty.[306] However, they do not describe or explain the underlying processes of this, nor do they provide a measure for goodness.

Following contingency theory, organizations can be conceptualized as actors connected by information and communication channels, using a range of communication tools and

[299]Tushman (1979b), p. 83.
[300]Tushman (1979a), p. 495.
[301]Tushman (1979a), p. 496.
[302]Tushman (1979a), p. 497.
[303]Tushman (1979a), p. 497.
[304]Van De Ven, Delbecq & Koenig (1976), p. 323.
[305]Van De Ven, Delbecq & Koenig (1976), p. 332.
[306]Van De Ven, Delbecq & Koenig (1976), p. 329.

structural mechanisms (e. g., formal meetings, reports, e-mail, telephone, information systems, et cetera.). This is summarized in the *information processing model of the firm* as summarized in Figure 3.7. The model suggests that organizational designers should first consider the tasks, composition and structure of subunits, and then consider appropriate mechanisms for linking those units together. The information processing model implies that subunits of an organization must choose from a set of structural alternatives to most effectively deal with their information processing requirements and achieve a level of "fit" between information processing requirements and information processing capacities. Specific structural mechanisms provide the amount of information needed to cope with uncertainty and achieve the desired task performance.



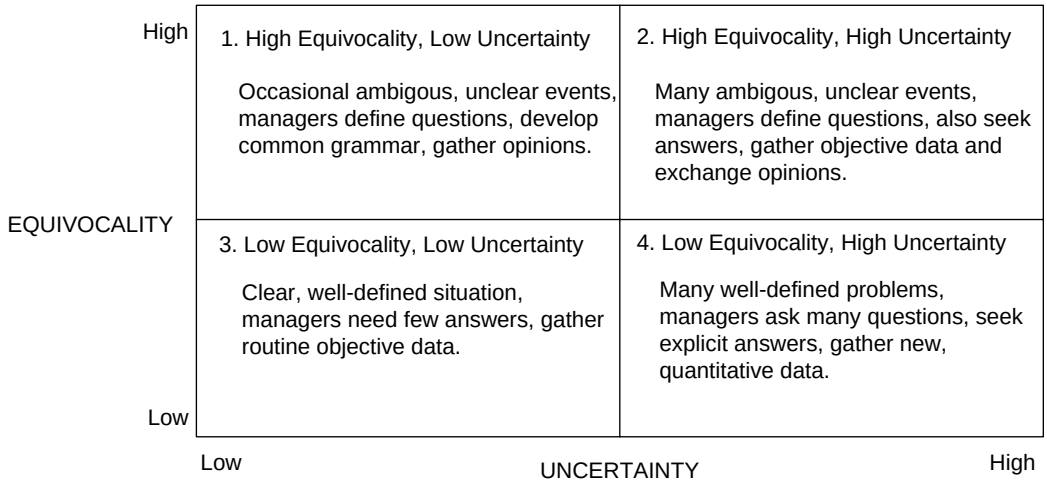
Source: adopted from Tushman & Nadler (1978), p. 622

Figure 3.7: The Information Processing Model

The goodness of an organization with regard to communication and coordination surely has something to do with the question whether a "fit" as proposed by contingency theory has been established. However, how does one measure this fit? Unfortunately, one of the major criticisms of contingency approaches is their lack of clarity as to what constitutes a match or fit between work characteristics and structure.[307] Daft & Lengel have tried to answer this question more clearly.[308] Traditional organizational theory suggests two answers to the question why organizations process information: (1) to reduce uncertainty and (2) to reduce equivocality.[309] Galbraith defines *uncertainty* as the difference between the amount of information required to perform the task and the amount of information already possessed by the organization.[310] *Equivocality* means ambiguity, the existence of multiple and conflicting interpretations about an organizational situation.[311] The concept of equivocality was introduced because uncertainty as studied in the psychology laboratory did not characterize the ambiguity experienced by managers: uncertainty is a measure of the organization's ignorance of a value for a variable in the space, whereas equivocality is a measure of the organization's ignorance of whether a variable exists in the space.[312]

[307] Tushman (1979b), p. 83.
[308] E. g., Daft & Macintosh (1981); Daft & Lengel (1986).
[309] Daft & Lengel (1986). p. 555.
[310] Galbraith (1977), p. 38.
[311] Weick (1979), pp. 4 ff.; Daft & Macintosh (1981); Daft & Lengel (1986), p. 556. See also Alvesson (1993).
[312] Daft & Lengel (1986), p. 557

As summarized in Figure 3.8, these two measures fundamentally influence the information requirements of an organization.



Source: Daft & Lengel (1986), p. 557

Figure 3.8: Framework of Equivocality and Uncertainty on Information Requirements

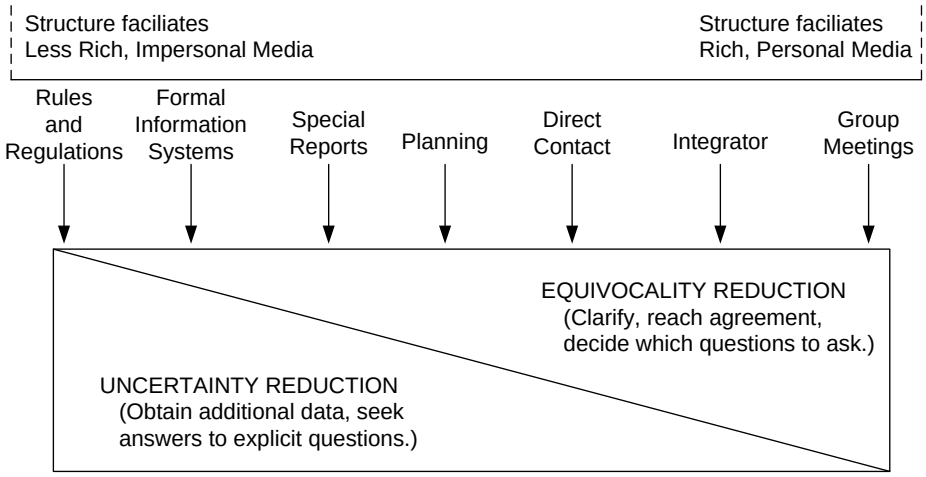
Daft & Lengel argue that information processing in organizations is conceptually more than simply obtaining data to reduce uncertainty; it also involves *interpreting* equivocal situations.[313] They propose that organizations should be designed to meet the needs for uncertainty and/or equivocality reduction, and that organizational design can provide information of suitable richness to reduce equivocality as well as provide sufficient data to reduce uncertainty.[314] As a result, they suggest a continuum of structural characteristics, illustrated in Figure 3.9.

This is compatible with a technology model proposed by Perrow and illustrated in Figure 3.10 that defined two underlying task characteristics, task variety and task analyzability.[315] Notably, the usage of IT does only feature in cells of high analyzability, and could be argued with recent advances like e-mail or video conferencing to be in some other cells as well now. In summary, according to Daft & Lengel, a feature that distinguishes human social systems from lower level mechanical and biological systems is equivocality: social systems do not work with machine-like precision; human beings have the capacity to interpret and respond to ambiguity.[316] However, they do not provide a description of how these processes operate.

3.4.2 Simulation Approaches to Organizations

Arguably the prominence of contingency approaches reaches its height with sophisticated simulation approaches to organizations. These simulations model the organization simply

[313]Daft & Lengel (1986), pp. 557 ff.
[314]Daft & Lengel (1986), p. 559.
[315]Perrow (1967) according to Daft & Lengel (1986), p. 563.
[316]Daft & Lengel (1986), p. 569. This is compatible with the placing of social organizations in the hierarchy of systems, see Table 3.1 in Chapter 3.1.1.



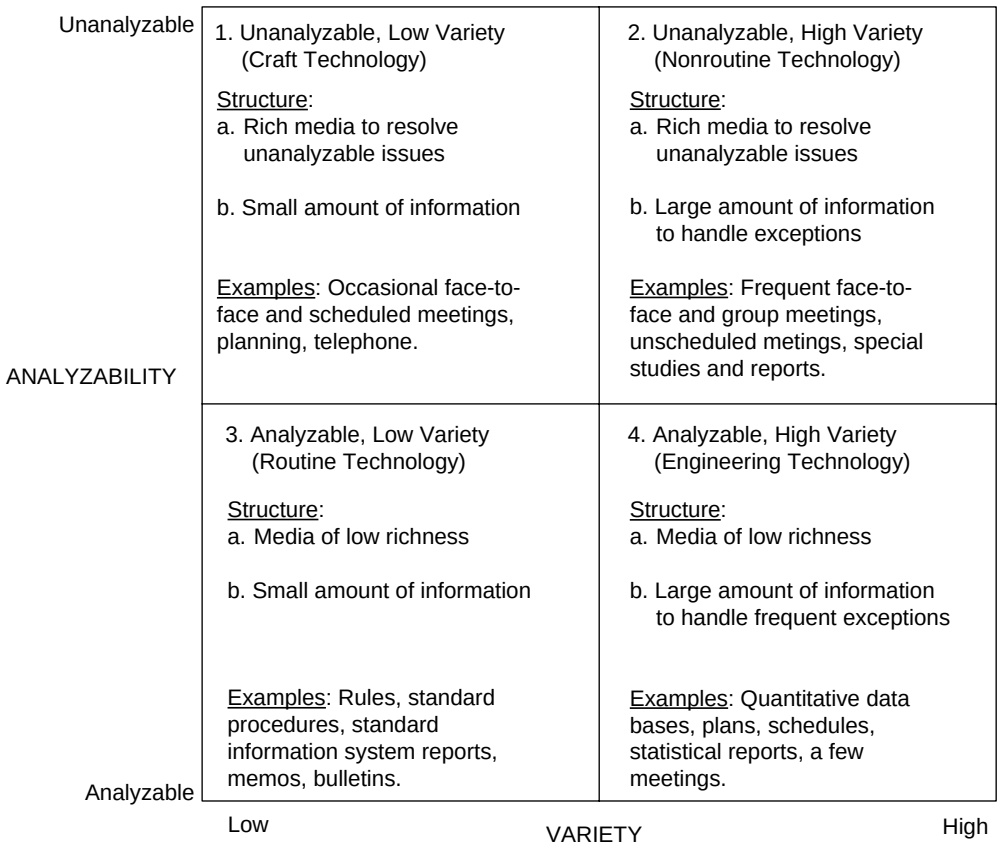
Source: Daft & Lengel (1986), p. 561

Figure 3.9: Information Role of Structural Characteristics for Reducing Equivocality or Uncertainty

as a network of information processing agents, and recognize that a distinctive feature of organizations is that they consist of separate agents, and are not unitary entities with a mind and will of their own.[317] In these approaches, the organization itself is defined by the pattern of information exchange among the agents; this pattern of communication between the agents can be described as a network graph, with different graphs corresponding to different organizational structures. The final element of the information model of the organization is the characterization of the processing capabilities of the agents, which depend both on their own intrinsic abilities and on the capacities of the communication channels between them.[318] Moreover, the fact that an optimum organizational chart theoretically exists does not mean that it is easy or even possible to specify what it might look like; the number of graphs rises very rapidly with the number of agents making up the organization, and the determination of the optimal organizational structure is in all likelihood computationally intractable.[319]

Most prominent among these simulation approaches are the Virtual Design Team and the Virtual Team Alliance.[320] The *Virtual Design Team (VDT)* explicitly represents organizations' tasks (e. g., the design tasks of a project), their actors (e. g., the particular designers and managers in a project), and organizational structures. For a given task and organizational setting, VDT generates emergent organizational performance through simulation of micro-level actions of, and interactions among, the actors in the organization. The initial VDT model is developed based on the observations that organizational tasks in project organizations can be divided into two parts: (1) the primary production work that directly adds value to final products, and (2) coordination work that facilitates the production work. Jin & Levitt argue that since for a given project the amount of

[317] DeCanio & Watkins (1998), p. 277.
[318] DeCanio & Watkins (1998), p. 278.
[319] DeCanio & Watkins (1998), p. 283.
[320] E. g., Jin & Levitt (1996); Kunz et al. (1998); Levitt et al. (1999).



Source: Daft & Lengel (1986), p. 563

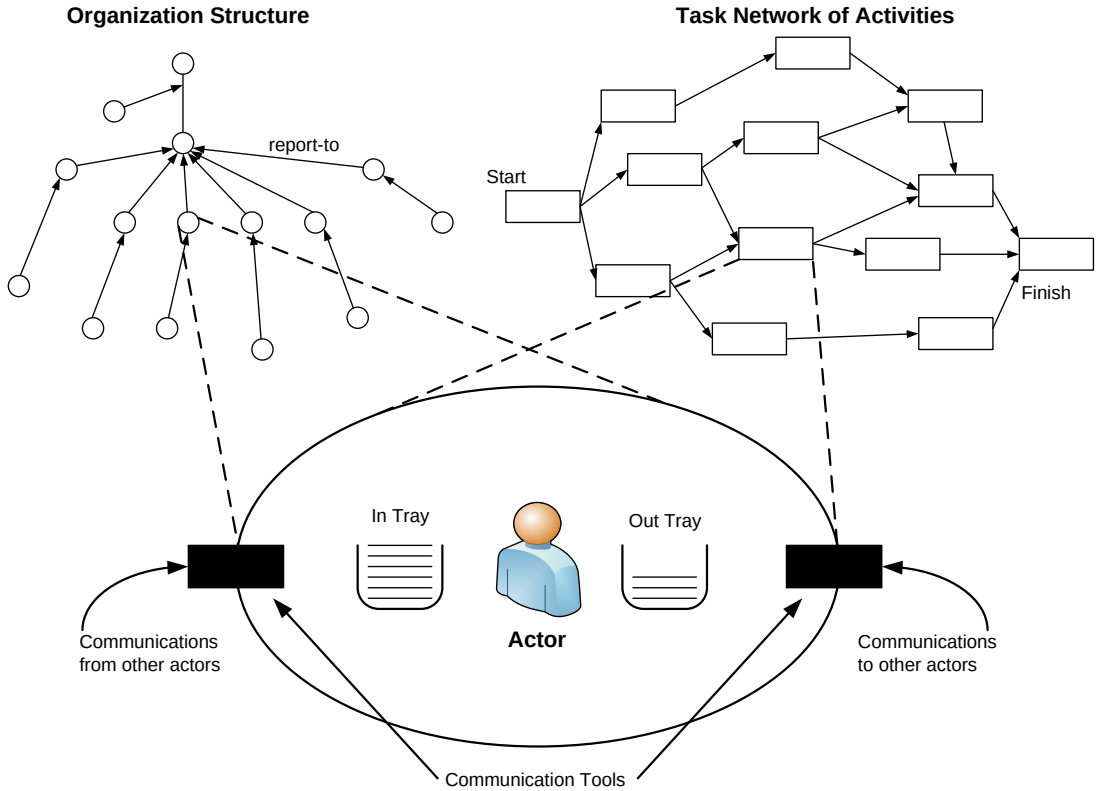
Figure 3.10: Relationship of Department Technology with Structures and Information Required for Task Accomplishment

production work is usually determined based on the specifications of the product to be produced, the variation of production work as a function of organization design is relatively low. However, the coordination work may vary considerably, depending on how the project team is organized. Accordingly, VDT generates a model of how coordination work is dealt with by team actors in order to allow project managers to analyze their organization's performance for better team design.[321]

In VDT, the amount and the content of production work are defined explicitly as attributes of activities as illustrated in Figure 3.11. Coordination work is implicit, and generated stochastically by VDT based on activity complexity, uncertainty, and task-actor skill match. Thus VDT models emergent coordination work volume and rework volume as dependent variables of both task situation and organization design, but does not take into account a very sophisticated actor model: communications may take place via informal information exchange between two actors, or in formally scheduled meetings among two or more actors.[322] However, mutual understanding of actors, meaning and

[321] Jin & Levitt (1996), p. 172.
[322] Jin & Levitt (1996), pp. 177 f.

sense-making are ignored. VDT, if at all, addresses only uncertainty[323], but does not address equivocality. Communication between actors is only seen as a process on a pure syntactical level in the sense of classical information theory.[324] Semantics and different meanings of a communication item are not considered in VDT's coordination work. This actor model has not been fundamentally extended since the original VDT model.[325]



Source: Jin & Levitt (1996), p. 174

Figure 3.11: An Overview of the VDT Model

The *Virtual Team Alliance (VTA)* extends the framework implemented in VDT in two ways: (1) it addresses less routine tasks with some flexibility in how they are performed, and (2) it treats project participants as individuals with potentially incongruent goals.[326] Thus goal incongruency is addressed, but not sense-making, meaning, or different understandings, that is, equivocality. Likewise, another extension[327] adds cultural factors; however, the VDT model limits this adaptation: factors such as multiple behavior patterns for different workers in a project, additional exceptions caused by work practice differences, organizational learning, as well as potentially positive impacts of cultural diversity that might result from cross-cultural interactions are not represented.[328] Moreover, VDT cannot account for

[323] VDT "*operationalizes activity uncertainty*", see Levitt et al. (1999), p. 1485.
[324] E. g., Shannon (1948), see Chapter 3.2.1.
[325] Levitt (2004), p. 135.
[326] Thomsen, Levitt & Nass (2004), p. 349.
[327] Horii, Jin & Levitt (2004).
[328] Horii, Jin & Levitt (2004), p. 317.

additional exceptions caused by differing values and practices between subgroups of a joint-venture team, and team members do not adapt their values or practices during the project.[329]

Other contemporary organizational researchers build on the conceptual foundation of VDT and VTA, for instance, Nissen in his simulation experiments on organizational forms.[330] In his work, the traditional thinking of contingency theory about organizational design is summarized:

> "*New organizational forms are being conceived and proposed continually. Indeed, our survey of forms proposed over the last half century reveals a plethora of propositional organizations, with more than 30 separate forms that are argued by their proponents to be distinct and superior in some respect. [...] This poses problems on terms of practice. Before a prudent practitioner can be expected to implement any new organizational form in an operational enterprise, he or she will likely demand some empirical evidence of its superiority.*"[331]

Although the simulation models arguably recognize the importance of individual agents, it still treats them as near-mechanistic elements and the resulting perspective of organizations as purposely designed and anthropomorphic entities is demonstrated clearly. This critique is further developed in the following sections.

3.4.3 Critique of Contingency Theory

General Critique of Linear Contingency

Contingency theory has made some important and interesting findings. However, as an advocate of contingency theory in general, even Donaldson notes concerns about whether correlations between contingency variables and structural aspects can be traced back to causal effects and about the neglect of policy and culture.[332] As cybernetics has argued, the reductionist analysis of the separate parts of a complex system will not help in the analysis of interactions of the whole.[333] Traditionally organization theory has treated complexity as a structural variable that characterizes both organizations and their environments[334] and organization design has tried to match the complexity of an organization's structure with the complexity of its environment and technology.[335] This largely ignores individual human behavior. As McKelvey points out, organizational scholars have emphasized macroevolution (within organizational populations) at the expense of microevolution (within organizations).[336] Scholars have abstracted away nonlinear interactions for the sake of analytical tractability, even though such interactions are the key to the emergence of pattern.[337] Therefore the measurement of the "fit" between information

[329]Horii, Jin & Levitt (2004), p. 317.
[330]Nissen (2007), pp. 217-223.
[331]Nissen (2007), p. 204.
[332]Donaldson (1996), p. 64.
[333]Jackson (2000), pp. 69 f.; Ashby (1964), pp. 86-117.
[334]E. g., Hall, Johnson & Haas (1967).
[335]E. g., Galbraith (1982); Galbraith (1977); Galbraith (1974).
[336]McKelvey (1997).
[337]Anderson (1999), p. 222.

processing requirements and information processing capacities, as proposed by contingency theory, has until today only been possible on a very abstract macro-level.[338] This has also been voiced early in critique on the application of contingency theory to the field of information systems.[339]

Critique of Constructivist Rationalism

The traditional contingency research treats organizations largely as anthropomorphic entities that can be purposely *designed*, like a machine. Although attention is given to human beings, the tendency is to treat them mechanistically, and people are not seen as self-conscious, autonomous actors capable of reading different meanings into situations they face. With contingency theory, managers are expected to learn how organizations should function, or should be structured, and to simply bring about the changes without further ado.[340]

In contrast, Tsoukas asks how have complicated biological objects, on the one hand, and organizational systems and procedures, on the other, come about: what is it that makes both biological organisms and organizations orderly, patterned, elaborate, and functionally specialized? In short, what explains the order that one finds in the arrangement and functioning of organisms and organizations?[341]

> "*It has long been tempting to want to explain organization in anthropomorphic terms, a temptation to which several organization theorists have frequently succumbed in one way or another. After all, organizations are human artifacts. Would it not be sensible to assume that they are the way they are because they have been so designed by certain individuals? [...] In organization theory, the postulate of the rational actor has long been the basic premise upon which anthropomorphic explanations have been based. An organizational form is the way it is, the argument goes, because of human choices and decisions made under norms of rationality [...] Both the strategic choice and the contingency perspectives, however, share the assumption that organizational forms are the outcome of* deliberate *human action.*"[342]

Tsoukas summarizes this perspective as believing that since social institutions are obviously human artifacts and they appear to serve certain human purposes, social institutions must have been deliberately designed and, therefore, can be deliberately redesigned; a view that is labeled the social equivalent of creationism, constructivist rationalism.[343] Both creationism and constructivist rationalism build on the idea of a purposeful designer who molds and instructs the organization to take a desired shape.[344] Therefore constructivist rationalism asserts that since social institutions serve human purposes, they are, and ought

[338] E. g., prominent frameworks building on contingency theory, such as OrgCon, rely on analytical lists and try to capture dozens of abstract contingency factors. See Burton & Obel (2005).
[339] E. g., Weill & Olson (1989).
[340] Jackson (2000), pp. 126-127.
[341] Tsoukas (1993), p. 501.
[342] Tsoukas (1993), p. 502.
[343] Tsoukas (1993), pp. 503 f.
[344] E. g., Mintzberg (1990); Popper (1987).

to be, the product of deliberate human design, which should be deductively derived from explicit premises and should be codified in propositional statements.[345]

This image of organization design is fundamentally anthropomorphic and presupposes complete knowledge of all the relevant facts, as well as complete power to manipulate them in order to produce the intended result.[346] However, as TSOUKAS argues, from a Darwinian point of view, complex design is neither the outcome of chance alone nor the result of an omniscient creator, and that an evolutionary perspective resolves the tension between freedom and control, chance and necessity, via regarding the organization as a hierarchical system of *plastic controls*:

> "*Clearly, it is not the case that "anything goes", since it is only certain design features that confer their carriers reproductive advantage. [...] It has replaced the simplistic dichotomy "either chance or cast-iron control" with the intermediate notion "chance and control" – what Popper (1979) has called "plastic control", that is, the simultaneously restrictive and enabling relationship between an organism and its environment based on feedback.*"[347]

As TSOUKAS claims, an organization can be seen as a hierarchical system of such plastic controls in the sense of POPPER[348] – as a system of quasi-randomly acting individuals having their own agendas and possessing their own local knowledge, who are plastically controlled by the "whole"; quasi-random movements and variations (i. e., the equivalent of mutations) are accepted and retained, when they fit into the higher-level structure of the controlling organization.[349]

> "*The problem of explaining organizational order is a central problem in organization theory. Organizing does imply higher-level control and constraint, yet without the autonomous activity of individuals organizing becomes impossible. Organizations do indeed manifest order, coherence, and patterns in their actions, and functionality in their design. It should not be surprising, therefore, to see that the individual and the organization have been pitted against each other, nor should it be strange to realize that, traditionally, the actions and design features of organizations (organizational order) have been conceptualized in anthropomorphic terms. Organizations (and social institutions more generally) do* appear *to serve certain purposes and it does not take much for one to jump to the conclusion that they must have been specifically designed to serve those purposes.*"[350]

Similarly are the comments of one of the most prominent authors related to the notion of self-organization, VON HAYEK. For VON HAYEK social theory begins with – and has an object only because of – the discovery that there exist orderly structures which are the product of the *action* of many men but are not the result of human design. To clarify his

[345] Tsoukas (1993), p. 505.
[346] Tsoukas (1993), p. 507.
[347] Tsoukas (1993), p. 507. See Popper (1979).
[348] Popper (1979), p. 232.
[349] Tsoukas (1993), p. 510.
[350] Tsoukas (1993), p. 513.

argument, VON HAYEK makes an explicit and crucial distinction between organization as a made order (*taxis*) and organization as a grown order or spontaneous order (*kosmos*):

> "*The made order which we have already referred to as an exogenous order or an arrangement may again be described as a construction, an artificial order or, especially where we have to deal with a directed social order, as an* organization. *The grown order, on the other hand, which we have referred to as a self-generating or endogenous order, is in English most conveniently described as a* spontaneous order. *Classical Greek was more fortunate in possessing distinct single words for the two kinds of order, namely* taxis *for a made order, such as, for example, an order of battle, and* kosmos *for a grown order, meaning originally 'a right order in a state or a community'.*"[351]

The most distinguishing property of spontaneous order is that spontaneous orders will often consist of a system of abstract relations between elements which are also defined only by abstract properties, and for this reason will not be intuitively perceivable and not recognizable except on the basis of a theory accounting for their character. Consequently, these orders may persist while all the particular elements they comprise, and even the number of such elements, change.[352]

Therefore, VON HAYEK argues, since one can know at most the rules observed by the elements of various kinds of which the structures are made up, but not all the individual elements and never all the particular circumstances in which each of them is placed, knowledge will be restricted to the general character of the order which will form itself. This means that, though the use of spontaneous ordering forces enable one to achieve an order of a very high degree of complexity, which comprises elements of vast numbers and variety of conditions) and which one could never master intellectually, or deliberately arrange, one has less power over the details of this an order than one would have over one which is produced by design. Consequently, the control over this spontaneous and more complex order will be much smaller than that over a made order.[353]

VON HAYEK goes on by arguing that in any group of men more than the smallest size, collaboration will always rest both on spontaneous order as well as on deliberate organization[354], and that rules of organization fill in the gaps left by the commands.[355] However, this does not imply that such rules exist in articulated or verbalized forms, but only that it is possible to discover rules which the actions of individuals in fact follow.[356] Moreover, the rules governing the spontaneous order must be independent of purpose and be the same for whole classes of its members.[357]

In a similar but different notion as VON HAYEK comments on the distinguishing property of spontaneous order, MATURANA & VARELA make a sharp distinction between the systemic concepts of *organization* and *structure*.[358] Organization represents the abstract relation

[351] von Hayek (1981), p. 37.
[352] von Hayek (1981), p. 39.
[353] von Hayek (1981), pp. 41 f.
[354] von Hayek (1981), p. 46.
[355] von Hayek (1981), p. 49.
[356] von Hayek (1981), p. 43.
[357] von Hayek (1981), p. 50.
[358] E. g., Maturana & Varela (1979); Maturana (1980); Maturana & Varela (1987); Varela (1979); Varela (1981b); Varela (1984).

between components and their properties at a type or class level. Structure describes the actual components and relations of a concrete instance of a given system. Consequently, there may be many different structures that are perspectives on the same organization, and the structure can change without necessarily altering the organization. Therefore an organization's structure consists of the concrete resources and relations that constitute its relationships: by the interrelation of people, their roles, the units in which they participate and the other resources which they employ.[359] As Espejo et al. summarize this view,

> "*[a]n organization is a closed network of relationships [between people] with an identity of its own. An organization's identity does not, therefore, depend on particular individuals: they can be any, as long as they satisfy the relationships.*"[360]

Taking into account the previous paragraphs, this study does not believe that most organizational adaptation is akin to a planned and systematic design of contingency factors in strategy, structures and processes, an adaptive cycle consciously planned and implemented by managers[361], but more often to be a continuous adaptation of individuals. There is little, if any, empirical evidence that challenges the fact that decision-making is multifaceted, emotive, and only partially cognitive; regardless of one's viewpoint on how individuals should make decisions, the processes they actually rely on are far from the rational ideal, and dramatic change rarely occurs in complex social systems.[362] Furthermore, the quality of an organization with regard to communication and coordination should be somehow be linked to this adaptation process.

3.4.4 Organizations as Complex Adaptive Systems

A more modern perspective on complex behavior examines regularity that emerges from interaction of individuals connected together in *complex adaptive systems*.[363] The hallmark of this perspective is the notion that at any level of analysis, order is an emergent property of individual interactions at a lower level of aggregation.[364] Anderson argues that in Boulding's arrangement of general systems according to their complexity, social systems are distinguished by the fact that symbol-processing actors who share a common social order organize information from the environment into a knowledge structure; therefore the social order that characterizes Boulding's social systems arises from interactions among agents or individual actors respectively, which struggle for control of shared interpretation and meaning.[365] Thus complexity arises due to nonlinear causes rooted on a lower level. For instance, an individual agent's behavior is dictated by a schema, a cognitive structure that determines what action the agent takes at time t, given its perception of the environment. Different agents may or may not have different schemata, and schemata may or may not

[359] Espejo et al. (1996), p. 76.
[360] Espejo et al. (1996), pp. 74 f.
[361] E. g., Miles et al. (1978).
[362] Keen (1981), p. 25.
[363] Anderson (1999) gives an overview about recent work on complex adaptive systems in organization theory.
[364] Anderson (1999), p. 219.
[365] Anderson (1999), p. 221.

evolve over time. Often, the agents' schemata are modeled as a set of rules, but schemata may be characterized in very flexible ways.[366]

Likewise, Lewin, Parker & Regine suggest that modeling complex adaptive systems involves identifying agent characteristics, the dimensions of relationships among the agents, and the figures of merit that govern their co-evolution.[367] They argue that qualitative field-based work can produce candidate parameters for each of these elements; the challenge, therefore, is to discover what behaviors should be used to define parameters outside the traditional economic utility function for modeling organizations.[368] Creating truly useful models of human dynamics may still be a long way off; the greatest challenge lies in translating insights into parameters, and finally into simple behavioral rules.[369] Anderson argues that simulation will allow one to see what emerges when agents whose behavior and cognitive structure have been assessed empirically interact with one another through a set of connections that are assessed empirically, but that can change over time as part of the model:

> "*What might a future empirical study look like, that introduces a new way of thinking about modelling complexity? It may well try to develop and test a theory that tries to explain an empirical regularity observed in standard causal-modeling research. Instead of asking which other independent variables seem to be significantly and causally related to the outcome, it will ask what model of interacting might lead to the observed outcome in dynamic equilibrium, and what other outcomes would be predicted from such a model.*"[370]

This co-evolutionary complex systems view suggests that evolution operates at the microscopic level; in information systems and organizations, this is the individual or agent. Therefore one distinguishes between the formal IT system and the information system of individuals that includes the IT system and other informal, personal and idiosyncratic contacts and connections. By taking an agent-based view of organizations, evolution is driven most strongly by individuals in the firm, whose information system co-evolves through interaction with other agents.[371] Allen & Varga argue that interactions in real systems exhibit non-linearity, and that traditional organizational theories do not take this into account. Organizations as complex systems adapt and evolve; however, they propose that this does not stem from random mutation and natural selection, but new order is generated via a process of self-organization, where at each level, new emergent structures form and engage in new emergent behaviors.[372] This corresponds to the notion of plastic controls.

For Allen & Varga, the essential driving force of evolution and of complex systems is the *micro-diversity*, that is, heterogeneous and idiosyncratic individuals.[373] Their key point

[366]Anderson (1999), p. 219.
[367]Lewin, Parker & Regine (1998), pp. 36-40
[368]Lewin, Parker & Regine (1998), p. 38.
[369]Lewin, Parker & Regine (1998), p. 39.
[370]Anderson (1999), p. 227.
[371]Allen & Varga (2006), p. 229.
[372]Allen & Varga (2006), p. 230.
[373]Allen & Varga (2006), p. 231.

is that agents need interaction with other agents in order to evolve concepts, constructs, and ideas; the agents need to transmit ideas and other agents need to be receptive to these. Consequently items and ideas that are codifiable and nearly tangible for many individuals with a near-homogeneous understanding (agreed upon meaning) are candidates for inclusion in IT systems, and such IT systems consist of those items that agents agree exist in reality and are necessary for the completion of organizational tasks.[374]

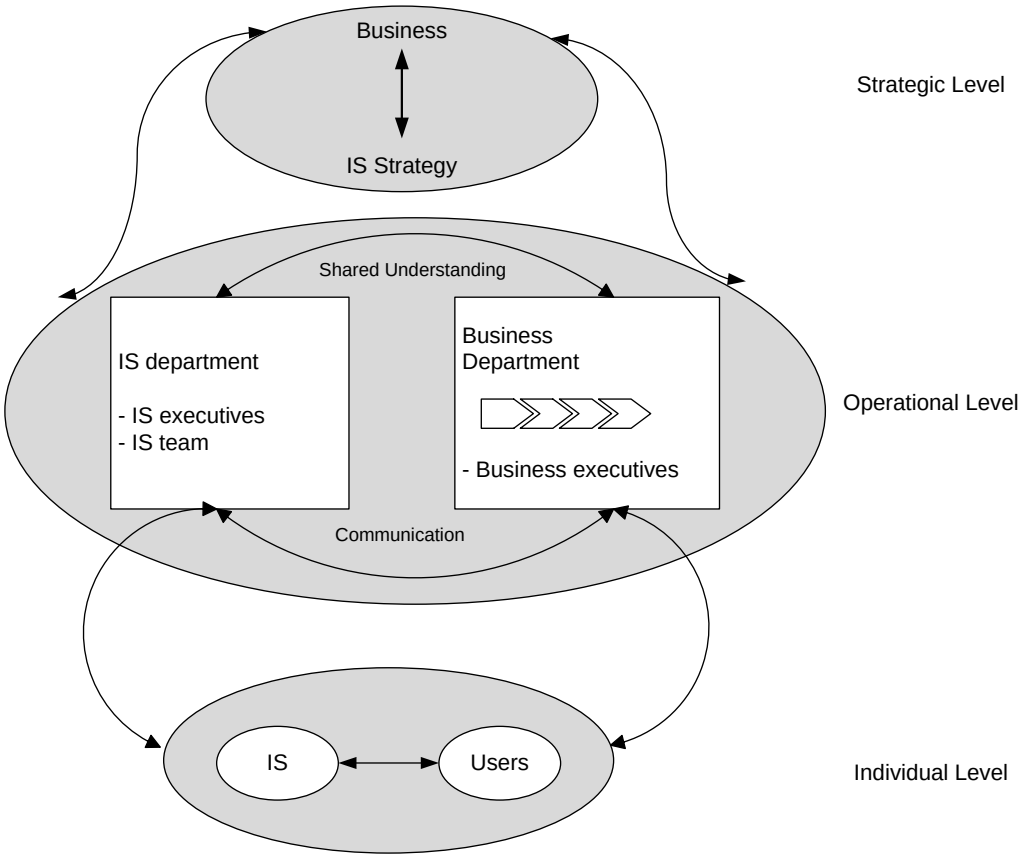
> "*Forces such as planning and controlling, which are largely supported by IT systems, push the organization towards stability and order. Forces of innovation and experimentation, that which remains uncodifiable (because new concepts are being invented and not yet described), largely abstract and not diffused, are forces of instability and disorder. [...] Constructs in the real world rapidly overtake IT systems. The IT system can only ever contain what is known. IT systems can clearly contribute most to the organizational IS when the business processes are well defined and stable.*"[375]

What makes an information system complex is that it can never be considered to be complete, closed or correct. The performance of the organization needs to be reviewed and updated continually if it is to survive in a changing world, and this requires that the information system should evolve and change qualitatively over time in order to allow this.[376] Therefore co-evolutionary perspectives on information systems and organizations frame the process of mutual adaptation and change between business and IT as a dynamic interplay of interactions, interrelationships, and effects, summarized in Figure 3.12.[377]

Based on this, Benbya & McKelvey suggests that in many organizations where misalignment occurs, business managers and information system planners are unable to express themselves in common language; therefore tightly aligned business and information system domains need continuous coordination and communication between business managers and information system planners.[378] They propose that requisite variety is related to the *least-effort* scale-free theory, which leads to efficient use of language words: it does not pay to know more words than used in talking or are understandable.[379] For instance, it does not make sense for IT people to talk to business people in terms of technical IT concepts that the business users cannot understand or find relevant.[380]

In this context, *sense-making* of individual actors is of special importance. Social order in any organization is predominantly based on negotiations; whenever individuals or groups work together then agreement about what, how, when, where, and how much is requried, and continued agreement itself may be something to be worked at.[381] Shared meanings between actors materialize, that means that sense-making is, importantly, an issue of

[374] Allen & Varga (2006), p. 233.
[375] Allen & Varga (2006), p. 234.
[376] Allen & Varga (2006), p. 237.
[377] Benbya & McKelvey (2006), p. 287.
[378] Benbya & McKelvey (2006), p. 289.
[379] E. g., Zipf (1949).
[380] Benbya & McKelvey (2006), p. 293. This perspective can of course be criticized because it proposes rational behavior of individuals and does not take into account factors such as culture, politics, and power.
[381] Strauss (1978), p. ix.



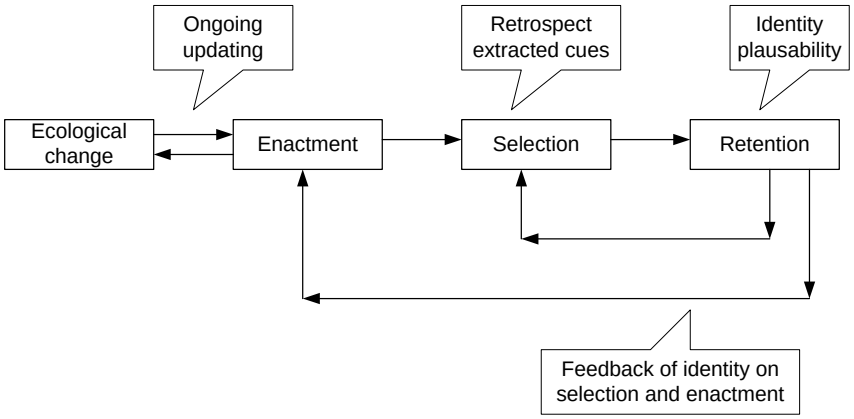
Source: Benbya & McKelvey (2006), p. 288

Figure 3.12: Co-evolutionary Information Systems Alignment

language, talk, and communication; situations, organizations, and environments are talked into existence.[382] According to Weick, "organizing" is a consensually validated grammar for reducing equivocality by means of sensible interlocked behaviors.[383] Organizational members must perceive and interpret their environment through strong and weak signs, and interactions with other members.[384] There is no objective environment, its perception depends on the members' cognitive maps.[385] This "enactment theory" model[386] is displayed in Figure 3.13 and conceptualizes the process of organizing as a sequence of three sub-processes – enactment, selection and retention. These processes as a microfoundation of organizing and sense-making make it easier to work with other meso- and macro-level formulations.[387] Results of retention feed back to all three prior processes because people

[382]Weick, Sutcliffe & Obstfeld (2005), p. 409.
[383]Weick (1979), p. 3.
[384]E. g., Alvesson (1993).
[385]E.g ., Weick & Bougon (1986).
[386]Weick, Sutcliffe & Obstfeld (2005), p. 409; Jennings & Greenwood (2003), pp. 201 f.
[387]Weick, Sutcliffe & Obstfeld (2005), p. 414.

organize to make sense of equivocal inputs and enact this sense back into the world to make that world more orderly:[388]



Source: Jennings & Greenwood (2003), p. 202, adopted from Weick (1979), p. 132

Figure 3.13: The Relationship among Enactment, Organizing, and Sense-making

- *Enactment*: this process incorporates the sense-making activities of noticing and bracketing, triggered by discrepancies and equivocality in ongoing projects, which begin to change the flux of circumstances into the orderliness of situations. These are relatively crude acts of categorization and the resulting data can mean several different things.
- *Selection*: this process reduces the number of possible meanings. Here a combination of retrospective attention, mental models, and articulation perform a narrative reduction of the bracketed material and generate a locally plausible story, which is nonetheless tentative and provisional.
- *Retention*: this process relates a story to past experience, connects it to significant identities, and uses it as a source of guidance for further action and interpretation.

3.4.5 Summary

Organizations and information systems as complex adaptive systems are nonlinear systems, plastically controlled and composed of many (often heterogeneous) partially connected components that interact with each other through a diversity of feedback loops. Their complexity derives from the partially connected nature and the nonlinear dynamics which make the behavior of these systems difficult to predict.[389] This is primarily due to language-based interpretation, communication, and sense-making: the unique human mode of reference, the "everyday miracle" of *word meaning* and *symbolic reference*.[390] These processes have to be taken into account by any theory dealing with organizations and

[388]See Weick, Sutcliffe & Obstfeld (2005), p. 409, in the following.
[389]Merali (2006), p. 219.
[390]Deacon (1997), p. 43.

information systems as complex adaptive systems. To achieve an effective representation of the dynamics of the process connecting the micro-level of individuals and the macro-level of the total system, a multi-scale description of complex systems is needed. Agent-based modeling and simulation facilitate the inclusion of the micro-level. However, for agents of social systems, the difficulty lies in identifying what constitutes the characteristic set of variables for defining the agents' behavior, and this challenge is not one of processing power for simulation.[391] Instead a theory for explaining and predicting theses processes is needed.

Traditional contingency theory has largely ignored these issues. Understanding the process of organizing requires the description of the actions and reactions of the organization. Most traditional organization theories that purport to address the process of organizing do not specify these actions and reactions.[392] However, the cybernetic concept of requisite variety is strikingly similar to the concept of "fit" found in some contingency organization approaches[393], and contingency theories yield recommendations virtually identical to those derived from cybernetics – higher external variety should be matched with greater internal variety.[394] What is most striking is that contingency theorists have obviously applied various cybernetic and systemic concepts such as variety, but have not really rigorously addressed the consequences of applying cybernetic knowledge. Whereas the general framework and conceptual approach of general system theory and cybernetics has been adopted and applied by a number of analysts[395], most researchers have completely disregarded these approaches' stance for understanding complex systems and their critique of the traditional concept of causality.[396]

3.5 The Concept of Self-Organization

Whereas contingency theory has mostly ignored its cybernetic successors, likewise, the complex adaptive systems perspective has been paradoxically ignorant of existing cybernetic research. Self-organization in the complex adaptive systems literature is mostly dealt with in the modern incarnation of the works of Kauffman, who conceptualizes evolution as a process of search over fitness landscapes.[397] Kauffman defines self-organization without reference to cybernetics, despite the fact that the term "self-organizing" in its modern sense has been first used by cybernetics.[398] Nonetheless, this study argues that cybernetics' conceptualization of self-organization is especially helpful for understanding and modeling the micro-level behavior and operations of individual agents.[399]

For Ashby, at the core of the concept of organization lies the *conditionality* of a relation between two entities A and B on the value or state of an entity C.[400] Consequently, entities

[391] Merali (2006), p. 223.
[392] Drazin & Sandelands (1992), p. 247.
[393] Osborn, Hunt & Bussom (1977), p. 298.
[394] Osborn, Hunt & Bussom (1977), p. 305. This has also been noted by Flood & Carson (1993), pp. 80 f.
[395] E. g., Katz & Kahn (1966); Thompson (2003).
[396] See Chapter 2. E. g., Scott (1975) argues that organizational research should abandon case study research in favor of more "scientific methods" such as surveys.
[397] E. g., Kauffman (1995).
[398] See Ashby (1947b) for the first known use of the term.
[399] Parts of this section have been published as Holten & Rosenkranz (2008).
[400] Ashby (1962), pp. 255 f.

or parts are organized when *communication* occurs between them that constrains their product space of the possibilities. The real world gives the subset of what *is*, the product space represents the uncertainty of the observer. It follows that, contrary to traditional organizational theory, a substantial part of the theory of organization should be concerned with properties that are not intrinsic to the thing but are relational between observer and thing.[401] *Organization* can then be defined as *the existence of communication or conditionality between a system's parts*, and the regularity in the behavior of conditionality as recorded by an observer.[402] Furthermore, an organization *per se* is neither "good" nor "bad"; what is meant by "good" must be clearly defined *in every case*.[403]

Therefore *there is no such thing as "good" organization in any absolute sense*; what is good in one context or under one criterion of stability may be bad under another. It all depends on the circumstances and on what is wanted, and a property of a system usually regarded as desirable may become undesirable in some other type of environment.[404] For instance, it is not good in general that a system has its part in rich functional connection: when the environment's parts are *not* richly connected, adaptation will be faster if the system's connectivity is small. Consequently, the degree of organization can be too high as well as too low.[405] Then an organization is judged "good" if it makes the system stable around an equilibrium assigned by an observer and achieves homeostasis in the case of disturbances.[406] Thus the definition of a "good" organization must in all cases give, and specify, two things:[407]

1. a *goal* which is specified as an assigned set of "essential" variables to be held within assigned limits, where a number of parts or sub-systems so interact as to achieve this given "focal condition".

2. a *set of disturbances* which threaten the goal, that is, the system's outcome is driven outside the limits specified for its essential variables; the focal condition is disrupted. That is, disturbances threaten the system's control and the system needs to adapt to the disturbances.

The "good" organization is then of the nature of a relation between the set of disturbances and the goal. But if the set of disturbances is changed, then the organization, without itself changing, is evaluated "bad" instead of "good".[408] For Ashby, *self-organization* then means *changing from a bad organization to a good one*; the system changes itself from a bad way of behaving to a good.[409] Then *a good system is a self-organizing system.*

[401] Ashby (1962), pp. 257 ff.
[402] Ashby (1962), pp. 257 and 261 f.
[403] Ashby (1962), p. 262.
[404] Ashby (1962), pp. 263 f.
[405] Ashby (1962), p. 265. This is compatible with the more generalized law of requisite variety introduced in Chapter 3.3.2.
[406] Ashby (1962), p. 263. See Chapter 3.1.1.
[407] See Ashby (1962), pp. 265 f. in the following.
[408] Ashby (1962), p. 266.
[409] Ashby (1962), p. 267.

Ashby formally demonstrates that *no machine can be self-organizing in this sense.*[410] A "machine with input" is in general defined by a set S of internal states, a set In of input or surrounding states and a mapping f of the product set $In \times S$ into S, $f\,(In \times S) \rightarrow S$. The organization between the parts of the machine is specified by the mapping f.[411] This is equivalent to saying that f determines the changes of S, where f can be defined as a set of couples (s_i, s_j) where the system changes from state s_i to s_j. However, a self-organizing machine in the sense described above would require f – which determines the machine's organization – to be some *function of* S, the states would change f, which would make nonsense of the whole concept of a machine.[412] With a set S and a change from function f to function g, a *variable* $\alpha(t)$ as a function of the time that had at first the value f and later the value g is needed.[413] To summarize Ashby's argument, the change from f to g cannot be due to any cause in the set S; it *must* always come from some outside agent or *controller*, represented by variable α, acting on the system as input. Thus the appearance of being "self-organizing" can be given only by the machine S being coupled to another machine, where S can be self-organizing within the whole $S + \alpha$.[414]

In going from *any* state of equilibrium, a system is going from a larger number of states to a smaller number of states.[415] In this way it is performing a selection, in that it rejects some states, by leaving them, and retains some other, by sticking to it. For instance, the business firm restocking after a sudden increase in consumption is such an *adapting* system. Only in *this* sense, then, *every* system can be thought of as "self-organizing", for it will develop some functional structure homologous with an "adapted organism". However, Ashby continues, what merges depends simply on what the system's laws are, which specify its behavior, and from what state it started; there is no implication that the organization developed will be "good" in any absolute sense, or according to the criterion of any observer.[416]

Following Ashby's argumentation, Beer defines "control" in complex, "big" systems as the stable state of the variety interactions between the sub-systems – requisite variety; and communication is interpenetrative between these richly interconnected sub-systems.[417] Looking at large and complex systems as composed of sub-systems means to understand *systemic stability* (homeostasis, stable variety interaction and stable communication between richly interconnected sub-systems) or control itself as *the object of the system* instead of holding steady an arbitrarily assigned output – which is the usual criterion of control engineering.[418] Beer claims that the reason for this is given by the volume of information defining the understanding of and the behavior of a complex system; complex systems such as organizations proliferate variety, and no one imagines that the set of actions open to

[410] A "machine" in the sense of cybernetics is that which behaves in a machine-like way, i. e., that its internal state, and the state of its surroundings, defines uniquely the next state it will go. See Ashby (1962), p. 261; Ashby (1964), pp. 42-48.
[411] Ashby (1962), pp. 261 f.
[412] Ashby (1962), pp. 267 f.
[413] Ashby (1962), p. 268.
[414] Ashby (1962), p. 269.
[415] Ashby (1962), p. 270.
[416] Ashby (1962), p. 273.
[417] Beer (1966), p. 226.
[418] Beer (1965), p. 226.

being taken by a manager constitutes the control of a company.[419] This means that complex systems are under control if they are self-organizing and adopt to changing environments.

The remaining question is how a controller doing all this can be designed? What is this controller, enabling a complex system to be self-organizing in this way, if it is not a rational designer? Following the law of requisite variety the controller needs the power to absorb the variety proliferated by what is to be controlled. Conant & Ashby made the point that in order to regulate (control) a system well, the regulator must work through a model of that system; and a model of a system must model every salient aspect or interesting feature of that system.[420] Consequently, a model of the complex system is needed. Some group-theoretic formulations are helpful to illustrate this point:[421]

- If M is the set of elements – the system – and the totality of world events which are under examination, A is a subset of M and gives the systemic configuration of events that are known to an observer. The *homomorphic* group $f(A)$ gives a model of M.[422]
- First, to enable control, the model of the system M has to preserve a one-to-one correspondence of elements with regard to the system to be controlled, otherwise control based on this model would not be possible due to the law of requisite variety. If a one-to-one correspondence between the model and the system is preserved, this is called an *isomorphism* in group-theoretic terms.[423]
- Second, one needs to understand what is isomorphic to a complex system, that is, preserving a one-one correspondence. According to Beer, the group-theoretic formulation gives the clue to answer this question: Cayley's theorem declares that every finite group is isomorphic to a certain group of permutations of itself; one of these is the identical permutation.[424] Then according to Beer the isomorphism that is sought for the complex system is *the system itself*. That is, to preserve the one-one-correspondence, a system as complex as the complex system itself is needed (one of the permutations of the finite group), and therefore the complex system itself (the identical permutation) is the model that is sought.[425]

Thus the complex system M, to which another system A is clamped, which is in fact itself, is to be called controlled; the power to absorb the variety proliferated by a complex system, which is to be controlled, must be disseminated throughout the complex system itself rather then being concentrated in a "control box" or manager.[426] Comprehension therefore begins with observations about the way in which sub-systems of the complex system interact, that is, the individual human beings (agents) and their communication in

[419] Beer (1966), p. 225.
[420] E. g., Conant & Ashby (1970); see Chapter 3.3.2.
[421] See Beer (1965), pp. 223-225, in the following.
[422] When one group is mapped into another group and one may either add the original elements and transform the later or transform the original elements first and then add them later, the mapping is called homomorphic. See Beer (1965), p. 224.
[423] Beer (1965), p. 224.
[424] Beer (1965), p. 225. See Cayley (1854) for the original formulation of Cayley's theorem.
[425] Beer (1965), p. 225.
[426] Beer (1965), pp. 225 f.

the case of complex social systems such as organizations and information systems.[427] This is consistent with the perspective of organizations as complex adaptive systems.

3.6 The Viable System Model

3.6.1 Origin & History

Organizations and information systems can be analyzed by using many different lenses and points of view. For this research, a systemic perspective is employed and organizations and information systems are regarded as complex adaptive systems. Since information which is communicated between two agents is an important concept for self-organization and is related to complexity and variety, following the line of argument in the preceding section, a method that allows *the observation and documentation of the interactions of sub-systems* (agents) of a complex system and the information flows between them would be useful. It would be convenient to have an instrument for analysis and diagnosis of organizations.

However, existing approaches for modeling organizations lack concepts for modeling information flows between different actors, or lack theoretical founding. For instance, business process modeling is considered to be an important instrument for analyzing and solving several technical and organizational design issues on an application level, enterprise level or industry level.[428] Business process models are typically graphical depictions of activities, events, and control flow logic[429], using notations such as event-driven process chains[430] or the business process modeling notation[431]. But most of these approaches focus on interrelated activities, and pay little attention to information flows, do not allow for aggregation and more profound analysis, and mostly are not based on any organizational theory.[432] The following sections introduce the *Viable System Model* (VSM), a common language developed by Stafford Beer for making organizational structures visible and comparable.[433]

According to Beer, the VSM is a *language for describing organizational structures*, building on fundamental cybernetic principles and theories.[434] As an approach for analyzing communication and information flows between different functions and actors, it is not a model or meta-model in the sense of an information model; in this the terminology and wording of Beer are confusing and misleading. Likewise, Tsoukas regards the VSM as a conceptualization of organizations stemming from a topographic conception of organizational structure, and Mintzberg argues that the VSM is a suitable perspective on the information flows within an organization.[435]

[427] Beer (1965), pp. 223-225.
[428] Moody (2005), p. 244.
[429] E. g., Curtis, Kellner & Over (1992).
[430] E. g., Becker et al. (2003); Davis (2001); Scheer (2000).
[431] OMG (2009).
[432] Kock & McQueen (1996), p. 16. See also Kock (2001); Kock (2003).
[433] A full and detailed overview of the VSM is given by Beer (1979); Beer (1981); Beer (1985). See also Christopher (2007) and Hoverstadt (2009).
[434] Beer (1981), p. 25; Anderton (1989), p. 50. Cybernetic theories and concepts, e. g., the law of requisite variety and homeostasis, are central building blocks of the VSM.
[435] Tsoukas (1992), p. 442; Mintzberg (1979), p. 39.

The VSM has been previously applied in various research approaches in management science.[436] In information systems research, the VSM has been used especially in the context of information systems development.[437] For instance, the VSM has been applied by Kawalek & Wastell for describing the organizational setting, identifying stakeholders and enhancing the understanding of the situation, and as a generic template of an information system which can be specialized to different organizational settings.[438] Similarly, Mumford suggests using the VSM for organizational analysis in the design of information systems.[439] Likewise, Snowdon & Kawalek aim to redraw conceptual barriers between software engineering and organizational theory in their study, seeking new conceptual underpinnings for this in the VSM.[440] Nyström found that the VSM can support the design of intranets according to essential functions such as early warning systems and identifies core functions in an intranet based on the VSM.[441] In this thesis, the VSM is used in Chapter 4 for describing the organizations examined in the exploratory field studies. The single components of the VSM are explained and discussed in the following. These components are the fundamental *conceptual language aspects* of the VSM.[442]

3.6.2 Components of the Viable System Model

General Overview & Principles

Seven main components or sub-systems form a viable system's structure on one level of hierarchy, as summarized in Table 3.2. For instance, specific elements make operative decisions and take actions for the present and short term environment, other elements make tactical and strategic decisions and take actions for the long-term adaptation to the environment, and other elements in turn make normative decisions and take actions governing the orientation of the organization as a whole.

The components are connected by *information channels*; each information channel is a two-way communication loop of variety attenuators and amplifiers.[443] *Attenuation* means to decrease high variety to the number of possible states the receiving entity can handle; *amplification* means to enhance low variety to the number of possible states the receiving entity needs if it is to be regulated. Attenuators and amplifiers need to be designed; when they are not designed, they simply occur because the law of requisite variety asserts itself.[444]

[436] E. g., Espejo (1989); Malik (1996); Bititci, Carrie & McDevitt (1997); Jackson (2000).
[437] E. g., Schuhmann (1993); Kawalek & Wastell (1999); Herring (2002); Mumford (2003); Vidgen (1998); Holten (1999).
[438] Kawalek & Wastell (1999), pp. 28-30.
[439] Mumford (2003), pp. 66-69.
[440] Snowdon & Kawalek (2003), p. 1022.
[441] Nyström (2006).
[442] The specification of a sound modeling method needs (1) a modeling technique comprising (a) conceptual language aspects, (b) representational language aspects and (c) action guidelines, and (2) a procedure model for problem solving, see Holten (2000), pp. 4 ff. In this thesis, these concepts are not specified in detail because the VSM is only used as an instrument and the development of a modeling method is not part of this research. See Rosenkranz, Holten & Laumann (2008) and Rosenkranz (2009) for a more thorough description of a modeling method building on the VSM.
[443] Beer (1985), pp. 19-35.
[444] Beer (1979), p. 92.

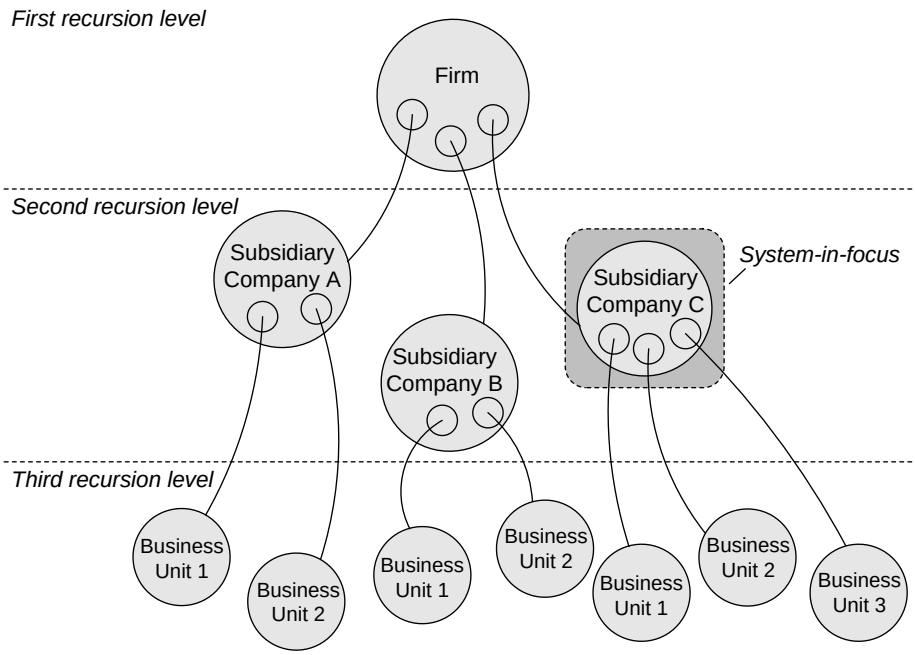
System	Description
Elemental Organizational Unit	On each given recursion level, Operational Divisions are responsible for certain parts of an organization's activities and have contact to the outside environment. The divisions are those *fundamental* to the viability of the system under discussion and are each managed by a divisional Management Unit. Together, they form an Elemental Organizational Unit (Beer (1979), pp. 94-97).
System 1	All Operational Divisions and divisional Management Units on one level of recursion together form System 1. System 1 acts a an interface between recursion levels (Beer (1979), pp. 94-97).
System 2	Each System 2 conducts a service function for System 1 (e. g., Finance, Human Resources or IT services), and serves to damp oscillation and disruptions that occur between the divisions on an operational level (Beer (1979), pp. 176-186).
System 3	System 3 supervises all internal operational activities of all divisions from a higher point of view of the total system. It optimizes the allocation of resources, assigns them to the divisions and regularly checks the use of these resources (Beer (1979), pp. 473-480).
System 3*	System 3* is the audit channel, which gives System 3 direct access to the state of affairs in the operational activities. System 3 can obtain immediate information by using System 3*, instead of relying on information passed to it by divisional management.
System 4	System 4 deals with the diagnosis of the long-term connection of a viable system to its outside environment and its adaptation to future trends (Beer (1979), pp. 235-240).
System 5	The ethos of the whole viable system is formed by System 5. It embodies supreme values, rules and norms for the stabilization of the whole system (Beer (1979), pp. 259-264).

Table 3.2: Summary of the Main Components of the Viable System Model

Any organization belongs to an arbitrarily large number of sets of *recursions*. Each of these recursive chains of systems is a *recursive dimension*. A recursive dimension needs to be explicitly specified by the modeler applying the VSM. Analyzing multiple dimensions results in multiple different models, each having a different dimension as a recursion criterion. Each recursive dimension has several hierarchical *recursion levels*. For instance, as illustrated in Figure 3.14, a firm (first recursion level) has many subsidiary companies (second recursion level), a subsidiary company has many business units (third recursion level), et cetera. According to the specification and need of the modeler, the components or sub-systems are modeled on every selected recursion level.

For a specific analysis, a modeler selects one element on one recursion level out of the many possible recursion levels, the so-called *System-in-focus*. The sub-ordinated recursion levels are treated as *black boxes*, that is, their internal elements are of no interest for the analysis of the System-in-focus, only their input and output relationships in form of information channels.[445] The so-called System 1 serves as an interface between recursion

[445]Beer (1979), pp. 40-47. See Ashby (1964), pp. 86-117, for a detailed introduction to the black box principle.



Source: adopted from Espejo, Bowling & Hoverstadt (1999), p. 669

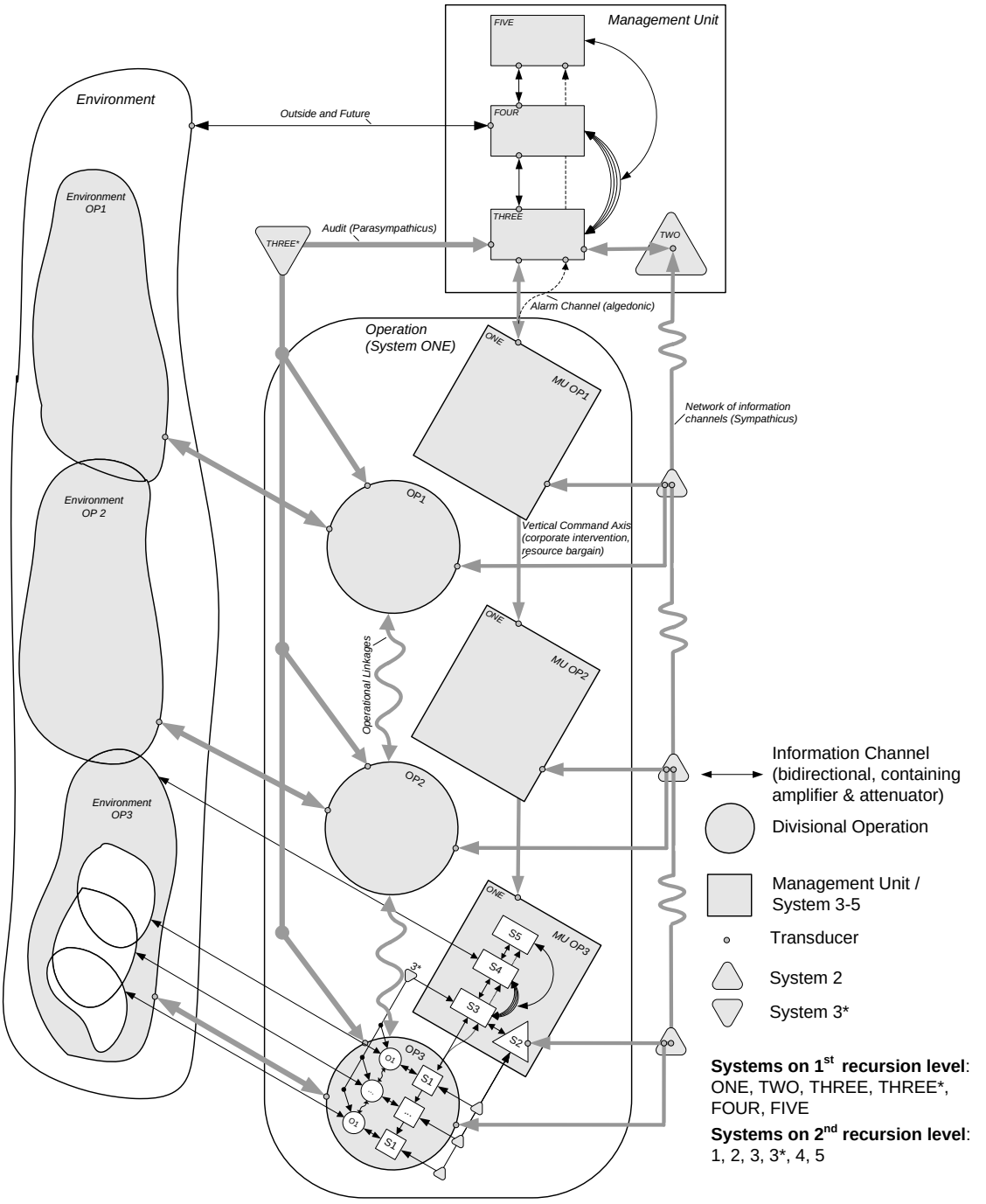
Figure 3.14: Exemplary Recursion Levels of an Organization

levels.[446] According to the black box principle, messages transmitted by information channels between sub-systems have to be "translated" when a boundary is crossed by a *transducer* that is capable of coding or decoding these messages.[447] Figure 3.15 displays the traditional visual representation of a VSM for the selected System-in-focus of Figure 3.14, showing two recursion levels simultaneously.

Elemental Organizational Unit

Each System-in-focus comprises one or many *Elemental Organizational Units*. An Elemental Organizational Unit comprises a *Management Unit*, the *Operational Division* it regulates, and their *Environment*, embedded in each other.[448] Therefore each Elemental Organizational Unit is an embedment of the Management Unit in its Operational Division, and an embedment of all that in an Environment. These are usually not analyzed in detail on *this* recursion level, and instead they are treated as a black box. The *square* in Figure 3.16 is the Management Unit and encloses all the managerial activity needed to regulate the variety of its Operational Division by negative feedback. The task of management is to design the feedback adjusters and adjuster organizers of this feedback control loop. The *circle* encloses the relevant operations that produce *this* viable system, and the *amoeboid shape* represents the environment of all this.[449] The *arrows* represent variety adjusters:

[446]Beer (1979), p. 68.
[447]Beer (1979), pp. 101 f.
[448]Beer (1979), pp. 94 f.
[449]Beer (1979), pp. 70-96; Beer (1985), p. 20.

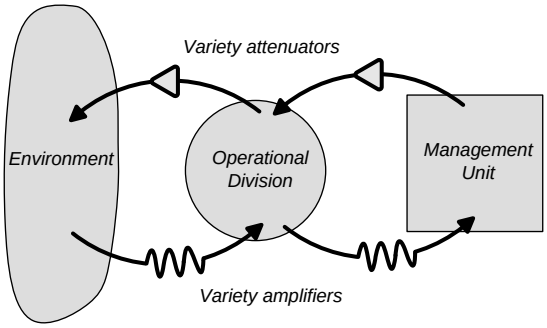


Source: adopted from Beer (1985), p. 136

Figure 3.15: A Traditional VSM Diagram

high variety is necessarily cut down, or attenuated, to the number of possible states that the receiving entity can actually handle by attenuators, low variety is necessarily enhanced,

or amplified, to the number of possible states that the receiving entity needs if it is to remain regulated by amplifiers.[450]



Source: adopted from Beer (1979), p. 96

Figure 3.16: Elemental Organizational Unit

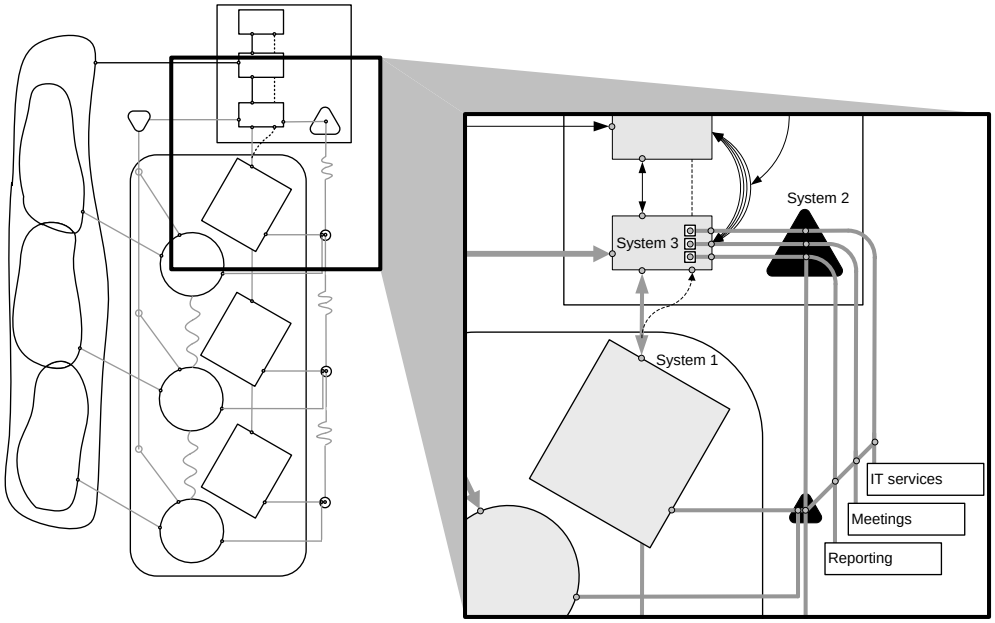
System 1

The *collection*, or set, of all Elemental Organizational Units is referred to as *System 1*.[451] System 1 is formed by those divisions *fundamental* to the viability of the system under discussion, and consists of the various parts of an organization directly concerned with carrying out the tasks that the organization, according to some observer, is supposed to be doing. OP1, OP2, and OP3 (the business units of the System-in-focus in Figure 3.14) in Figure 3.15 are all parts of System 1 of this viable system, each being an Operational Division with its own relations to the environment, its own Management Unit, and interactions with other Elemental Organizational Units. Management in System 1 is charged with conducting operations according to a *resource bargain* struck with senior management.[452] For this, each Elemental Organizational Unit of System 1 is connected to senior management by a specific information channel, the *Vertical Command Axis*. In effect, each part of System 1 is a black box for senior management. For instance, instructions are given to the Management Unit MU OP1, which instructs its operational element, OP1, what actions it should take. The actions of OP1 are monitored and transmitted back to MU OP1, which is able to send information about OP1's performance back to senior management by using the Vertical Command Axis, and can adjust OP1's behavior to achieve desired goals (negative feedback).[453] Each Elemental Organizational Unit is autonomous and a viable system in its own right on the next lower recursion level. The only restrictions and limits on them stem from the instructions of senior management (in form of System 3, acting as a negative feedback loop seen from the next higher recursion level where System 3 is part of *that* recursion level's Management Unit) and the coordination and control by System 2.

[450]Beer (1985), pp. 21-35.
[451]Beer (1979), p. 132; Beer (1985), p. 19.
[452]Beer (1979), p. 94-97.
[453]Jackson (2000), p. 158; Beer (1985), pp. 37-53.

System 2

In principle, each Elemental Organizational Unit has autonomy for conducting its purpose within the framework given to it by senior management. *System 2*, displayed in Figure 3.17, is a viable system's anti-oscillatory device for System 1.[454] It connects senior management's System 3 and System 1 (in fact, the Systems 2 of the Elemental Organizational Units on the next recursion level). Its function is anti-oscillatory with respect to vertical interactions within System 1 in the operational domain, that is, it damps oscillation.[455] Each System 2 conducts a service function for System 1 (e. g., Finance, Human Resources or IT services), and serves to damp oscillation and disruptions that occur between the divisions on an operational level.[456] System 2 is *not* dedicated to the performance of all routine procedures, just to those that are anti-oscillatory. Most other routine procedures are part of the information channels between senior management and System 1.[457] In principle, System 2 tries to coordinate System 1 since the Elemental Organizational Units cannot be informed about all states that the other Elemental Organizational Units are in.[458] System 2 receives and shares information from all Elemental Organizational Units about the actions of the various parts of System 1, collects and aggregates this information and shares it with all Elemental Organizational Units. By doing this System 2 tries to prevent oscillations resulting from uncoordinated actions.



Source: adopted from Beer (1979), p. 96

Figure 3.17: System 2

[454]Beer (1979), p. 132; Beer (1985), p. 66.
[455]Beer (1979), pp. 176-183.
[456]Beer (1979), p. 176-186.
[457]Beer (1979), p. 184.
[458]Beer (1979), p. 178.

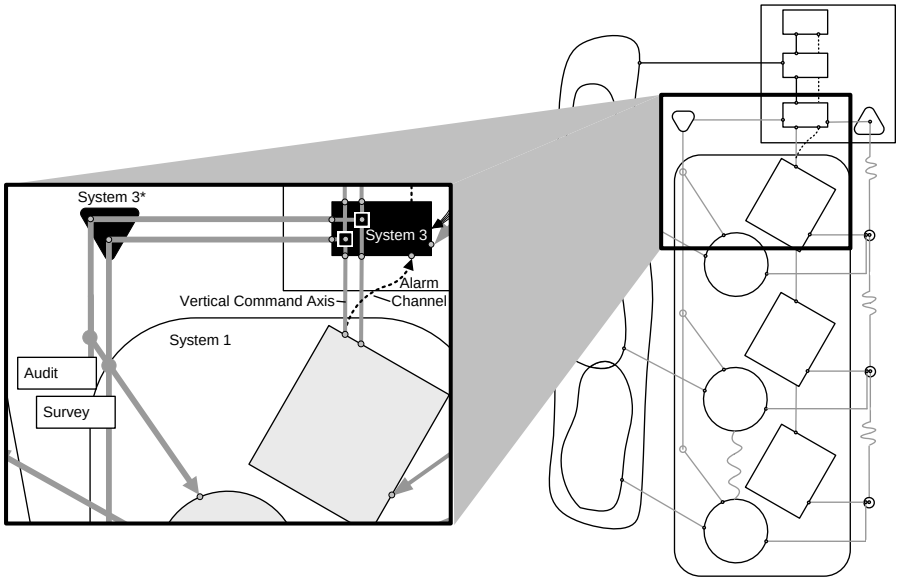
System 3 / System 3*

Senior management in the form of *System 3* supervises all internal operational activities of all Operational Divisions in System 1 from a higher point of view of the total system. It optimizes the allocation of resources, assigns them to the divisions and regularly checks the use of these resources.[459] System 3 can see all operations simultaneously, and it is intended to lead the whole viable system to a higher total pay-off for the total system than the sum of independently acting elements could produce, by promoting synergistic behavior. Thus, System 3 is the center of a major resource allocation procedure, and intervention into the autonomy of System 1 by rules and accountability.[460] It is responsible for the internal and immediate functions of the organization.[461] *System 3** is the audit channel, which gives System 3 direct access to the state of affairs in the operational activities. System 3 can obtain immediate information by using System 3* instead of relying on information passed to it by divisional management (e. g., by special surveys or studies). This is illustrated in Figure 3.18.[462] As such, System 3 is a control function, which interprets internal data received from Systems 1, 2 and 3* and external data from System 4. Then it monitors the performance of System 1 and takes control action based on the received information, and accordingly passes down instructions for behavior and distributes resources to System 1. Moreover, it transmits aggregated information from System 1 upward to Systems 4 and 5. If something very important threatens the viability of the whole system, information is directly transmitted to System 5 using the *Alarm Channel* as an algedonic loop, warning System 5 of an immediate and vital threat or an important opportunity. Therefore System 3 is the managerial fulcrum of a viable system.[463]

System 4

System 4 is illustrated in Figure 3.19 and deals with the diagnosis of the long-term connection of a viable system to its outside environment and its adaptation to future trends.[464] System 4 expands variety by contemplating rather than creating alternatives, and reduces variety by the mental elimination of those alternatives.[465] Basically, System 4 acts as an *algedonode*, transmitting urgent information upward to System 5 or wholly surpressing it.[466] Recognizing important threats or opportunities in the environment, System 4 filters this information and transmits it upwards to System 5, if it has long-term implications, or downwards to System 3, if immediate actions are necessary. As System 4 brings internal and external information together, examples of it are corporate planning, marketing research, research and development, or public relations.[467] While System 3 has the responsibility for the inside and now of the organization, System 4 has the responsibility for the outside and the

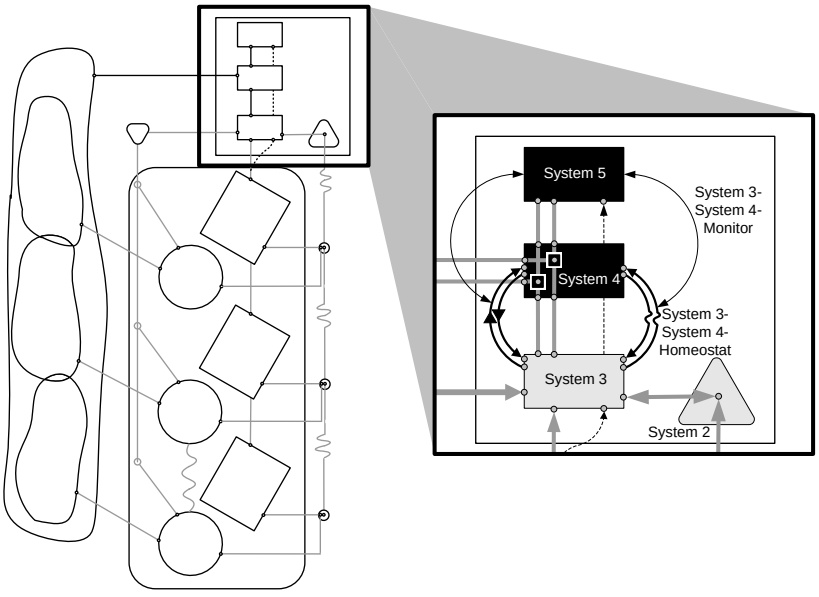
[459] Beer (1979), pp. 473-480.
[460] Beer (1979), pp. 202 f.
[461] Beer (1985), p. 86.
[462] Beer (1985), pp. 82-87.
[463] Beer (1979), p. 263.
[464] Beer (1979), pp. 235-240.
[465] Beer (1979), p. 230.
[466] Beer (1981), p. 230.
[467] Jackson (2000), p. 161. Beer, based on his World War II experiences, proposes to implement an *operations room* for System 3 and System 4 activities, see Beer (1979), pp. 242 f.



Source: adopted from Beer (1979), p. 96

Figure 3.18: System 3 and System 3*

future. The very strong connection between System 3 and System 4 makes these systems' collaboration a powerful homeostat. This *System 3-System 4-Homeostat* stabilizes the present and regulates the operations of the whole viable system.



Source: adopted from Beer (1979), p. 96

Figure 3.19: System 4 & System 5

System 5

The ethos of the whole viable system is formed by *System 5*, see Figure 3.19. It embodies supreme values, rules and norms for the stabilization of the whole system.[468] System 5 is responsible for the direction of the whole organization, formulating its policy and general behavior based on the information passed to it by Systems 3 and 4. On the next higher level of recursion, System 5 must represent the Management Unit to the whole system. Moreover, it regulates the System 3-System 4-interaction (*System 3-System 4-Monitor*).[469]

3.6.3 Theoretical and Methodical Explanations

Beer's remarks on the scientific process help to explain how he understands the development of the VSM and are illustrated in Figure 3.20.[470] According to Beer, when similarities between two different systems are noticed by *perception*, for instance between the regulatory system of an individual and a group, or between a brain and a firm, the comparison often begins in a literary manner. Similes like "management communications are like the nervous system, in that..." and metaphors as comparisons help to convey *insights*. Nevertheless one comes to hold conceptual models of both systems that become exciting and helpful. For Beer, it is now worth to draw an *analogy*.[471]

The process continues, and begins to have the marks of a scientific method, when *rigorous formulations* of the two conceptual models are developed. Each of these is a *homomorphic mapping*, insofar as many elements in the system that is conceptually modeled will map on to one element in a rigorous model. All falling apples, and not only the particular falling apple observed by Newton, obey the law of gravitation: those mappings that exhibit mathematical invariance are selected. If invariances between the two systems can be found, then these are *isomorphic mappings*, one-to-one in the elements selected as typifying systemic behavior in some selected but important way. The generalized system that comes out of this process, which applies to all systems of a particular class, is according to Beer a *scientific model*, for instance, the model of gravitation. The generalization of some behavior invariably and invariantly exhibited by the system as interpreted through this systemic model is usually called a law.[472] However, there is no way of proving a scientific model; only the criterion of falsifiability remains: as experience of the scientific model grows, more and more systems are mapped on to the model and the invariances must hold.[473]

For Beer, the VSM is derived in this manner from fundamental cybernetic principles and offers a theoretically sound foundation for the analysis of functions, actors, tasks and

[468] Beer (1979), p. 259-264. Beer envisions System 5 as a *multinode*, a set of managers, see Beer (1979), p. 265.

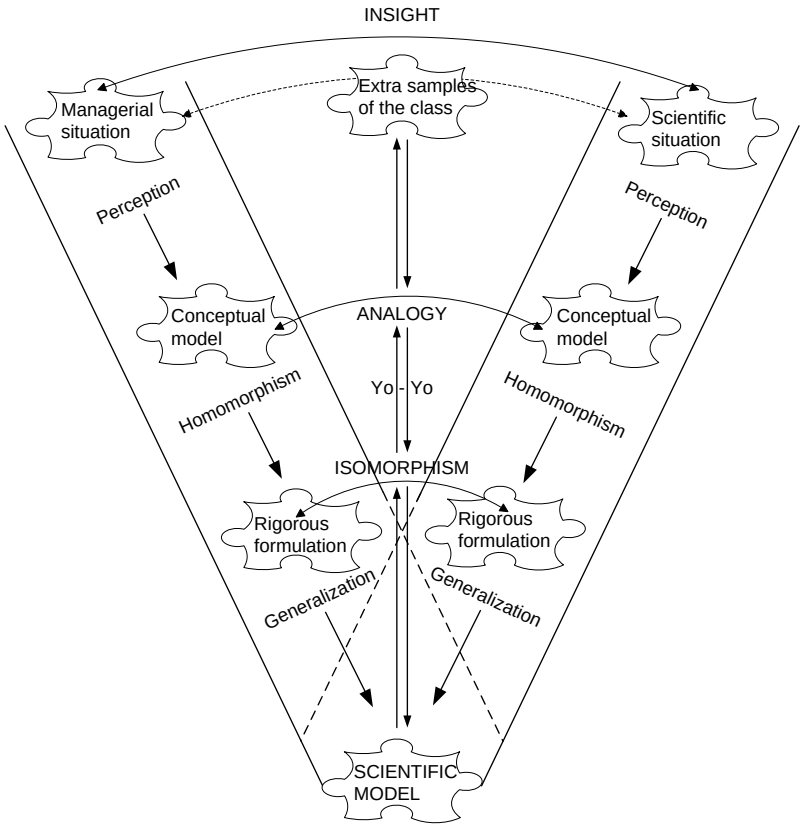
[469] Beer (1985), pp. 128 f..

[470] See Beer (1965), pp. 223-225, Beer (1966), pp. 95-119, and Beer (1989), pp. 13-16, in the following. Beer calls this methodology the *yo-yo technique*. See also Tsoukas (1991), pp. 573-577, on the description of this process. These statements are to some degree compatible with Lee (1991) and this study's methodological view, see Chapter 2.

[471] Beer (1989), pp. 13 f. This corresponds to the first role (construction of data) and second role (interpretation of data) of the researcher as introduced in Chapter 2.

[472] Beer (1989), pp. 14 f. This corresponds to the third role of the researcher (matching to theory).

[473] Beer (1989), p. 15. This corresponds to the fourth role of the researcher (theory testing).



Source: Beer (1989), p. 14

Figure 3.20: The Process of Scientific Modeling

the information flows between them within an organization; the black box technique allows to structure them without reductionist assumptions:

> *"Organizations are collections of decision elements and the channels by which they are connected – the neurons and their processes in the brain, men and their communications in the firm."*[474]

Beer even claims that the VSM is a scientific theory and that it specifies the minimum structural constraints – the existence of the invariances described (i. e., the sub-systems) and the securing of requisite variety – by which a given system can be said to be capable of independent existence in a changing environment; according to Beer, if a system meets these constraints it is said to be *viable*.[475] That is, the system should be able to maintain and sustain its identity, responding to changes in the environment, even if these changes could not have been foreseen at the time the system was designed.[476] According to Tsoukas, the specific concepts used in the VSM, developed in an analogical manner

[474]Beer (1981), p. 231.
[475]Beer (1979), pp. 40 and 68 ff. Following the description of the yo-yo method in Beer (1989), it is quite clear that Beer views the VSM as a falsifiable theory.
[476]Jackson (2000), p. 157.

from the source domain of the human nervous system, do not really matter as such; what matters is that the relationships in the source domain are isomorphically mapped onto the target domain. Therefore the VSM is not merely a metaphor of organizations, but the organization and the human nervous system are *identical* over a specified area of activity – that is, identical once an invariance has been established.[477] But TSOUKAS argues that topographical conceptualizations as the VSM are faced with some inherent limitations:

- First, it is assumed that organizations-as-places have single identities. Differences between organization members – the latter understood both as individuals and groups – are submerged in the name of an overarching organizational rationality, which is usually defined in terms of its competitive relation to the environment, that is, survival.[478]

- Second, conceptualization is synonymous to abstraction and to the creation of formalisms. The latter seek to represent a social system in such a way so as to capture its most crucial features and, hopefully, fundamental dynamics. Formalisms are necessarily, but by default, they are one-sided and generic. By formally representing organizations in the language of the VSM, abstraction is raised to such a high level so that organizational specificities are discarded in search for literal identities and invariances.[479]

However, the status of the VSM as a theory is a point of debate among researchers.[480] This thesis sees itself as agnostic regarding the question whether the VSM is a scientific model or theory in the traditional sense. Instead, the VSM is treated and applied as a language for describing organizational phenomena, which is in turn built upon cybernetic theories and principles as the law of requisite variety.[481] As HOVERSTADT points out, one might argue forever about the VSM, but arguing with the law of requisite variety is about as futile as arguing with the law of gravity.[482] The functions represented by the components of the VSM can be mapped to individual agents and their interactions. Following ACKOFF,

[477] Tsoukas (1992) p. 450.

[478] Tsoukas (1992) p. 442. Likewise, JACKSON cautions that emphasizing organizational design with the VSM may preclude proper attention being given to the generation of shared perceptions and values: shared beliefs enable organizations to be adaptive and viable over longer periods of time. See Jackson (1988), p. 566.

[479] Tsoukas (1992) p. 450.

[480] See Flood & Carson (1993), pp. 87-91, on several points of critique against the VSM as a scientific theory. Schwaninger (2006) attempts to underpin the theoretical claim with a number of case studies. Recent quantitative studies show that from a behavioral science perspective, the VSM *can* be formalized for empirical, quantitative testing, see Bröker (2005); Frost (2005); Tran (2006). Opponents of this view argue that the VSM is too general to be ever falsified, and as such does not easily lend itself to empirical studies that attempt to corroborate or falsify it, see Malik (1996), p. 490, and the comments in Jackson (1989) and Harnden (1989).

[481] In applying the VSM in several cases, the author has made the experience that it is hard to built testable and falsifiable hypotheses based on the VSM, since its nature is very general. However, Rosenkranz & Feddersen (2007) and Rosenkranz & Feddersen (2008) try to form an explanatory, quantitative model for the success of virtual community management teams based on the VSM. Empirical results of tests of this model have not been obtained yet.

[482] Hoverstadt (2009), p. 23.

the analysis of a system and its parts reveals its structure and how it works: it provides the knowledge required to make it work efficiently and to repair it when it stops working. Its product is know-how and knowledge, not understanding.[483] To enable a system to perform effectively one must be able to explain its behavior, which requires being aware of its functions in the larger system of which it is a part. The VSM should be an appropriate instrument for modeling the behavior of an organization, its parts, and the information channels and communication between the parts.

In summary, the VSM is a powerful language for describing organizations which embodies all the properties of formalisms. Compared with conventional organigrams[484] the VSM is much more abstract, generic, and immutably mobile – hence more powerful in allowing for the control over organizational activities in a way commonsense based organigrams do not.[485] Using the VSM, crucial aspects of organizations can be talked about, reflected upon, and rearranged. Not unlike an explorer looking at relevant maps, an organizational strategist can now view those aspects of the organization that have been taken to be its most significant, assess the current performance of Systems 1-5, and take appropriate action. Insofar as the VSM is a generic representation of organizations it is meant to be applicable in all sorts of contexts. By using it, organizational diagnosis followed by the appropriate actions becomes possible.[486] Therefore the VSM offers a language for mapping organizational functions and actors, and the information channels between them. This can help in diagnosing the information processing capacities of an organization.

Likewise, the law of requisite variety stands at the center of any application of the VSM. However, existing work mostly has not responded to this issue in a satisfactory way. For instance, instead of providing an inter-subjective operationalization of variety, most methodological proposals and applications focus on the rigorous identification of sub-systems, and not on the analysis of the variety transmitted by information channels between those sub-systems.[487] This is compatible with statements of Beer that the measurement of variety is not an exact science, but both Beer and Ashby showed clear examples of how variety can be measured inter-subjectively.[488] Every sound application of the VSM therefore should heed their examples, and focus on the variety transmitted by information channels. What is missing so far are detailed guidelines on how to measure variety inter-subjectively.[489] However, it is still unclear on how to proceed *after* problems have been diagnosed, that is, on how to change the organization to correspond to the identified issues. The focus of the VSM is not really on people, their reactions in the role of a specific component, or the processes of their perception of and adaptation to requisite variety. The VSM is more like a map for identifying necessary components, but provides no guidelines or measures for determining the goodness of communication and coordination.

[483] Ackoff (1999), p. 12.
[484] E.g., Hansen & Neumann (2005), pp. 183 ff.
[485] Tsoukas (1992) pp. 451 f.
[486] Tsoukas (1992) pp. 451 f.
[487] E. g., Espejo, Bowling & Hoverstadt (1999); Ríos (2006). Snowdon & Kawalek (2003), p. 1024, argue that the relative balance of the variety between sub-systems rather than their absolute measurement is important.
[488] E. g., Beer (1979), pp. 518 ff.; Ashby (1981a); Ashby (1981b).
[489] Since variety is inherently subjective, it can never be measured purely objectively. Useful suggestions for operationalizing this measurement and their application are explored in Chapter 4.

3.7 Information Systems as Language Communities

In accordance with the communication-based conceptualization of social systems as autopoietic systems and the importance of communication for organizing and self-organization in complex adaptive systems, the following section introduces a conceptualization of information systems as social systems which is based on the unique *human mode of communication*: language and speech.[490]

3.7.1 The Importance of Language for Organizations

The Faculty of Language

Language is an every-day phenomenon and therefore seems to be unimportant at first glance.[491] However, this is not the case: several fields like linguistics, philosophy, psychology or neurology inquire about the nature of language and demonstrate the importance of language and speech for understanding human behavior and human beings' uniqueness as a symbolic species.[492]

There is no consensual answer to the question as to how meaning is given to language, or how two persons are able to communicate and comprehend each other by the use of language. For instance, it is not quite clear whether the human ability for language results from a universal grammar underlying all languages, or to what extent language and meaning are shaped due to cultural factors.[493] A consensual understanding can be found in different contexts in the literature regarding a common-sense meaning of concepts, terms, and ideas that can be transferred between groups of individuals that share a common language or language community; two individuals can communicate to the extent that their languages are sufficiently similar.[494]

In parallel to this understanding follows what is commonly known as the *linguistic turn within philosophy*.[495] Wittgenstein argued that every perception of the world is language-bound, so that language becomes the mediator between reality and an individual.[496]

[490] A *language* is defined as a mode of communication based upon symbolic reference and involving combinatorial rules that comprise a system for representing synthetic logical relationships among these symbols, see Deacon (1997), p. 41. *Speech* refers to the processes associated with the production and perception of sounds used in spoken language. Although other non-human species make use of quite sophisticated communicative systems, none of these are known to use a language defined in this sense, see Deacon (1997), pp. 41-54.

[491] Although one can reflect upon language, e. g., by distinguishing between object and meta level language, the ability to speak and understand a language is commonly regarded as a competence that cannot entirely be comprehended, see Lorenz (1996), p. 49. Therefore any research that either aims at analyzing a language and its use or at inventing new "language games" has to face a subtle challenge: every researcher is trapped in a network of language, patterns of thought and action she or he cannot completely transcend – leading to a paradox that can hardly be resolved: understanding a language is not possible without using a language; at the same time, any language that is used for this purpose will bias the perception and judgment, see Frank (1998).

[492] E. g., Boulding (1956); Deacon (1997).

[493] E. g., Hauser, Chomsky & Fitch (2002); Everett (2005). See Christiansen & Kirby (2003) for an overview of different arguments.

[494] Chomsky (1988), p. 36. See also Gergen (1982), p. 80; de Saussure (1974), p. 77.

[495] E. g., Das Gupta (1996).

[496] Wittgenstein (1953), § 2.

Nothing is an object "inherently"; it only becomes an object as we talk about it. For this reason we use language to represent some meaning that we conceive.[497] However, many linguists believe that a logical language can bring out and make explicit the complexities and subtleties of expression.[498] However, ambiguities in language are clarified, not by logical analysis, but by looking at how the words or phrases in question are used in our daily activities and practices.[499]

From this point of view, language is an individual experience, especially in the way in which meaning is assigned to language. For instance, implications, associations and connotations of certain vocabulary vary notably between individuals depending on their background.[500] A narrow focus on words and syntax does not necessarily lead to meaningful linguistic use as is shown in the sentence "*Colorless green ideas sleep furiously*": the sentence is totally correct from the point of view of structural linguistics; yet it needs not to be necessarily meaningful, as most people would agree.[501] Especially the discussion of metaphor, and therefore the inevitable vagueness and inaccuracy of language, challenged the conception of a clean logical structure of language because it does not account entirely for meaning.[502] Likewise, recent anthropological studies suggest that the cultural influence on meaning in language may indeed be of great importance. For instance, "red" stands for danger in some cultures and for celebration in others.[503] Natural languages not only have a syntax and a semantics but also a pragmatics.[504]

Consequently, it is out of place to investigate the meaning of each single word individually or solely based on syntax and common semantics in order to understand the meaning of complete sentences or statements in texts or speech. Indeed, if the concept of a logical structure underlying all language would account for all meaning within language, then computer science and artificial intelligence research in general would not have failed to deliver natural language interfaces for computers; if a logical structure underlying language exists then meaning could somehow be traced back to a calculable problem because today's computers based on the von Neumann architecture[505] are, in a fundamental sense, logical machines.[506] But as of today, they cannot model organizational and managerial decision-making artificially.[507]

[497]Bühler (1934), p. 254; Bühler (1934), p. 8; Bühler (1934), pp. 54 ff..

[498]The basic underlying assumption of these efforts is the existence of an underlying logical structure of any sentence in any language, see Frege (1892); Chomsky (2006).

[499]Blair (2005), p. 1.

[500]E. g., Allan (2001).

[501]Fromkin & Rodman (1988), p. 223.

[502]E. g., Quine (1960), p. 125; Eco (1984), p. 130.

[503]E. g., Nakakoji (1996); see also Everett (2005).

[504]Dreyfus (1996), p. 182.

[505]E. g., Burks, Goldstine & Neumann (1946).

[506]Blair (2005), p. 1.

[507]E. g., Weizenbaum (1976); Dreyfus, Dreyfus & Athanasiou (1986); Copeland (1998). Central to this view is the empirically well supported finding that metaphoric constructs are used naturally and unproblematically all the time in normal communication by human beings, see Hamilton (2000), p. 241. Arguments from linguistic interpretivism show that the process of linguistic predication is not Turing-computable, see Holten (2003b), pp. 46-55. Computers based on the von Neumann architecture implement all components of a universal Turing machine, see Turing (1937) and Burks, Goldstine & Neumann (1946). Hermes (1954) shows that physical computers based on the von Neumann architecture

Moreover, language's emphasis on communication makes clear that it is a *social phenomenon*: language is not just a way to communicate, but a way to cooperate as well, a device that people use to coordinate their behavior with one another so as to achieve some purpose. Basically, language is a complex adaptation for communication which evolved piecemeal.[508] For instance, the English language is a set of rules, hundreds of thousands of them, of which the great majority define words, assigning meaning to specific sounds uttered in particular sequences. In German, every noun has one of three genders, and students are taught that no noun has been learnt unless one knows which gender it takes. This has led countless students of the language to look for some general rule that might govern the assignment of gender, some pattern that might make sense of what otherwise seems to be a completely random attribute of nouns.[509] However, there *is no central authority* with the jurisdiction to say what the rules are or the power to enforce them once they have been established. It is the individual users of the language themselves, with all the many purposes they bring to speaking and listening, who continuously legislate, repeal and amend its rules. As the English language is spoken by millions of ordinary people in an infinite variety of constantly changing circumstances, new rules are proposed by the simple act of speaking in a novel or unexpected way that the speaker finds useful or amusing. Old rules change and new ones are ratified by the community of speakers themselves.[510] An important consequence of this "linguistic democracy" is that there is not just one community of, for instance, English speakers, but thousands, each distinguished by local rules that reflect the peculiar knowledge and shared experiences of its members.[511]

Language in Organizations

In organization theory the literature is rife with evidence that organizational life is characterized by a substantial amount of communication: in meetings, conferences, and social events that fill the everyday life of workers and managers.[512] Linguistic communication is a central component of sense-making and organizing: sense-making, to the extent that it involves communication, takes place in interactive talk and draws on the resources of language in order to formulate and exchange, through speech, symbolically encoded representations of these circumstances.[513] A situation is talked into being through the interactive exchanges of organizational members to produce a view of circumstances including the people, their objects, their institutions and history, and their siting in a finite time and place.[514] For instance, MINTZBERG describes the roles of managers as the following:

> "*Rather, communication is [the manager's] work, and these media are his tools. The operating work of the organization – producing a product, doing research, purchasing a*

are Turing complete. Therefore, one inevitably has to rely on human judgment and knowledge, at least as long as one is bound to computers which are based on von Neumann architectures.

[508] Pinker & Jackendoff (2005), pp. 201-234.

[509] See Adelstein (1996), pp. 223 ff., in the following.

[510] Adelstein (1996), p. 228.

[511] Adelstein (1996), p. 229.

[512] E. g., Mintzberg (1973); Prescott & Visscher (1980).

[513] Taylor & Van Every (2000), p. 58.

[514] Taylor & Van Every (2000), pp. 33-34.

> *part – appears to be undertaken infrequently by the senior manager. The manager's productive output must be measured in terms of information, a great part of which is transmitted verbally.*"[515]

Likewise, SCHUHMANN argues that the most important structural coupling connects consciousness-systems (e. g., individual humans) and social systems (e. g., organizations):

> "*Only consciousness-systems do have the sensory apparatus needed for perception. Social systems cannot hear or see, they cannot be irritated by sound or heat, but they are open for irritations (thoughts or feelings) from consciousness-systems, introduced into communication. The mechanism for those irritations is language [. . .].*"[516]

However, linguistic conventions form a complex pattern:

> "*The intention signified by a sign may, e. g., differ according to who the speaker is. 'Half a Dispril' may e. g. between pharmacists denote half the standard package of the drug. A word that denotes one thing in one context may even denote the opposite thing in a slightly different context.*"[517]

> "*'It is a though we do not talk the same language,' reported the other. In a nutshell, the managers felt that they knew their business and were able to prescribe solutions that would fit. However, they were unable to translate these solutions into formal IT requirements, nor were they able to translate the suggestions of technologists back into their own language. 'When they say that the answer is Oracle,' one of the managers commented ruefully, 'what are we supposed to make of that? Why is the answer Oracle?'* "[518]

ESPEJO et al. found that communication processes are often defective or pathological. Typical symptoms include that people of different functions, such as research and production or marketing and quality assurance, are unable to understand each other, and poor communication between those developing an idea and those implementing it.[519] Researchers often try to analyze the effect of "cultural intelligence" and different cultures on the forming of understanding and meaning in this context.[520] Although differences in meaning and understanding are important for goodness with regard to communication and coordination, "culture" is a vague and diffuse concept in itself and hard to measure.

But in each community, cultural *norms* exist which govern how members behave, think, make judgments and perceive the world. The shared norms are what define a culture or subculture, for instance, for members of a team who know how to work effectively together, and their norms include a solution to their organizational problems. Norms are represented, in all kinds of signs, whether in documents, oral communication or behavior.[521]

[515] Mintzberg (1971), p. B-101.
[516] Schuhmann (2004), p. 621.
[517] Kaasbøll (1987), p. 375.
[518] Snowdon & Kawalek (2003), p. 1022.
[519] Espejo et al. (1996), p. 28 f.
[520] E. g., Earley & Ang (2003); Weber & Camerer (2003).
[521] Stamper et al. (2000), p. 15.

This normative meaning of words corresponds to the observable behavior that people using those words produce in each other's presence; this meaning is a *dialect* particular to those people. Consequently, cultural differences can be directly observed in language differences.[522] Such dialects or *domain-specific languages* carry significant economic value for their users, because they make redundant the iterative specification of all the words that embody them, since dialects are common knowledge among their participants. Then coordination costs are a decreasing function of the number of past interactions of these participants.[523] Dialects are thus codes which allow people to communicate efficiently, reliably and covertly. This decreases the costs of internal coordination and communication, and increases the entry barrier into the group of participants.[524] Thus language is shaped by the permanent conflict between man's communicative needs and his tendency to reduce his mental and physical activity to a minimum.[525] From this follows that the benefits of communicative acts are compared with the costs of linguistic expression.[526] This logic of reasoning gives rise to significant economical consequences because the human capacity to process data, information, and knowledge is restricted.[527] Therefore language and human beings' ability to communicate by speech form essentially a bottleneck for information processing. Consequently, the needed time for overcoming this bottleneck becomes a *commodity* in the strict economical sense of this word: time itself is scarce, especially for communication. As a consequence of this scarcity, the efficient communication of data, information, and knowledge, whether transmitted personally or by IT, becomes imperative for organizations of all kind.

Therefore linguistic communication is of paramount importance for information systems research.[528] Furthermore, recent studies suggest that more attention should be given to the social act of adaptation of information systems by organizational members.[529] This implies a focus on social processes, including issues such as users' meaning constructions and sense-making.[530] The resulting understanding recognizes that it becomes increasingly important to study the meanings that organizational members ascribe to information systems, given the local context in which they are to use IT, and in which their meanings about the application systems are constructed. For instance, Kjaergaard & Jensen suggest to explore the relationship between users' sense-making and the appropriation of information systems by drawing on cognitive mapping, where cognitive maps may be used to represent users' meaning constructions of information systems.[531]

[522] E. g., Weber & Camerer (2003) employ specialized, task-specific languages in order to represent culture in a series of experiments. See Weber & Camerer (2003), p. 404.
[523] Moldoveanu (2002), p. 237.
[524] Moldoveanu (2002), p. 239.
[525] Martinet (1964), p. 167.
[526] E. g., Selten & Warglien (2007).
[527] E. g., Miller (1956); Miller, Galanter & Pribram (1960).
[528] E. g., Lyytinen (1985).
[529] E. g., Avgerou, Ciborra & Land (2004); Vaast & Walsham (2005).
[530] E. g., Weick (1995).
[531] E. g., Kjaergaard & Jensen (2008). This is also addressed by studies on the role of social influence from different workplace referent groups, such as superiors and colleagues, from the same or IT department, on the intention to adopt technology, e. g., Eckhardt, Laumer & Weitzel (2009).

Likewise, proponents of the open system model of organization as PONDY point out the role of language as a self-reflection of complexity, and criticize traditional organizational research using BOULDING's hierarchy of systems: human organizations are level 8 phenomena, but traditional theoretical models with minor exceptions are fixated at level 4, and the formal models and data collection efforts are rooted at levels 1 and 2.[532] PONDY proposes to direct research efforts not just to explaining order and congruence, but to how do organizations go wrong, and to picture man as having the capacities for self-awareness and the use of language, for instance, by asking if organizations reproduce themselves – are autopoietic –, and if so, how.[533] Moreover, he questions the traditional view of the organization as an open system that solely needs to be controlled and brought back to heel in case of disturbances. Along these lines, he criticizes the usual explanation from contingency theory – the organization needs to be complex in order to cope with environmental variety – for the fact that organizational complexity is positively correlated with environmental diversity. Implicit in this explanation is that surplus complexity is possible but not necessary. However, an alternative explanation flowing from a proper analysis of open systems is that an organization is unable to maintain internal complexity except in the presence of environmental diversity. Surplus complexity is simply not possible from this point of view, but a shortage of variety on the organization is.[534]

Moreover, PONDY regards language as a fundamental concept for organizational research, and he criticizes that only a small number of organization theories have made language, awareness, and meaning central concepts in their theories[535], but the dominant trend is still toward "mind-less conceptions of organization."[536] For instance, PONDY claims that THOMPSON ignores language as a variable of interest[537], whereas MARCH & SIMON make language a central feature of their analysis of communication in organizations, offering a thorough and largely ignored treatment of the effects of language on the efficiency and accuracy of communication.[538] MARCH & SIMON define language broadly to include engineering blueprints and accounting systems as well as natural languages such as English, where standardized languages permit the communication of large amounts of information with minimal exchanges of symbols (effectiveness):

> "*[...] it is extremely difficult to communicate about intangible objects and nonstandardized objects. Hence, the heaviest burdens are placed on the communication system by the less structured aspects of the organization's tasks, particularly by activity directed toward the explanation of problems that are not yet well defined.*"[539]

In this context, PONDY advises to recognize the point that objects become standardized by having terms in the language referring to them. Objects are not standardized in and of themselves.[540] Consequently, language is a technology for processing both information and

[532] Pondy (2005), p. 124.
[533] Pondy (2005), p. 125. See also Chapter 3.1.2.
[534] Pondy (2005), pp. 126 f.
[535] E. g., Weick (1979); Silverman (1971).
[536] Pondy (2005), p. 128.
[537] E. g., Thompson (2003)
[538] March & Simon (1958), pp. 161-169.
[539] March & Simon (1958), p. 164.
[540] Pondy (2005), p. 133; Bühler (1934), pp.54 ff.

meanings just as production technologies process inputs into outputs. Accordingly, languages vary in their capacity to process high variety information. For instance, the language of written communication, unaided by non-verbal cues, is less able to detect complex events than is the verbal plus non-verbal language of face-to-face communication.[541] Furthermore, in highly unstructured situations, PONDY argues that even face-to-face communication may be inadequate for conveying the full meaning, and he therefore expects physical inspection to be most common in poorly structured areas.[542] In addition, he claims that possession of a *common language* facilitates the exercise of social control, and that organizations can be thought of as collections of jargon groups, within each of which specialized sub-languages grow up that set it apart from other jargon groups in the organization.[543] Not only is language functional for the operation of the organization, but it is central to the evolution of organizational forms within the lifetimes of individual members:

> "*Mind need not wait for genetics to bring about change. If that premise is accepted, then the fundamental structures of language must be reflected in social organization.*"[544]

Consequently, the meaning of a word is its use in the language: one understands a word if one knows how to use it. This includes knowing in what situations and what contexts it can be used. One has to know a word's purpose in a language game. The meaning of any utterance must be linked to certain observable behavior and activities, to a certain context.[545] Therefore one of the most important factors for how a person uses information from information systems and the real world is language. All information is conveyed to the person in the form of signals or messages; to be meaningful they must be embodied in a code or language.[546] There is no doubt that one of the managerial tasks is to generate a climate that fosters communication, and language is significant for the managerial process.[547] Although scholars widely recognize that innovation generally occurs through combining different knowledge and experience and that diversity of opinion is a way of expanding knowledge, *meaningful communication* – an essential part of social exchange and combination processes – requires at least some sharing of context between the parties to such exchange.[548] NAHAPIET & GHOSHAL suggest that this sharing may come about in two main ways, where these two elements constitute facets of shared cognition by acting as both a medium and a product of social interaction:

1. through the existence of *shared language and vocabulary* and
2. through the sharing of collective narratives.[549]

[541] Pondy (2005), p. 132.
[542] Pondy (2005), p. 132. The fastest rate at which individuals can transmit bytes is limited to speech and movement, which makes the transmission of information around 10,000 times slower than the reception of information by sight, see Turnbull (2002), p. 265. Therefore direct inspection of a situation allows to grasp far more variety than a report or specification might yield.
[543] Pondy (2005), p. 133.
[544] Pondy (2005), pp. 133 f.
[545] Wittgenstein (1953), § 2.
[546] Land (1985), p. 212.
[547] von Foerster (1984), p. 22.
[548] Nahapiet & Ghoshal (1998), p. 253. See also Boisot (1995); Boland & Tenkasi (1995); Campbell (1969).
[549] Nahapiet & Ghoshal (1998), p. 253.

They claim that there are several ways in which a shared language influences the conditions for combination and exchange:

- First, language has a direct and important function in social relations, for it is the means by which people discuss and exchange information, ask questions, and conduct business in society. To the extent that people share a common language, this facilitates their ability to gain access to people and their information. To the extent that their language and codes are different, this keeps people apart and restricts their access.[550]
- Second, language influences the perception in that codes organize sensory data into perceptual categories and provide a frame of reference for observing and interpreting the environment. Thus, language filters out of awareness those events for which terms do not exist in the language and filters in those activities for which terms do exist. Shared language, therefore, may provide a common conceptual apparatus for evaluating the likely benefits of exchange and combination.[551]
- Third, a shared language enhances combination capability.[552] Knowledge advances through developing new concepts and narrative forms.[553] For instance, Boland & Tenkasi demonstrate how the existence of a shared vocabulary enables the combining of information. Discussing the development of language, they note that it is through action within communities of knowing that humans make and remake both their language and their knowledge.[554] Accordingly, such communities must have space for conversation, action, and interaction in order for the codes and language to develop that facilitate the creation of new intellectual capital.[555]

For all these reasons researchers increasingly recognize group-specific communication codes as a valuable asset within organizations.[556] Consequently, an evolving body of research examines language in organizations and suggests that conversations, both written and verbal, and the artifacts and practices associated with those conversations, create the organization's culture. In this context it has been suggested that people will not engage in a change until they understand it, suggesting that conversations for understanding must come before conversations for performance. Therefore research that considers how associated conversations support or hinder a change effort would make a valuable contribution to the understanding of change as a phenomenon in communication.[557] The foundation for such an analysis of language, discourse, and dialects in organizations is provided by philosophy of language.

[550] Nahapiet & Ghoshal (1998), p. 253.
[551] Nahapiet & Ghoshal (1998), pp. 253 f.
[552] Nahapiet & Ghoshal (1998), p. 254.
[553] E. g., Nonaka & Takeuchi (1995).
[554] Boland & Tenkasi (1995), p. 353.
[555] Nahapiet & Ghoshal (1998), p. 258.
[556] E. g., Arrow (1974); Prescott & Visscher (1980); Kogut & Zander (1992).
[557] Ford & Ford (1995), pp. 563 f. Ford & Ford therefore argue that research is clearly needed to identify and propose different *sequences* of conversations and then test their effectiveness.

3.7.2 Philosophy of Language & Language Critique

Philosophy of language or "linguistic philosophy" is the reasoned inquiry into the nature, origins and usage of language.[558] As argued before, the dominant linguistic paradigm for almost half a century views human language as having a universal underlying logical structure or "universal grammar".[559] But in the wake of the linguistic turn in philosophy, doubt has arisen as to whether human language can be captured in a clean formal calculus, since language itself is the prime example of a collective phenomenon arising out of local social interactions, a complex adaptive system in its own right.[560] For instance, WITTGENSTEIN argues that languages are learned by pointing at something and uttering the word in a sequence of so-called language games.[561] In a similar fashion, SAPIR examines the relationship between language, speech and thought and implicitly concludes that different languages lead to different thoughts.[562] This point is specified more clearly by QUINE who claims that knowledge and language are insuperable.[563] Summarizing this philosophical understanding most clearly, WHORF concludes that language may influence our knowledge and thinking in the so-called Sapir-Whorf hypothesis or linguistic relativity hypothesis.[564]

In linguistics, DE SAUSSURE's seminal work conceptualized a linguistic sign as a union of a concept – the signified (signifié) – and a sound image – the signifier (significant).[565] According to DE SAUSSURE, the combination of concept and sound image is arbitrary. Therefore, a language consisting of linguistic signs is based on conventions.[566] Following this, MORRIS proposed that a language consists of a set of interrelated signs, or symbols.[567] Both DE SAUSSURE's and MORRIS' approaches are based on conventions as a precondition for meaningful language-based communication, and both separate a concept from its representation. However, with reference to symbols, MORRIS addresses only what DE SAUSSURE termed the signifier.[568] This does not specify how these conventions are formed that align syntax, semantics, and pragmatics of symbols.

To answer this question and building on linguistics and philosophy of language, WINOGRAD & FLORES have developed a theoretical perspective for analyzing group action in information systems research based on ideas from linguistics.[569] This perspective relies on PEIRCE and emphasizes different kinds of *speech acts*, such as requests and commitments.[570] For instance, WINOGRAD & FLORES suggest to analyze several generic conversation type such as "conversation for action" in terms of the possible states and transitions involved

[558] E. g., Wolf (2006); Stanley (2008).
[559] E. g., Chomsky (2006); Das Gupta (1996); Hauser, Chomsky & Fitch (2002).
[560] Loreto & Steels (2007); see also Deacon (1997).
[561] Wittgenstein (1953), § 2.
[562] Sapir (1921), pp. 14 f.
[563] Quine (1960), p. 26.
[564] E. g., Whorf (1956). This hypothesis is usually denied by proponents of the universal grammar approach, e. g., see Pinker (1994), p. 60. Today, researchers agree to disagree on the influence of language on thinking, see Pinker & Jackendoff (2005).
[565] de Saussure (1974), p. 66.
[566] de Saussure (1974), p. 67.
[567] Morris (1971), p. 24.
[568] On the difference between syntax, semantics, and pragmatics see Chapter 3.2.1.
[569] E. g., Winograd & Flores (1986); Winograd (1988); Flores et al. (1988).
[570] E. g., Peirce (1931-1935).

when one actor performs a task at the request of another. An actor may respond to a request, for instance, by (1) promising to fulfill the request, (2) declining the request, (3) reporting that the request has already been completed, or (4) simply acknowledging that the request has been received. The analysis of this and other conversation types provided the basis for designing "the Coordinator", a computer-based cooperative-work tool which helps people make and keep track of requests and commitments to each other.[571] The resulting *language/action perspective* as a theory of communication deals with the process of creating a shared understanding. In this, it builds on HABERMAS' theory of communicative action and on SEARLE's and PEIRCE's speech act theory.[572] In accordance to the arguments in the previous section, the language/action perspective argues that the presence of a shared background or "common ground" is an essential part in creating a shared understanding of a situation.[573] From a language/action perspective, an information system is regarded not as an image of reality that stores true information about the world but rather as a vehicle for social action and communication within a business context.[574] However, the language/action perspective has been criticized for several reasons. Firstly, and more generally, the approach has been criticized for oppressing the user since using speech act theory in a normative way for the development of communication systems enforces discipline and control.[575] Secondly, and more importantly, much of today's work in the language/action perspective unreflectively uses the theory of communicative action and speech act theory as the philosophical foundation, which have both been sharply criticized; the former due to empirically not observable or corroborated assumptions about human behavior[576] and the latter for not being able to account for the multi-functionality of speech acts.[577]

In accordance with the language/action perspective, this study argues that traditional language-based research in information systems has focused too much on the syntactic and semantic aspects of language and too little on the pragmatics.[578] In other words, what is the process by which this common language emerges in the context of a given information system, company, or project, and how do members of an organization accomplish collective meaning-making to enable action and a shared vision?[579] But where the language/action perspective proposes to use the theory of communicative actions and speech act theory as a theoretical foundation, this study proposes to build on another and less criticized strand of philosophy of language in order to explain the importance of language and the generation of a shared understanding for information systems and organizational research: *language critique*.[580]

[571] E. g., Winograd (1988).
[572] Schoop (2001), p. 3. See Peirce (1931-1935); Habermas (1984); Searle (1996).
[573] E. g., Clark (1992); Clark (1996).
[574] Ågerfalk & Eriksson (2004), p. 81.
[575] E. g., Suchman (1994).
[576] E. g., Hohendahl & Silberman (1979); Thompson & Held (1982); Keuth (1989); Keuth (1993), pp. 324-339.
[577] E. g., Allwood (1998).
[578] Ågerfalk & Eriksson (2004), p. 90.
[579] Hansen & Rennecker (2006), p. 3.
[580] E. g., Kamlah & Lorenzen (1967); Kamlah & Lorenzen (1984); Kamlah & Lorenzen (1996); Lorenzen (1987); Lorenzen (2000).

Language critique as a branch of constructive philosophy of language known as the "Erlangen School" by Kamlah & Lorenzen provides useful insights and backup for the understanding of how meaning is given to signs, and has been successfully applied to information systems research before.[581] By separating *language* (as a schema which one knows how to speak) and *discourse* (as linguistic action and activities), Kamlah & Lorenzen separate concepts from their linguistic usage. Discourse means the repeatedly actualized usage of concepts in changing combination and variation. Thus, discourse is an actualized activity, whereas language comprises potential activities, or activity-schema.[582] Kamlah & Lorenzen argue that language as a system of signs promotes mutual understanding. The question of how the conventions that align syntax, semantics, and pragmatics of symbols in order to provide meaning are formed can be answered using the construct of a *language community*:

> *"Since discourse as actualized activity pursues the particular end of mutual understanding, we may say of language [...] that as a system of signs it promotes mutual understanding. For this very reason it is, in a unique way, a 'know-how' held in common, the possession of a 'language community'. [...] And yet a language consists of a supply of linguistic schemata which is the same for all members of the language community,* as if *the speakers had explicitly agreed upon a system of signs."*[583]

A new term is introduced by explicit agreement between language users with respect to its usage (*first agreement*) and meaning (*second agreement*) as illustrated in Figure 3.21.[584] This agreement leads to a relation of concept and term, and is shared by a language community as the knowledge of using this term. Thus, terms are syntactical representations used in discourse with fixed conventions (*first abstraction*), whereas in order to get concepts, one abstracts from the phonetic form of terms (*second abstraction*).[585] To put it simply, one can mean the same thing with different words.[586]

Accordingly, if members of a group of people communicate, and each has an aligned semantic and pragmatic dimension of a symbol (or term) in mind, then this group of people forms a language community.[587] The implications are that the semantic and pragmatic

[581] E. g., Wedekind (1981); Becker, Niehaves & Pfeiffer (2008); Holten, Dreiling & Becker (2005); Pfeiffer (2008); Rosenkranz & Holten (2007c); Holten (2007). The constructive philosophy of the Erlangen School is an epistemological or *methodological constructivism* which is concerned about questions regarding what is "scientifically knowable" with regard to truth and knowledge, see Lorenzen (1987), pp. ix f. Therefore it stands in the Kantian tradition in contrast to radical constructivism, see Wasser (2008), pp. 5 f. Likewise, Becker, Niehaves & Pfeiffer claim that the Erlangen School seeks to provide a philosophical basis for an interpretivist epistemological understanding by focusing on the social artifacts of speech and language, thereby mediating between the positivist paradigm and the hermeneutic philosophy, see Becker, Niehaves & Pfeiffer (2008), p. 95. This is compatible with the general epistemological position of this study as introduced in Chapter 2.

[582] Kamlah & Lorenzen (1984), pp. 32-52.

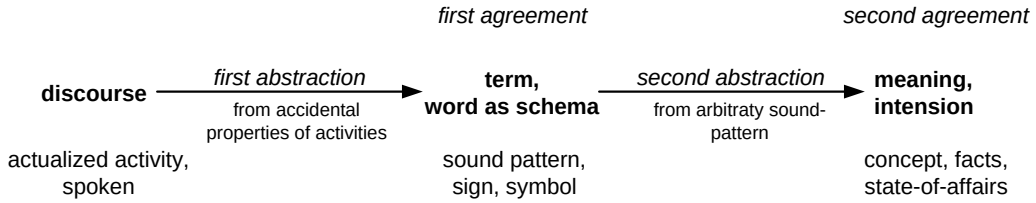
[583] Kamlah & Lorenzen (1984), p. 47.

[584] Kamlah & Lorenzen (1984), p. 57.

[585] Kamlah & Lorenzen (1984), pp. 70 ff.

[586] Lorenzen (1987), pp. 115-118.

[587] This is compatible with recent arguments from neurolinguistics. For instance, Deacon (2005), p. 9, argues that a complex symbolic act consists of at least one grammatical unit playing a symbolic role and another playing an indexical role. A symbol token must thus be paired with an index in



Source: Holten, Dreiling & Becker (2005), p. 184; Holten (2007), p. 2

Figure 3.21: Levels of Agreements and Abstractions in Language Critique

dimensions of symbols need to be introduced together. If a language community has been created, the members of this language community share the pragmatic dimension of a symbol. All members have the same concept in mind if they are confronted with a symbol of the language and vice versa. This agreement on *predicators*[588], or language (re)construction, is carried out in three steps:[589]

1. *Exemplary introduction (first agreement)*: linking a term to an extra-linguistic entity. For instance, defining the meaning of the word "bassoon" begins with a simple linguistic activity, by pointing to an appropriate object and saying "This is a bassoon." This is called a *deictic* activity (from the Greek *deixis* , "pointing") and is performed with the pointing or grasping hand and the word "this". What a "bassoon" is, what a "rose" is, what "rattling", "pointing", "funny" are, all this has been learned by the partner-in-discourse through examples and counter-examples, that is, these predicators have been "introduced by example."[590] If all parties in discourse use the same common natural or colloquial language, it is considered sufficient to describe these situations in natural language terms to achieve a mutual understanding and teach the meaning of words.

2. *Stating the predicate rules (second agreement)*: defining the relations between the technical term and other terms, as to how the order of the terms is to be understood. A predicate rule states which terms are synonymous or represent super-ordinated concepts, or specify further attributes of a term, for instance, "this bassoon is a woodwind instrument".[591]

3. *Stipulated definition (second agreement)*: defining the meaning of words explicitly. A definition gives an explanation of a certain term with the help of other already known terms. For instance, "A bassoon is a woodwind instrument in the double reed family that typically plays music written in the bass and tenor registers, and occasionally

order to have definite reference and meaning, that is, words need to be included within the special combinatorial expressions that are known as sentences, propositions, or predications in order to refer to something concretely. See also Deacon (2003), p. 123.

[588]Predicators in this sense are introduced by Carnap (1956), p. 6.

[589]See Kamlah & Lorenzen (1984), pp. 17-25, and Becker, Niehaves & Pfeiffer (2008), pp. 98 f., in the following.

[590]Kamlah & Lorenzen (1984), pp. 17 f.

[591]Kamlah & Lorenzen (1984), pp. 23-26 and 36-38.

> higher, it is a non-transposing instrument known for its distinctive tone color, wide range, variety of character, and agility."[592]

In summary, based on language critique, two main operations characterize the function languages have for communication in organizations. First, to create a language for domain specific communication, language constructs need to be introduced and explained. This leads to a language schema and is called *(re)construction*. To really align meanings of terms in language communities, living and acting together is required and creates a joint attention frame.[593] This is also compatible with the view of language as action – when one thinks of language use one thinks of activities in which language plays a necessary role.[594] Speakers use different words to draw the attention of the hearer to different aspects of the same object or event. Just from perceiving an object and hearing a word that supposedly describes that object, a word learner cannot know the intended meaning of the word due to referential indeterminacy; language speakers cannot have at hand all the concepts and perspectives that are embodied in the words of the language they are learning – they have to construct them over time through language use.[595] Thus *empractical learning* is part of this (re)construction process:

> "*What 'walking' or 'eating' is, 'sawing' or 'plowing' or 'roasting', 'controlling oneself', 'agreeing', 'praying', 'loving' and so on: we learn these things linguistically only along with the activities themselves, at the same time.*"[596]

Secondly, *terminological discourse* is possible for members of a language community only. A prerequisite for (re)construction is men's ability for speech, becoming manifest in natural and colloquial languages. The use of language in communication aims at a mutual understanding of both sender and receiver; an agent's mental schema is therefore fundamentally affected by the language community.

3.7.3 Conceptualization of Information Systems as Language Communities

Information systems can be argued to be social systems.[597] Social systems are characterized by language-based communication.[598] Therefore contemporary work in the field of information systems research by Holten has drawn on both the idea of autopoiesis and the ideas of language critique, and has proposed to conceptualize information systems as social systems which are autopoietic and operate by communication. He argues that it is reasonable to transfer insights from language critique into the information systems domain itself to better understand how communication based on language does work.[599]

[592] Kamlah & Lorenzen (1984), pp. 26-32.
[593] E. g., Tomasello (1995).
[594] Clark (1992), p. xi.
[595] Wellens, Loetzsch & Steels (2008), pp. 1-2.
[596] Kamlah & Lorenzen (1984), p. 36.
[597] E. g., Land (1985); Lee (2004). See also Chapter 3.2.3.
[598] See the hierarchy of systems in Table 3.1 of Chapter 3.1.1.
[599] This study presents only the general arguments of this formalization. An elaborate and formal description of this approach can be found in Holten (2003b), pp. 33-80. See also Holten (2007) and Holten & Rosenkranz (2008).

Languages as the common knowledge of a language community are called *terminologies* ($T \in \Phi, \Phi$ the set of all terminologies) in the following and are separated from pre-terminological (standard as well as colloquial) languages ($X \in \Psi, \Psi$ the set of all pre-terminological languages), which are the prerequisite for (re)construction and serve as basic infrastructure in this conceptualization to anchor the creation of language communities in real world settings. Any terminological or pre-terminological statement on the discourse level can become a *perturbation* for the language community. For instance, if a new standard application system is implemented in an organization, this will also introduce perturbations due to new terms and previously not encountered language. Perturbations cause (re)actions of the language community as a system. An action or reaction (symbolized as α) may comprise a series of terminology modifications on the schema level (symbolized as κ), that is, new or modified agreements on the meaning of terms, as well as terminological statements on the discourse level (symbolized as φ):[600]

- Firstly, *terminological discourse* φ is characterized by the following three possible reactions of the language community. The system really understands what is going on but (1) decides to react *not at all* (neutral reaction), or (2) may say something else (terminological statement) – for whatever reason. For instance, in the case of a new standard application system, actors could choose to not use the new application system. (3) The system is not in a position for a correct terminological statement, because the perturbation is – at least partially – perceived based on pre-terminological languages only. A suitable terminological discourse about the situation is not possible. For instance, specific terms associated with the new application system are interpreted differently by different actors, or the same function of the new application systems is described by different actors using not the same words.

- Secondly, *(re)construction* κ is characterized by the following three possible reactions of the language community. (1) The system decides to behave neutrally, that is, not to alter the terminology. (2) The system alters the given terminology, because a new term allowing for synonyms is introduced (e. g., possible terminological statements using terminology T are felt to be circuitous or not suitable for other reasons), or because (3) at least one term is missing to describe the given situation correctly on the discourse level. This last reaction defines the system's ability to terminologically *adapt to new or formerly unknown situations*. For instance, in the case of the new application system, specific terms are used to describe specific functions. To summarize, terminologies are altered by (re)construction κ leading from terminology T to terminology T' (cases 2 and 3). This is called *transition of configuration* and an arbitrary sequence of configuration transitions leads from a terminology T_1 to a terminology T_n in n-1 steps of transition configurations.

- Finally, the total *reaction* α of the system on a given perturbation is characterized as follows: two terminologies T_1 and T_n are related by an arbitrary sequence of configuration transitions, and a terminological statement using the final terminology T_n on the discourse level is the system's final reaction on the given perturbation. It

[600] See Holten (2003b), pp. 33-80, and Holten (2007) in the following.

> is important to note that reaction α certainly produces a final terminology but that no observer will ever be in a position to command the use of this final terminology to the system.

According to this approach, an *information system is a language community*, made up of a terminology (T) on the schema level, the discourse level with terminological speech (φ), statements comprising natural and colloquial as well as terminological speech on the discourse level, and is characterized by reaction (α), reacting on perturbations by terminological discourse or (re)construction (κ) concerning its terminology.[601] According to Holten, this conceptualization of information systems as language communities directly leads to the following consequences for every information system:

1. a terminology (T) should exist, directly related to an identifiable set of people belonging to the language community possessing this terminology,
2. terminological discourse (φ) should be observable, and
3. traces of developing or revising terminologies (κ) should be identifiable.[602]

Along similar lines, Holmqvist argues that groups of people in the same organization carry out different functions, and that these groups develop different sub-languages on the basis of their professional backgrounds and the nature and organization of their functions; the development of an information system – the application system and the interpretation and use of it – will be influenced by these languages.[603] When the computer system is introduced, a confrontation of a number of different professional languages and work languages take place:

> "*We tend to look upon our common national everyday language as the default value for our linguistic interaction: a means of communication which is always at hand and which we do not reflect upon until we find ourselves in a situation where communication breaks down and causes a phsycological or physical inconvenience [...] I believe that the different sub-languages of an organization – here expressed as differences in perspective – always are in constant contact with each other, influenced by each other, and thereby they create new language forms and new meanings.*"[604]

Strikingly similar to the operations of terminological discourse and (re)construction, Holmqvist & Andersen introduce the concepts of *work language* – a language used in a work situation (discourse level) – and *professional language* – a wider concept that includes all languages that are motivated by the work situation, for instance, also language used to talk about the working process on a planning or educational level (schema level). That is, in an organization, it is possible to distinguish between two fundamental roles in relation to the work: one role that performs the work, and another that describes and organizes the

[601] Holten (2003b), p. 65; Holten (2007), p. 6.
[602] Holten (2007), p. 6.
[603] Holmqvist (1989), p. 73.
[604] Holmqvist (1989), p. 74.

work. Linguistically, this means that one either talks *in* the work or *about* the work.[605] In the design of an application system, the different groups are forced to accept each other's linguistic conditions, but the result of the compromise is not necessarily what was expected by the designers.[606]

Conceptualizing an information system as language community gives rise to the understanding that an information system can use the operations of terminological discourse and (re)construction to ensure meaningful speech and thereby to ensure meaningful actions in new and previously unknown situations. This means that information systems are *open systems* on the schema level and *closed systems* on the discourse level since the operation type (reaction α) produces itself the parts that constitute the system.[607] Therefore Holten claims that information systems as language communities are *autopoietic systems* and supports his argument by using a key introduced by Varela, Maturana & Uribe for determining whether or not a given system is autopoietic.[608] One of the major consequences of the autopoietic property of information systems relates to the possibilities and boundaries of information systems design: every external attempt to actively design the system is understood by the system as a perturbation from the environment. The system reacts on perturbations according to reaction α. Therefore *changes in terminologies* cannot be decreed or dictated to the information system.[609] The total reaction α of the information system as a language community on a given perturbation is characterized as follows: two terminologies T_1 and T_n are related by an arbitrary sequence of configuration transitions, and a terminological statement using the final terminology T_n on the discourse level is the system's final reaction on the given perturbation. It is important to note that reaction α certainly produces a final terminology but that no observer will ever be in a position to command the use of this final terminology to the system. Consequently, a language community can only be a self-organizing system in the sense described in Chapter 3.5, and control of a self-organizing system strictly is disseminated throughout this system itself. There is no possibility to directly change or even judge activity schemas in people's minds. Consequently, Holten argues, only "good and plausible" suggestions can induce or encourage the information system to generate the desired terminology on its own as a spontaneous order.[610]

Holten proposes that further research

1. could investigate if a characterizing terminology for every information system really exists,

2. could develop criteria for "good information systems" and measures for this goodness, and

[605] Holmqvist (1989), p. 77; Holmqvist & Andersen (1987).
[606] Holmqvist (1989), p. 88.
[607] Holten (2003b), p. 69.
[608] Holten (2003b), pp. 69-71. For a description of the key see Varela, Maturana & Uribe (1974), pp. 192-193.
[609] Holten (2003b), pp. 69-71. See Chapter 3.6.3.
[610] Holten (2003b), p. 73. See Chapter 3.4.4.

3. could examine conditions which positively influence the development of language communities, for instance, to better understand information systems development processes.[611]

To leverage this conceptualization and to address the areas of study proposed by HOLTEN, this study combines three individual strands of theory – cybernetics' concept of self-organization, social systems theory's autopoiesis, and information systems as language communities – as they all share the importance of language-based communication, and could be useful to understand and explain individual agents' behavior in information systems as complex adaptive systems. The conceptualization of information systems as language communities might be the key to answer how organizational change is conducted, not by command, but by individual behavior of human agents. This might yield insights on how to measure the goodness with regard to communication and coordination since communication in social systems is fundamentally based on language. To address these questions, this study explores the collective meaning-making processes of organizations in organizational design situations.

[611] Holten (2007), p. 8.

4 Exploratory Field Studies

Organizations and information systems are becoming more and more complex. This complexity seems to be grounded, for a large part, in the behavior and interactions of an organization's individual human agents. Therefore organization theory and information systems research need more profound knowledge of the interactions and self-organizing behavior of individual human beings. This part of the thesis aims to tackle the question which parts of individual communicative behavior contribute to understanding these processes and the goodness of organizations and information systems with regard to communication and coordination. The purpose of this chapter is to explore the usefulness and consequences of the conceptualization of information systems as language communities, as introduced in Chapter 3, for understanding and explaining the behavior of individuals in real organizational situations. Similar to work by Larsen et al., this research takes a hybrid approach in that it emphasizes preexisting concepts and constructs such as variety and the law of requisite variety but seeks to consider a broad range of relationships between individual organizational actors and their organizational contexts.[612] Therefore this thesis uses observations taken from two exploratory field studies (1) to explore possible applications and necessary refinements of the concept of variety for measuring the complexity of information systems and organizations, (2) to examine variety's relation to self-organization and the conceptualization of organizations and information systems as language communities, and (3) to challenge the propositions of the law of requisite variety and explore its usefulness for organizational analysis and design. Furthermore the VSM is applied in the field studies to make organizational structures visible and comparable.

With reference to the research framework introduced in Chapter 2, this chapter relates to the first and second role of the researcher. However, the framework is also applied at the level of each individual field study. The first field study in Chapter 4.1 describes an action case which deals with organizational diagnosis and design of the IT controlling function in the German subsidiary of a large European banking group. Chapter 4.2 describes the second field study, an action research study at the German site in the healthcare division of a European third party logistics provider. In both field studies, the measurement of variety, the consequences of the law of requisite variety and possible antecedents of organizational change are explored. The findings are summarized in Chapter 4.3 and indicate that organizational adaptation is largely grounded in language-based communication between individual human beings.

[612] Larsen et al. (2009), p. 88.

4.1 Organizational Design at FSB Germany

4.1.1 Case Overview & Business Processes

The *FSB Group* (fictitious name due to reasons of anonymity) is among the leading asset managers and financial service providers throughout Europe as measured by managed capital. FSB runs subsidiaries in over 20 countries, engaging approximately 20,000 employees in over 600 branches. In the field of Internet banking FSB is among the market leaders in Europe as measured by number of customers. Throughout Europe FSB serves more than five million customers, one million of these in Germany. *FSB Germany* is the German subsidiary of FSB Group and operates within the business areas retail banking, merchant banking, commercial real estate and asset management.

In November 2004, managers of FSB Germany approached the information systems research group at Goethe University, voicing difficulties in their IT controlling processes.[613] Reporting was especially mentioned as an area of concern, creating frustration amongst the employees of the business units. The managers stated that the current IT controlling and reporting system seemed to be defect and too complex. After a joint workshop where the relevant practical questions for FSB Germany and the appropriate research methodologies were discussed, it was agreed that the IT controlling and reporting system and the accompanying information flows and business processes at FSB Germany should be analyzed by a research team of Goethe University and be led by the author. This resulted in the setup of a joint organizational diagnosis and design project. Addressing both relevance and rigor, the following questions were of special interest for this project and related to this thesis:

- What are the causes for the (perceived) complexity of the IT controlling and reporting system?
- How can the IT controlling and reporting system be redesigned with respect to theses causes?
- Can the complexity of an information system or organization be qualitatively or quantitatively measured?
- What consequences arise from viewing organizations and information systems as language communities?
- Can the concept of variety and the law of requisite variety be practically used for organizational analysis and design?

The project was conducted between November 2004 and March 2006. It comprised three phases as illustrated in Figure 4.1: (1) analysis of IT controlling and reporting, (2) redesign of IT controlling and reporting (preliminary study), and (3) follow-up interviews. The second phase included the design of a new IT artifact and was initially not planned, but resulted from preliminary findings of the first phase.

[613] Parts of this chapter have been previously published as Rosenkranz & Holten (2007a) and Rosenkranz & Holten (2007b).

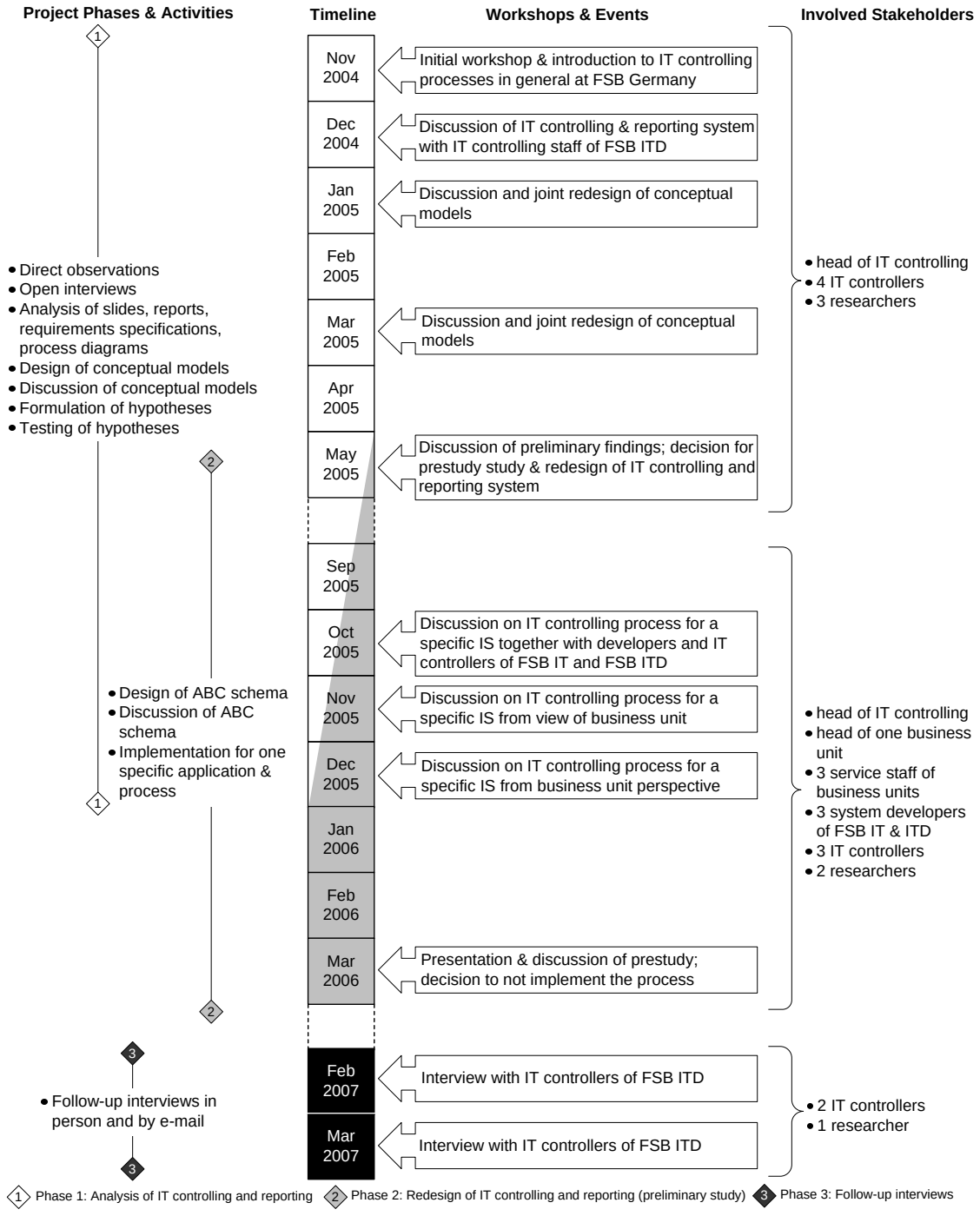


Figure 4.1: Timeline of Action Case Study & Data Collection Summary

4.1.2 Research Methodology

Action Case as Research Method

As stated before, the over-riding concern of this thesis is that the research should be both relevant to practical problems and rigorous in its operationalization. The managers of FSB Germany expected an outcome of the study to be an audit or evaluation of current work practices and recommendations for possible changes. The author intended to use the case to develop a first understanding of the use of variety measurement in real organizations, to explore variety's relation to information systems conceptualized as language communities, and to test if the law of requisite variety can be applied for organizational diagnosis and design.

Therefore this research draws on a framework proposed by Braa & Vidgen in order to describe the multi-disciplinary space of the so-called organizational laboratory.[614] Braa & Vidgen argue that all research conducted in an organizational setting will ultimately have an interventionary element, whether deliberate or unwitting. From this point of view, it is rather unlikely that a researcher is able to study a phenomenon in its environment in-depth by only measuring it without any impact on the phenomenon itself. Although the researcher in interpretive case studies can either take the idealistic role of an "outside observer" or that of an "involved researcher", even if a researcher views him– or herself as an outside observer, he or she is in some sense acting by influencing what is happening in the domain of action, if only by the sharing of concepts and interpretations with the other actors in the case study site.[615] Consequently, Braa & Vidgen suggest *action cases* as a research method which recognizes that case studies often have a significant interventionary content.[616] In line with the research position introduced in Chapter 2, this study adopts a weak constructive stance in this exploratory research. The conducted project in this research can be described as an action case, and combines aspects of traditional case study research[617], action research[618], interpretive field studies[619] and design science.[620] In effect, the selected approach mirrors the general research framework of this thesis introduced in Figure 2.1 of Chapter 2 as applied to an individual case level. First, based on exploratory, interpretive empirical work during the conducted project, this action case created an interpretive understanding of an existing organization. Second, a positivist understanding was created based on the cybernetic concepts introduced in Chapter 3 and the conceptualization of information systems as language communities in order to explain the empirical reality.[621] Afterwards, hypotheses were formed and subsequently tested.

[614] Braa & Vidgen (1999), p. 26.
[615] Walsham (1995a), pp. 74 ff.
[616] Braa & Vidgen (1999), p. 28; see also Hughes & Wood-Harper (1999).
[617] E. g., Cavaye (1996); Eisenhardt (1989); Lee (1989a); Yin (2003).
[618] E. g., Avison et al. (1999); Baskerville & Pries-Heje (1999); Susman & Evered (1978).
[619] E. g., Baskerville (1999); Klein & Myers (1999).
[620] E. g., Hevner et al. (2004); March & Smith (1995). See also Chapter 2.3.
[621] Lee (1991), p. 351. This explanation can be seen as a scientific theory consisting of formal propositions. As has been stated in Chapter 2, a theory needs not to be stated in terms of independent and dependent variables, it may be stated in the form of propositions not mentioning any variables, see Lee (2004), p. 9.

Data Collection & Actions

For gathering data in the first project phase, a series of open, unstructured interviews were conducted in workshops with different stakeholders from the domain of IT controlling at FSB Germany. The workshops focused on the IT controlling process, the roles of different employees within this process, and the IT controlling and reporting system. They were of variable length, ranging from 30 minutes to 180 minutes. Direct questions were asked by the researchers in order to analyze the IT controlling and reporting system, and the participants made direct statements as answers. The interviewers consisted of one or two researchers. The interviews were held in German, allowing informants to speak in their mother tongue, and increasing their comfort level, so that they would share their views and ideas. The interviewees were encouraged to provide a narrative of their experiences as freely as possible, without restraint from an interview guideline or a recorder. During the interviews, the researchers wrote down notes (see Appendix A for an example). These were complemented by direct observations of the author who studied the IT controllers during their work, being able to inquire directly when questions arose, and took handwritten notes. He had full access to all operational processes, application systems and documentation. Documents, work descriptions and field notes of the researchers were collected in a project diary. Afterwards, the researchers formulated an interpretation of the patterns that occurred during the case. The first analysis occurred in parallel to the data collection. Field notes were subsequently discussed by the researchers regarding different impressions and interpretations of patterns in the data. Given the general interest in applying existing concepts from cybernetics to a real organizational context, no coding was used at all since the aim of the study was neither the explicit generation or development of new categories or theory nor the testing of existing categories and theories, but rather the observation and exploration of real situations through the lens of this theoretical framework.[622]

For an interpretation and analysis of the overall organizational setting at the case setting, the VSM was applied by the researchers as a language for specifying the organizational structure and information channels, reflecting on the obtained information, and deriving first possible causes for the reported problem. The development of the VSM was the responsibility of one of the researchers who reflected on the obtained and interpreted information. The other researchers provided feedback and critique on the model.

In addition, conceptual models were used as instruments for analyzing and investigating the IT controlling reports and the IT controlling and reporting system. In information systems research, *conceptual modeling* is the process of building a representation of selected phenomena in a problem domain for the purpose of understanding and communication among stakeholders.[623] For this, *MetaMIS* was chosen as a modeling language tailored to the domain of reporting and management views.[624] Initially, the conceptual models were constructed based on the researchers' understanding of the reports and the IT controlling and

[622] In the end, this research does not yield a set of elemental cause-effect pairs that could serve as the basis of causal analysis mapping for this thesis. Rather, the findings are combined with the literature review and the resulting theoretical framework and serve to inform the generation of a theory in Chapter 5.

[623] E. g., Wand & Weber (2002).

[624] MetaMIS has been originally developed for the specification of management views on business processes. By using a semantic model based on Riebel (1979)'s enterprise theory, MetaMIS is an ontology-driven method which aims at bridging the communication gap between IT departments and business units.

reporting system, which was refined by insights gained from the workshops and observation of controller activities. Subsequently, all project participants at FSB Germany were made familiar with MetaMIS, which resulted in a common language in order to discuss the conceptual models during workshops. However, the language was not forced on the subjects. Instead, all project participants jointly agreed that MetaMIS is especially suitable to the phenomenon under examination and meets the requirements of researchers (clarification, formalization and interpretation of the subjective understanding of the problem domain) and practitioners (specification, documentation and analysis of the existing IT controlling and reporting system). Consecutively, the models were refined together with all project participants. This resulted in a presentation of statements about the IT controlling and reporting system in such way that all project participants could understand it and relate it to their objectives.

The conceptual models also ensured that the researchers became part of FSB Germany's IT controlling community of practice[625], and that they actually understood what was really happening in IT controlling at FSB Germany because these descriptions were created and discussed by the language community consisting of all project participants. In accordance with the research position of this thesis, this makes the models available as a kind of document which is open for interpretive analysis.[626] In order to generate an interpretive understanding of a situation, a researcher must repeatedly move from her or his own interpretive understanding to the subjective understanding and then back again to her or his own interpretive understanding, using the hermeneutic cycle.[627] The resulting understanding is the researcher's reading or interpretation of the first-level, common sense understanding.[628] The construction of the conceptual models helped the researchers to form an interpretive understanding of the situation. Issues and misunderstanding could be minimized by pointing to the conceptual models for clarification. The specialized technical language or terminology of the domain in focus is usually expressed in natural language, thus ambiguities and misunderstandings are more the rule than the exception.[629] The formal description of the interpretive understanding in the symbolic language of a conceptual modeling notation formalizes and clarifies the interpretive understanding of statements made in the specialized language or terminology of the domain in focus. This helps to address critical questions regarding the interpretation. To test the validity of the resulting interpretive understanding, the researchers referenced back to the subjective understanding, for instance, by discussing the conceptual models with other participants to verify the sensibility of "apparent absurdities".[630] Misunderstandings or misinterpretations of the subjective understanding could be more easily recognized by jointly constructing and

See Holten (2003a); Holten (2003b); Holten, Dreiling & Becker (2005) and Dreiling (2005) for a detailed description of the approach and its development history.

[625] Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly, see Lave & Wenger (1991); Wenger (1998); Wenger, McDermott & Snyder (2002).

[626] An elaboration of this argument can be found in Rosenkranz & Holten (2007c).

[627] E. g., Butler (1998); Klein & Myers (1999).

[628] Lee (1991), pp. 351-353.

[629] E. g., Blair (2005); Fromkin & Rodman (1988); Radman (1997).

[630] Lee (1991), p. 352.

discussing the conceptual models. Therefore conceptual models can serve as an instrument for the researcher to engage into a dialogue with practitioners.[631]

Proposal for Measurement of Variety

One purpose of the action case was to explore the usefulness of variety as a measure for complexity in organizations and information systems. Therefore a novel proposal was made for measuring variety in the case setting. Theoretically, measuring variety is straightforward: in principle, one just has to count the number of states or elements. But as has been stated before, what if different observers of the system distinguish the states or elements differently, or observe it at different scales? However, accommodating for subjectivity is an established part of science. As Nissen & Bushey argue, the investigation of alternatives to model and quantify the factor of requisite variety is a valid area of inquiry.[632] In order to create an inter-subjective understanding, the observer of a system has to make explicit which elements she or he distinguishes. For instance, Pentland shows two possible operationalizations of variety for business processes – content variety and sequential variety –, which he points out nevertheless strongly depend on the purpose described to the business process and the point of view of the observer.[633] For a concrete case, the abstract concept of variety must be transformed into an applicable measure to be useful.[634] Generally, either *activity-based measures*[635] (actual effects of variety on activities, e. g., frequency measures or content analysis of records) or *perception-based measures*[636] (perception of effects of variety, e. g., surveys) can be used.

Regarding activity-based measures, the *amount of time used for an activity* by an actor can be considered as a first indicator for variety. Since coordination corresponds to communication that is responsible for the mutual information between two or more workers, the information communicated by a part of a system does not exceed that part's variety. Each of these (information, variety) is measured per unit time, where a certain amount of time is required to switch to the next state. If it is assumed that a manager has a limited variety, then this bound on the communication capacity (bandwidth) limits the coordination of workers under the supervision of the manager.[637] Activity time is also used as a measure in process management and total quality management.[638] However, this does not address the critique that variety is purely syntactical since "amount of time for an activity" is only an indicator and does not yield any reference to meaning of a message for sender or receiver.

For perception-based measures, it would be very convenient if organizational actors could simply be asked "how much variety is there in your organization and/or your information system?" Unfortunately, there are good reasons to expect that actors will have difficulty perceiving or describing constructs such as variety. Firstly, systems-theoretical concepts

[631] E. g., Mårtensson & Lee (2004).
[632] Nissen & Bushey (1999), p. 17.
[633] E. g., Pentland (2003).
[634] Backlund (2002), p. 40; Rivett (1977), p. 37.
[635] E. g., Beer (1979), pp. 518-530; Fransoo & Wiers (2006); Ribbers & Schoo (2002).
[636] E. g., de Raadt (1987); Osborn, Hunt & Bussom (1977).
[637] Bar-Yam (2004), p. 41.
[638] E. g., Anupindi et al. (2006); Laguna & Marklund (2005).

like variety are not easy to "translate" univocally into questions to be answered by actors of an organization.[639] Secondly, each actor will have her or his own point of view of the organization, or information system, and its elements. In such cases, methods that rely on subjective responses from individuals are inherently flawed.[640] In summary, survey methods seem unlikely to be a valid or reliable way to detect constructs as variety in organizations and information systems. Therefore PENTLAND concludes that without some kind of process-tracing method to make the process visible, participants are unlikely to be aware of just how varied (or routine) their work actually is.[641]

This shifts the attention to instruments that help participants to become aware of and to make the variety of a system visible. A system may have high variety if participants need to be aware of a large number of concepts in order to use the system. A concept is any logical item of knowledge defined or used by the system. Then the size of the body of knowledge required to manage the system or use the system to perform tasks is a measure of variety. For instance, RANGANATHAN & CAMPBELL suggest to employ task graphs which represent the structure of the set of actions that actors need to perform to achieve a goal.[642] Likewise, FIORETTI & VISSER argue that complexity should be understood in terms of the human cognition of a structure or behavior.[643] Then complexity can, for instance, be measured by looking at the structure of causal links, or blocks of intertwined causal links, in a cognitive map, which can be reconstructed by means of a linguistic analysis.[644] For instance, having memorized a play by Shakespeare, it is only necessary to invoke the name to retrieve the whole play.[645] For BAR-YAM, this is the essence of naming – *a name is a short reference to a complex system*, and all words are names of more complex entities. Language provides a systematic mechanism for the compression of information; the words that are used to describe it.[646] This also suggests that variety and language should be directly linked in the case of social systems.

This point can be further elaborated. As previously argued, conceptual models offer an elegant way of representing domain knowledge in a (semi-)formal presentation. Moreover, conceptual models play a significant role in making language communities as introduced in Chapter 3.7.2 explicit: conceptual models are designed through linguistic actions of a language community, and therefore are a (written) expression of a shared language understanding, so-called *marks*.[647] Marks are written-down or printed writing-signs, which are actualized as activities by the one who produces the marks in writing them, and again actualized by the one who reads them.[648] Models as marks create persistent things. Like road signs, they are solidified activities which stay put, are produced and can be read. Accordingly, conceptual models as marks have persistence just as words do. Then variety as

[639] See the discussion in Zouwen (1996) who comments in detail on the difficulty to empirically test cybernetic concepts in social theories.
[640] Pentland (2003), p. 532.
[641] Pentland (2003), p. 532.
[642] Ranganathan & Campbell (2007), pp. 38 f.
[643] Fioretti & Visser (2004), p. 11.
[644] Fioretti & Visser (2004), p. 15.
[645] Bar-Yam (1997), p. 763.
[646] Bar-Yam (1997), p. 764.
[647] Kamlah & Lorenzen (1984), p. 46.
[648] Kamlah & Lorenzen (1984), pp. 46-51. See Gemino & Wand (2004) for a similar argument.

a measure of the number of possible states of a system can be expressed with the terms of a language community. Conceptual models should enable researchers to determine the variety of the organization or information system under consideration: based on the conceptual models of a system, the variety of this system can potentially be measured and calculated by counting the number of different concepts and categories used in the conceptual models. This leads to the proposal that the variety of a system can be expressed by the *number of technical language terms* used to describe the system within conceptual models. Thus, one can measure the variety of a task by counting the number of concepts and different elements in a conceptual model, which are relevant to the task.[649] If actors are forced to think about a system by jointly designing and using conceptual models, creating an inter-subjective domain-understanding, they are forced to think sequentially and about possible exceptions and variety of elements. As a result, Ulrich's argument – that variety operates only at the syntactic level, which is solely concerned with whether a message is well formed or not, and consequently ignores the meaning and significance of messages for the receiver[650] – falls short in this case: although variety is an inherently subjective concept, variety should become inter-subjective for the members of a language community as soon as the language community is created. Each member has an aligned semantic and pragmatic dimension of a syntactic symbol of a term in mind. Variety as a measure of complexity for the language terms used by a language community indeed should consider pragmatics and semantics respectively, as language restricts the possibilities to communicate the possible states of a system.[651]

Conceptual models of the organization or information system under consideration, which are jointly designed by all stakeholders, can therefore be leveraged to determine the variety of the examined system. The variety of the system can be calculated by counting the technical language terms used in the conceptual models. Consequently, in the action case setting, it was proposed to count the technical language terms which are used in the jointly designed MetaMIS models of the reports and the IT controlling and reporting system. The resulting number is used as a measure for the variety of the IT controlling and reporting system, as perceived by all stakeholders which were involved in constructing the MetaMIS models.

4.1.3 Action Case Description

General Overview of IT Controlling at FSB

At FSB Group, all operative tasks concerning IT are delegated to *FSB IT*, a wholly owned subsidiary. For instance, this includes the development and maintenance of networks, mainframes, host systems, databases, servers, and user support and help desk. In Germany, these functions are operated by the German branch of FSB IT. Additionally, the Chief Information Officer (CIO) of FSB Germany manages all central tasks concerning application systems and IT with respect to the business areas, roles and responsibilities of the German business units. From the business perspective, the specification and design of application

[649] Ranganathan & Campbell (2007), pp. 39 f.
[650] Ulrich (1981), pp. 33-59; see Chapter 3.3.2.
[651] See Daft & Wiginton (1979), p. 181, for a similar argument.

systems are the responsibility of the so-called *system owner* which is usually a business unit. This business unit is responsible for the application system budget-wise, concerning requirements, change requests et cetera during the whole system life cycle.

FSB ITD (FSB IT Development) is a staff department that conducts planning, development, control, and support of application systems exclusively for the German business units. Figure 4.2 gives an overview of its functions. On the one hand, FSB ITD develops and supports application systems (development functions). On the other hand, FSB ITD plans and controls both self-developed application systems as well as application systems developed and maintained by FSB IT in order to make the use of IT services transparent to the German business units and divisional management on behalf of the CIO (controlling functions). The *structure of rationality*, often referenced in controlling literatue[652], includes all tools and information which directly or indirectly ensure rational action and behavior of management.[653] Consequently, controlling aims at ensuring decision-making for management by designing and using this structure of rationality. *Structure design* in the context of IT controlling includes the creation of controlling tools, standards, and procedures as well as the development and implementation of a controlling infrastructure, for instance, the *IT controlling and reporting system* for the needed information supply of the business units concerning their IT usage. *Structure utilization* includes the use of this infrastructure in order to actually execute planning and controlling. This is done by raising, preparing and supplying relevant information for divisional management through this infrastructure. FSB ITD carries out both structure design and structure utilization for IT controlling at FSB Germany.

The original IT controlling and reporting system under examination was based on a data warehouse solution using an Oracle database.[654] Data were consolidated from sources of both FSB IT and FSB ITD, and were directly extracted from the system for individual reports, for instance, for use with Microsoft Excel.

Figure 4.3 gives an overview of the organizational situation at FSB Germany with regard to IT controlling using the VSM. The sub-systems of the first recursion level are labeled in capitalization (e. g., System 1 as "ONE"). System 1 of FSB Germany as the System-in-focus is formed by the different business units (e. g., retail banking). Sine both provide IT services to the German business units, FSB IT and FSB ITD both act as Systems 2 for divisional management. Furthermore the controlling functions of FSB ITD fulfill an additional coordinatory and anti-oscillatory System 2 function. Systems 3 to 5 of the System-in-focus are formed by various senior managers (e. g., CEO, CIO and managers of FSB IT and FSB ITD) and committees (e. g., German board of directors). One recursion level up, FSB Germany is a part of System 1 of FSB Group. The IT controlling and reporting system which was examined in this action case acted as an information channel which linked Systems 3 (CIO and managers of FSB IT and FSB ITD) and Systems 2 (FSB

[652] E. g., Schäffer, Weber & Prenzler (2001); Schultz (2005), pp. 80-85.

[653] Or with regard to critical stances on the concept of rationality, for instance, Hatch (1997) or Alvesson & Deetz (2000), *justified* action and behavior. Well-informed actions (i. e., those based on true beliefs) are more likely to achieve desired ends. Information is valuable insofar as it helps individuals form true beliefs which, in turn, promote effective, goal achieving action, see March & Smith (1995), p. 251.

[654] A data warehouse is a subject-oriented, integrated, nonvolatile, and time-variant collection of data in support of management's decisions. See Inmon, Strauss & Neushloss (2008), p. 7.

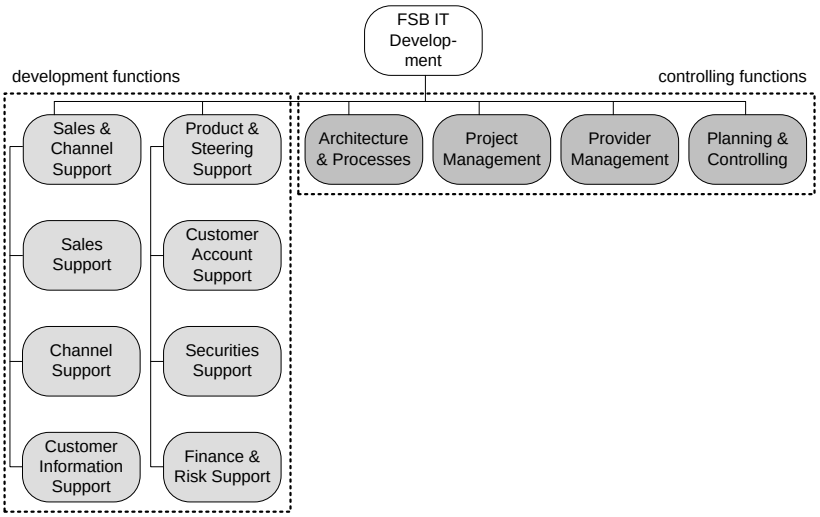


Figure 4.2: FSB ITD Functions and Responsibilities

ITD managers and controllers) and Systems 2 and the Operational Divisions (the divisional managers of the German business units) respectively. The IT controlling and reporting system was the focus of interest for the diagnosis, as highlighted in Figure 4.3.

Phase 1: Analysis of IT Controlling at FSB Germany

According to the analysis, FSB ITD in its controlling function as System 2 created very detailed reports of IT usage for the IT services provided by both FSB ITD and FSB IT. An in-depth diagnosis of the reports using MetaMIS models revealed that the reporting was purely cost-based; qualitative aspects pertaining service level agreements (SLA) or projects were not looked upon. The costs for the IT services supplied by FSB IT were based on internal transfer prices for items collected in a special *item catalogue*. These items were also used for the chargeback of IT costs. The item prices and IT costs respectively were negotiated between the divisional management of the German business units and FSB IT's management. This chargeback structure and the item catalogue were originally applied for the resource bargaining during periodical budgeting negotiations between FSB IT and the business units.

> "*These negotiations usually take about four months, from August to November, as the guys bicker about single items and their costs.*"[655]

The charged items were formulated in language terms that were extremely technical and IT-resource-oriented. For instance, items were measured as "costs per CPU second used", "costs per GB used" et cetera. The corresponding MetaMIS models are extremely large and intricate, mirroring this phenomenon. Figure 4.4 gives an excerpt of the MetaMIS models for the item catalogue which were jointly created based on the workshops. The researchers' interpretation of this item catalogue, using the constructed conceptual models and applying

[655]IT controller in workshop in January 2005 (analogously), translated by the author.

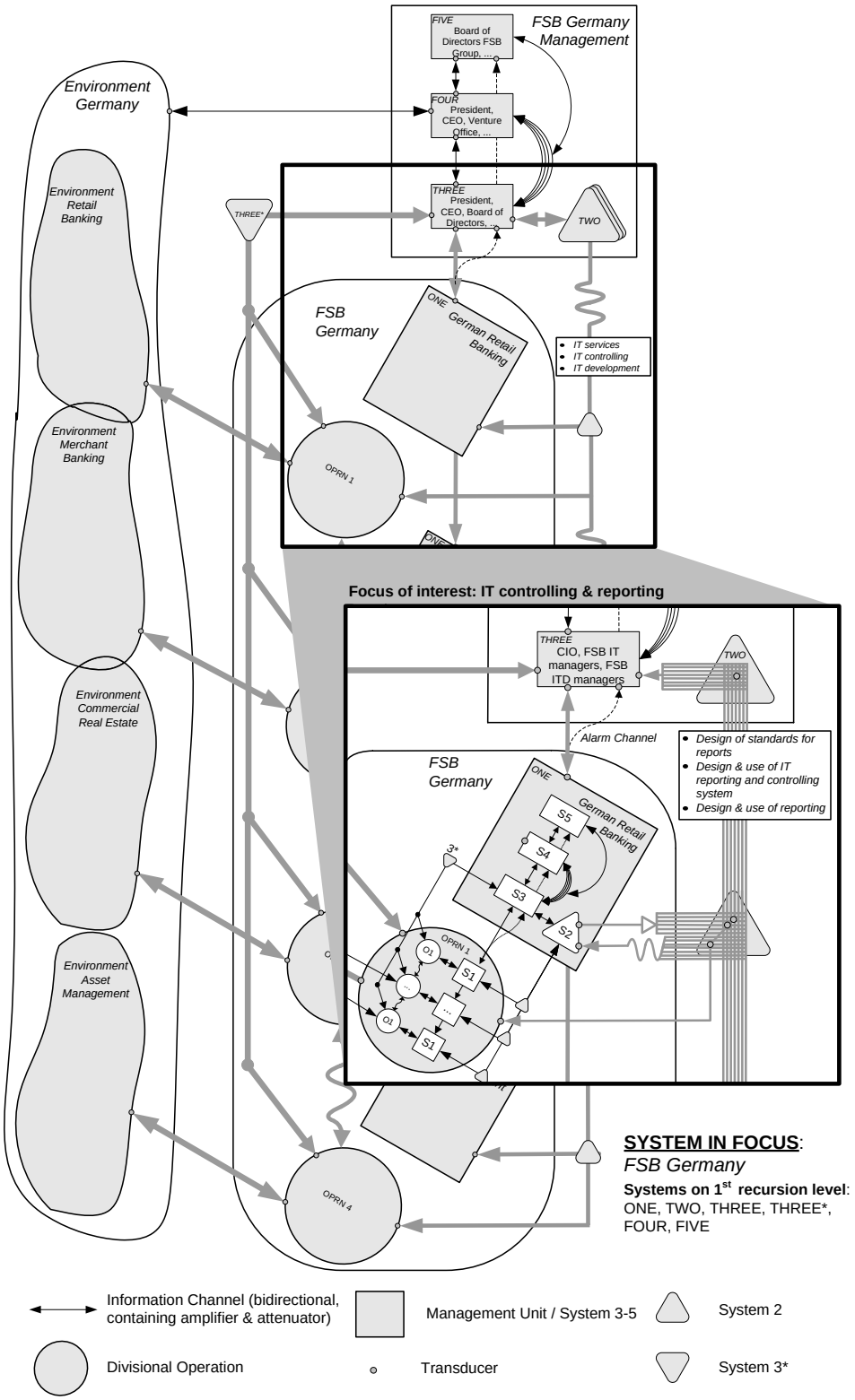


Figure 4.3: VSM of FSB Germany (Excerpt)

the propositions for variety measurement introduced in the previous section, suggested that all in all the variety of the item catalogue was very high: it listed over 1,000 single items, grouped according to around 85 services. Each of these items was used in several application systems, for which both price negotiation and controlling were undertaken. There were approx. 550 items used per period in total– each one in several application systems and each with a price accuracy down to Euro and cent. The average application system at FSB Germany included about 150 single items per period. FSB had approximately 150 application systems in total for which IT chargeback and reporting were conducted.

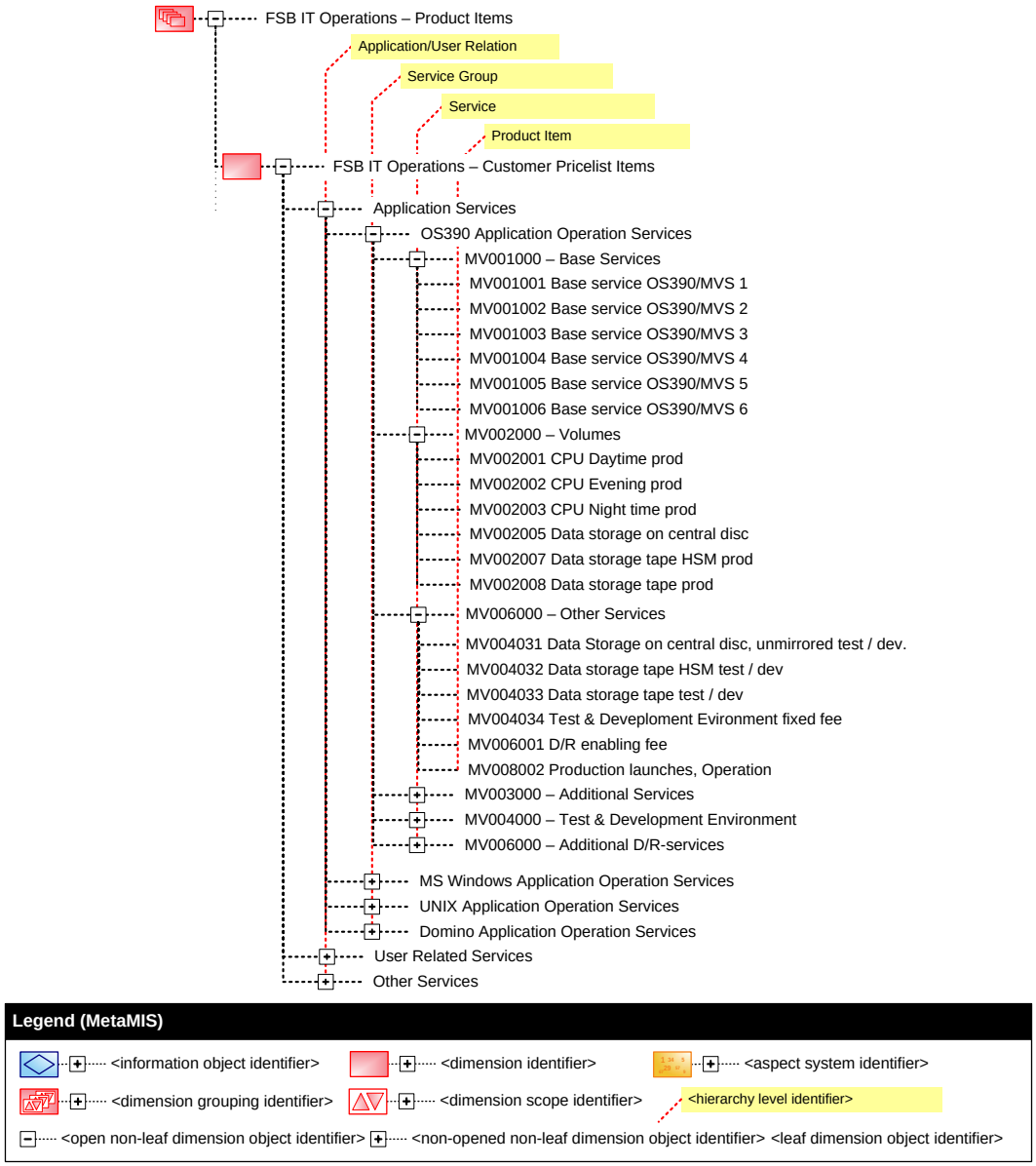


Figure 4.4: MetaMIS Model of Item Catalogue (Excerpt)

Additional variety arose because even this large number of items was not constant over time, but changed between and during budget periods. In the example of a document management system, the MetaMIS models revealed that nearly two-thirds of the charged items for this system changed between two exemplary budgeting periods. Figure 4.5 compares the corresponding MetaMIS models of reports for this document management systems in two periods. As a subsequent inquiry showed, this change was due to a major modification in the application system, which transformed the underlying IT infrastructure considerably.

Figure 4.6 shows a comparison of costs for the exemplary document management system, based on data of actual reports. Overall, the use of the detailed item catalogue led to a transparency in detail, which in fact hid important changes. For instance, the rise in fixed IT costs due to a change in infrastructure was not directly observable without checking a large list of single items in detail.

Usually, a management decision is the selection of one possible state from all the others. The *potential* variety of the IT controlling and reporting system, as revealed by the conceptual models and reflected in the item catalogue, appears as approximately

$$\begin{aligned} V \approx \textit{No. of app. systems} \times \textit{set of possible combinations using } 150 \textit{ items} \\ = 150 \times 2^{150} \approx 157 \textit{ bits.} \end{aligned}$$

Note that the additional variety, which is a result of the changing item structure, is not considered. In order to identify a particular item – for instance, a maintenance service for one application service – one out of that total variety needs to be selected.[656] Of course, constraints do apply here.[657] For instance, a Unix-based system usually will not have any Microsoft-related items. But even with grouping and categorization of items, which leads to a further reduction of numbers and which is a rather fruitless task since the item structure is constantly changing, a decision for a single application system was a matter of selecting "yes/no" answers for more than 150 items on average. Even though this measure is not numerically accurate, the magnitude of the problem is quite clear and unambiguous. These numbers are large, and usually there are many more dimensions entailed. Moreover, this analysis disregards connections between the items. Consequently, the numbers involved in calculating variety for IT controlling were indeed enormous, and hence for decisions based on this information as well.

Thus the conceptual models pointed to a high variety within the IT controlling and reporting system and the information channel connecting the coordinatory System 2 function of FSB ITD with the divisional managers of the German business units: the item structure used for IT controlling and reporting (1) had many detailed items, and (2) was often changing. A measure of this kind is irrelevant to any conceivable response and it is impossible to imagine a situation in which the addition of one cent to the price of one single item, or the removal of one cent, could possibly have any operational significance on an application system other than nitpicking.[658] The change of the item structure during and

[656] See Beer (1979), p. 529, for a similar comment.
[657] Ashby (1964), p. 127.
[658] See Beer (1979), pp. 35 f., for a description and critique of a similar situation.

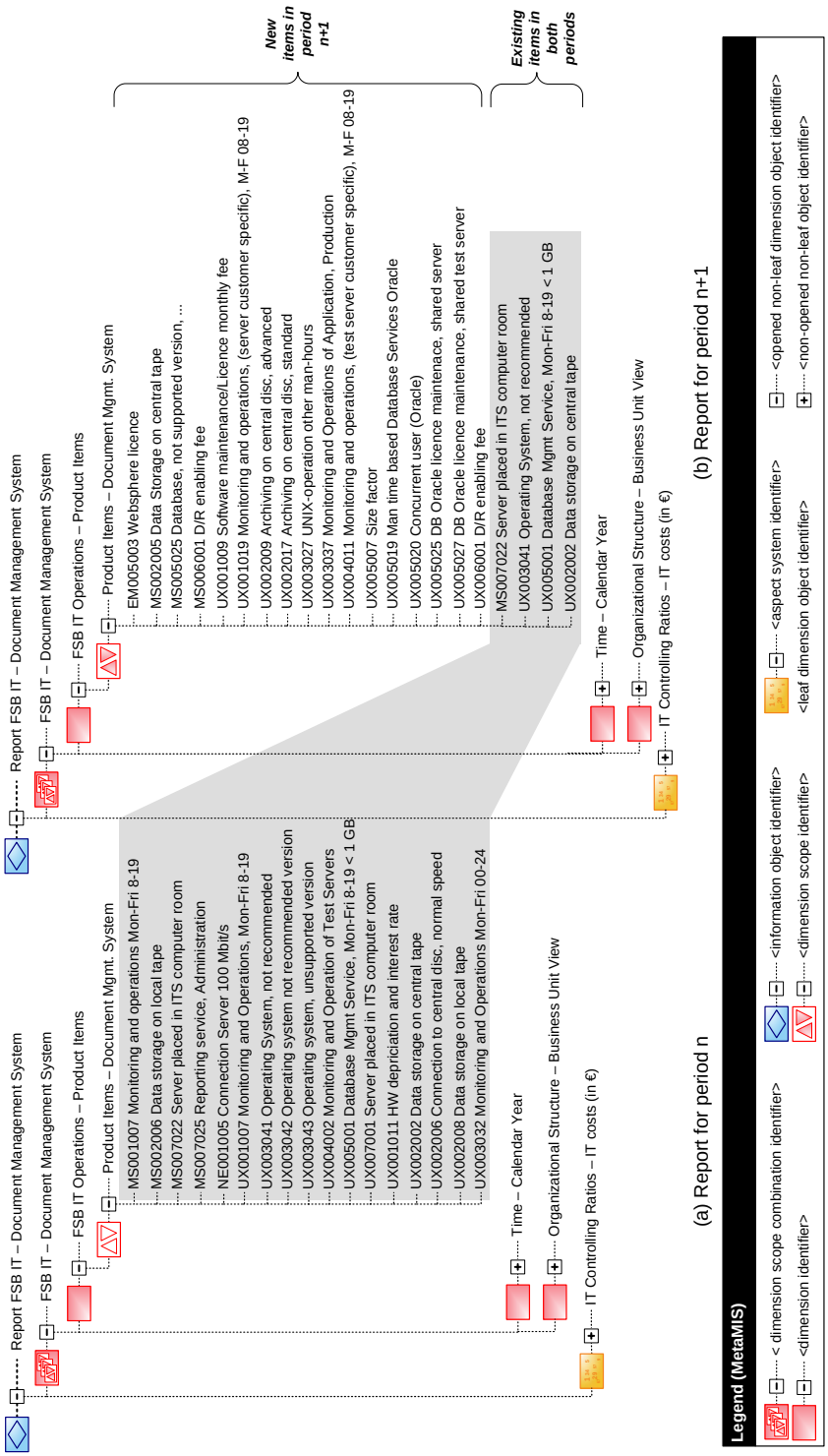


Figure 4.5: MetaMIS Model of Report for Document Management System (Excerpt)

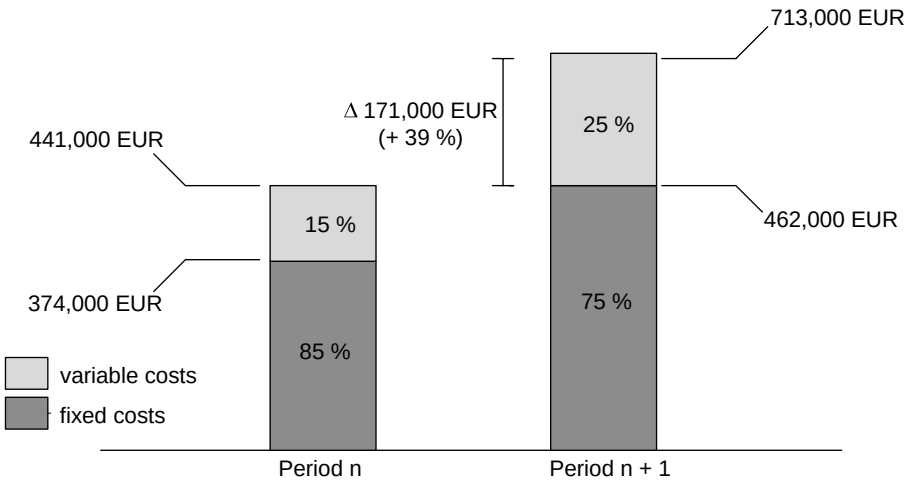


Figure 4.6: Total Costs Document Management System per Year (in EUR)

between budgeting periods led to even more proliferation of variety. To summarize, the IT controlling and reporting system at FSB Germany exhibited proliferating variety due to its underlying item catalogue. The conceptual models made the magnitude of that variety visible.

As a next step in the project, the interpreted findings were matched to the law of requisite variety. According to the law of requisite variety, varieties tend to equate naturally because only variety absorbs variety.[659] Consequently, the proliferating variety should be compensated by other means: the *actual* variety had to be less enormous than the potential variety. Amplifiers and attenuators establish requisite variety and should be detectable accordingly for the IT controlling and reporting system.[660] As a result, the cybernetic theory of the law of requisite variety was confronted with the interpreted observations of the action case in order to deduce meaningful hypotheses. The following hypotheses were proposed:

- **Hypothesis 1 (H1):** *In order to establish requisite variety, attenuation on the side of the German business units reduces the variety generated by the IT controlling and reporting system.*
- **Hypothesis 2 (H2):** *In order to establish requisite variety, amplification on the side of the German business units increases the variety of divisional management to match the variety generated by the IT controlling and reporting system.*

As a consequence, this research sought an understanding of the variety amplifiers and attenuators whereby FSB Germany met the requirements of the law of requisite variety. In order to corroborate or falsify the two hypotheses, a second set of semi-structured interviews was conducted in workshops between October 2005 and December 2005. The interviews, which were guided by a semi-structured interview outline designed to test the

[659] Beer (1979), p. 95; Beer (1985), p. 30.
[660] E. g., Beer (1979), pp. 89-93; Beer (1985), pp. 19-35. See Chapter 3.6.2.

hypotheses (see Appendix B), comprised questions which were derived from the law of requisite variety. First, the precondition that the variety of the IT controlling and reporting system is very high was shown. Afterwards, evidence was sought for the existence of attenuators and amplifiers for balancing this variety, which are a consequence of the law of requisite variety.[661] The researchers were interested in exploring how organizational members adapt to the variety generated by the IT controlling and reporting system. The conceptual models were used as a starting point for discussions. However, as a limitation, again no coding for cause-effect pairs took place since the aim of the research was not to test any specific theory, but rather to explore the general usefulness of the applied concepts.

Following the findings from the interviews, both hypotheses were confirmed. To summarize the results, employees from FSB Germany's business units had difficulties in understanding the IT controlling reports. They were not "*written in business language*" and "*not related to the daily affairs*". In addition, the pure number of the provided information generated a feeling of "*information overload*".[662]

> "*Many [customers in the business units] say [...] 'I didn't understand it anyway' [...] They [FSB IT] talk of transparency concerning the item catalogue: everything and every detail is open to analysis. But providing all the detailed information does not create transparency with regard to daily business. In fact, we are drowning in details.*"[663]

In order to cope with this problem, the divisional managers of the German business units had developed various strategies. In the following, four instantiations of amplifiers and attenuators are exemplarily presented and discussed regarding their variety response strategy:[664]

- *Amplifier*: one business unit which was responsible for providing internal services for the other business units (e. g., operation of the German customer service center) appointed two employees with a background in IT that were responsible for the analysis of the IT reports and for the understanding of the item catalogue. Due to their background these employees understood the technical terminology used for the item catalogue very well (behavioral route to variety response).
- *Amplifier*: the same business unit extended the original item catalogue with self-provided descriptions in order to make the items understandable for their non-IT personnel by describing the items they encountered most or deemed important in more casual business language. With this mechanism, this business unit established missing variety to match the variety of the IT controlling and reporting system by amplification (behavioral route to variety response).
- *Attenuator*: employees which were responsible for the analysis of the IT reports in other business units inherently knew from previous experience and subjective

[661] This is in line with hypothetico-deductive logic, see Lee (1989b), p. 129, and following the modus operandi of the effective dialogue rule in constructive logic, see Lorenzen (1987), pp. 90 ff.; Lorenzen (2000), pp. 64, 75.

[662] Statements analogously taken from various interviews.

[663] IT controller in a workshop conducted in October 2005, translated by the author.

[664] Strategies for variety response can eithr take a cognitive route or a behaviroal route, see Chapter 3.3.2.

evaluation which items were important and which were not for their business unit's application systems. By directly looking only for those few items in the reports, they reduced the potential variety of the item catalogue, chopping down variety on a large scale by attenuation (cognitive route to variety response).

- *Attenuator*: other business units, mostly larger ones directly within market range, ignored the item catalogue and the IT controlling reports completely. They simply waved the IT costs through their internal cost control as long as they lay within a certain range. This acts like an attenuator that filters out the variety generated by the IT controlling and reporting system (cognitive gerlach to variety response).

  > "*Units that have to pass to account their costs in the allocation cascade down to units within market range had to process and analyze the data in detail due to allocation and questions of the market-related units. However, these [the market-related units] could carry out a simpler comparison between budget and actual costs, and only when larger discrepancies occurred a detailed analysis became necessary.*"[665]

According to these findings, the implemented IT controlling and reporting system at FSB Germany was not designed with regard to requisite variety. Therefore it became quite clear by the different strategies employed by actors in the different business units for amplification and attenuation, that the existing IT controlling system failed to deliver reasonable or meaningful information that made the usage of IT transparent to the actors in the business units. Consequently, control and regulation were not successful, since no sufficient model had been built. For instance, this led to the need of experts with good knowledge of IT in order to establish requisite variety for divisional management, and consequently to a misuse of resources, that is, time, people and money. For instance, approx. 50 full time equivalents (FTE) were responsible for IT controlling for the total FSB Group.

> "*The amounts of data related to this [the item catalogue] are much too large for effective IT controlling. The majority of the monthly work comprise data checks/data import and consistency/plausibility checks respectively. The transformation of the item-related IT charging into the – product-oriented – business unit view is not easily comprehensible.*"[666]

Phase 2: Redesign of IT Controlling and Reporting

A number of practical recommendations were made in the form of a report for the management team of FSB ITD. The report was a distillation of the rich account produced by the analysis into a relatively short document that largely ignored academic and scientific issues. As the main practical recommendation resulting from this analysis, the research group suggested a redesign of the IT controlling and reporting system. It was proposed that this problem could be solved by a radically reduced item catalogue, made up of terms that are understandable by both business units and IT departments.[667] The attention should be

[665] IT controller in e-mail in March 2007, translated by the author.
[666] IT controller in e-mail in March 2007, translated by the author.
[667] E. g., Nolan (1977); Zarnekow & Brenner (2003).

directed to a classification of items which attenuates the variety of the application system to the nearest matching item of a much smaller list of items, thus reducing the variety and the combinatorial implications.

As a result, FSB ITD and the researchers decided to engage into a second phase and to jointly design and test a new IT controlling and reporting system in a preliminary study. Building up on the original item catalogue, an activity based costing (ABC) approach[668] was used, intended to foster communication between the IT departments and the business units.[669] In order to make the use of IT more transparent to divisional management, the technical items were encapsulated in packages based on business processes and activities. ABC allows a fair allocation of costs according to the input involved in terms related to business processes and daily business affairs. The preliminary study successfully tested the approach for a specific application system in one of the German business units. The reduced item catalogue offers items in terminology that is closely related to business processes. Volume-driven costs are calculated by spreading the sum of the IT costs according to the activity-specific IT usage indicated by cost drivers. Volume-neutral costs, which occur independently of cost drivers, are charged to the activities proportionally to IT usage. The sum of both cost types is used in order to determine the process cost rate which mirrors the IT costs for the handling of one process. One difficulty regarding ABC for IT services is to determine the exact contribution of specific IT resources to volume-driven costs.[670] Since several business processes share one or more application system, sometimes the contribution of each application system to a process or activity can only be estimated, relying on assumptions and judgments jointly made by IT staff and business users. Figure 4.7 exemplarily summarizes the construction of a new business-related item. Instead of listing costs for every used IT resource and every application system using a multitude of technical language terms, the variety of the original item catalogue has been encapsulated in one process-oriented item. The resulting process cost rate determines the costs for this packaged item and determines the internal transfer prices. Business units can influence the cost drivers of the activities and the resulting IT costs respectively, which are now described in language terms and categories related to their daily affairs.

Phase 3: Follow-up

After the presentation of the preliminary study results, the managers at FSB ITD decided not to implement this design on a large scale, since at the same time, a similar initiative was started on a corporate level by FSB Group headquarters. Instead, FSB ITD's managers wanted to combine the existing efforts with this new initiative. Since the project had officially ended, the researchers dropped out and agreed to undertake a follow-up examination one year after the end of the project to evaluate the long-term success. Shortly after the preliminary study had been presented to managers at FSB Germany, the group executive committee of FSB Group decided to drastically reduce the number of items in the item catalogue by using it on an aggregated level only. Internally, managers talk about

[668] E. g., Kaplan (1985).
[669] E. g., Ross, Vitale & Beath (1999).
[670] E. g., Gerlach et al. (2002).

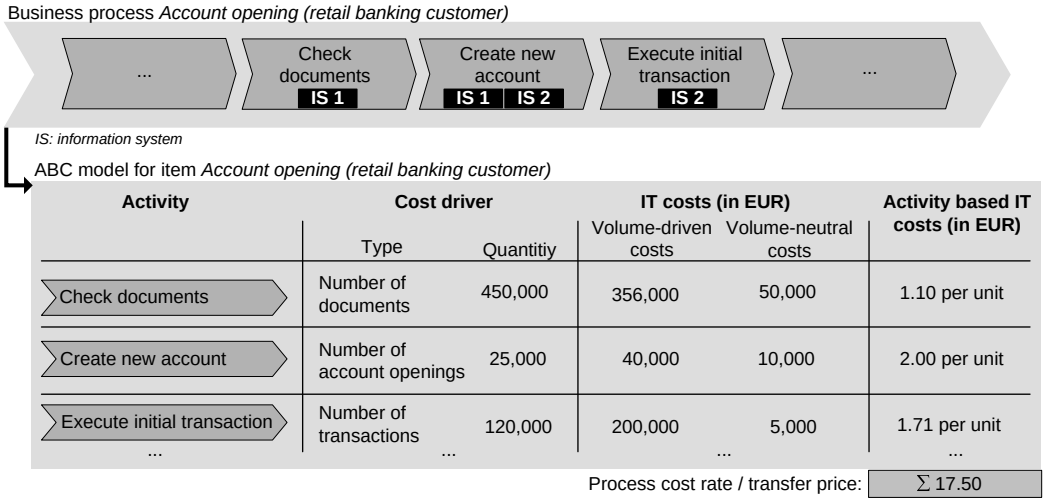


Figure 4.7: Exemplary ABC Model for Item

> "*[...] a changed playfield in IT Governance. Due to a lack of trust in FSB IT creating demands of detail, the current pricing model has become obsolete and Group Executive Committee has decided to implement a simplified model.*"[671]

The new cost allocation model targets less than 100 IT-oriented items for charging, and aims at around 30-35 FTE group-wide and 70 SLA. This is not the most simple and radical model, but a pragmatic first step ready for short term implementation with "no allocation" as the vision.[672] In the first budgeting process using the new item catalogue, the negotiations took only one month. Reportedly, there was no major discussion about the costs of single items and it only took two meetings at group executive level.[673] Although this brought the further extension of the preliminary study to a full stop, this indicates that the analysis of the first phase and the approach taken in the second phase were going in the right direction.

> "*[...] The potential for improvement of the charging and the item catalogue has been discussed since [...] 2006 at [FSB] group level as well. This discussion has been set in motion and pursued by the new CIO. The result of this is that the item catalogue [...] will be reorganized in April 2007. The foundation of the new model are fixed prices for IT services. [...] The complexity [...] for the customer will be massively reduced (e. g., reduction of items from over 1,000 to circa 100), which reduces the effort and complexity of the allocation. Therefore, the project made a valuable contribution to this discussion.*"[674]

Figure 4.8 compares and summarizes the aspects of the old and the new IT controlling approach as of May 2007, one year after the dropping out of the researchers.

[671] FSB internal presentation slides, March 2007.
[672] FSB internal presentation slides, March 2007.
[673] IT controller in interview in February 2007.
[674] IT controller, e-mail in March 2007 (analogously), translated by the author.

	Old reporting system	New reporting system
Follow up	In detail (detailed allocation)	Deviations
Items	approx. 1,000	approx. 100
SLA	800	70
FTE	50	30-35

Figure 4.8: Comparison of Old and New IT Controlling Approach

4.1.4 Discussion & Analysis of Findings

As should be clear by now, an objective measure for complexity is not possible; this is in line with the epistemological position of this thesis and the definition of variety.[675] In order to assess the variety of a situation, the observer of a system has to *linguistically* describe the situation. The action case showed that the language-based measurement of variety by interpreting conceptual models is very useful for organizational analysis and information systems research. The findings of the action case study confirmed that the proposal to use conceptual models as linguistic marks for measuring variety is reasonable and works. This confirms that language-based communication and variety transmitted by information channels must be directly related in the case of social systems. This is exactly the reason why conceptual modeling ("By what terms and categories can a situation or system be described in a structured way?") can be used for measuring variety. While the VSM helped to analyze the different stakeholders at FSB Germany and their interaction by information channels, a detailed analysis of the information channels regarding their variety became possible by modeling the content of one of these channels (i. e., the IT controlling and reporting system) with MetaMIS. The findings show that if the starting point and the ending point of an information channel have different orders of magnitude in variety – meaning amplifiers and attenuators do not sufficiently balance varieties of start and end points – communication and coordination over this information channel are defective.

The law of requisite variety, unexceptional as it may seem at first glance in its implications, has important consequences for the design of organizations and information systems. Managerial, operational and environmental varieties, necessarily diffusing through an organization, tend to equate due to the law of requisite variety; they should be designed with minimal damage to people and to cost.[676] For instance, data is often confused with variety. Data distinguishes possible states of the system, but they are generated by terms, classifications, categories, meanings and definitions in a language-based terminology, which determine the actual variety and are within the organizational actors' power to design.[677] In the action case, the IT chargeback structure was not instantly usable for IT controlling and reporting because the level of detail needed for cost allocation did not make the usage

[675] See Chapter 2.1 and Chapter 3.3.2.
[676] This is expressed in Beer's so-called "First Principle of Organization", see Beer (1979), p. 97; Beer (1985), p. 30.
[677] Beer (1985), p. 24.

of IT transparent and meaningful to the employees of the business units. Instead, the employees responsible for dealing with the reports struggled with the meaning and the numbers of technical language terms and employed strategies for coping with this problem. This also suggests that individual agents adapt to variety by language-based mechansims.

Interpretive methods were employed to generate subjective and interpretive understandings of the problem situation in the described action case, and interview-based evaluation techniques to test the proposed hypotheses. In this, this research followed Daft & Wiginton who suggested that research into more complex aspects of organizations would rely on some type of human observation of the system (the action case), human thought processes would be used to form the observations into a model of the system (the constructed MetaMIS models), imprecision would characterize measured variables and relationships among measured variables (the operationalization of variety and the application of the law of requisite variety), and the research process would rely heavily on language of high variety rather than on mathematics or statistics (the description of this research).[678] However, an IT artifact (the new IT reporting and controlling system) for addressing the identified problem has been designed as well. The success or failure of the IT artifact can also be seen as a test of the hypotheses, that is, if the situation has been understood correctly then the IT artifact should address the right problem. However, due to the social and political context, the designed IT artifact was never tested on a large scale, but had a major influence on the design of the actual new item catalogue, chargeback model and IT controlling and reporting system. For evaluating this part of the research, this study follows Niehaves and combines Hevner et al.'s guidelines with selected principles for interpretive field studies suggested by Klein & Myers as summarized in Table 4.1.[679]

The overall exploratory findings from this research can be summarized as follows:

- Variety in social systems is embedded in language. More specifically, it is found within the terms and categories used in language-based communication. The variety transmitted by the IT controlling and reporting system was made visible by jointly specifying conceptual models and by subsequently counting the number of different technical language terms used in the conceptual models. The strategies employed by organizational members were a direct consequence of adaptation to this variety.

- A large proportion of the identified problems were due to inappropriate technical language terms. Business users experienced problems in understanding the item catalogue. The IT controlling and reporting system did not ensure that the intended meaning was understood and shared by all employees. Consequently, FSB Germany had a technical language problem in its IT controlling and reporting system. Therefore the variety was too high. This resulted in several amplifying and attenuating strategies on the side of the German business units in order to adapt. The reason for the perceived complexity lay in the mismatch of technical language terms.

- The concept of variety and the law of requisite variety were important for the analysis of the old and the design of the new IT controlling and reporting system as a

[678] Daft & Wiginton (1979), p. 186. See Chapter 2.3.
[679] Niehaves (2007); Hevner et al. (2004); Klein & Myers (1999).

Hevner et al. (2004)'s guidelines	Assessment addressing selected principles by Klein & Myers (1999)
Design as an artifact	The contributions of this project are (1) the proposed and applied method for the measurement of complexity by using the concept of variety in combination with conceptual models (artifact type: method), and (2) the socio-technical redesign of the IT controlling and reporting system in a preliminary study (artifact type: instantiation).
Problem relevance	The first contact to FSB Germany at the management level led to the impression that the business units would experience a lack of information pertaining operational, tactical and strategic decision-making with regard to IT controlling. This was an important and relevant business problem to these managers and IT controllers. Other stakeholders involved in the project (system developers, service staff of business units) had a similar understanding of this problem. For instance, service staff from the business units voiced information overload and a pseudo transparency due to too many technical details as their main problems in the subsequent second round of interviews (principle of suspicion, principle of multiple interpretations). The analyses demonstrate different stakeholders' problem perceptions and their similarity (triangulation).
Design evaluation	Within the project, (1) a preliminary study and (2) follow-up interviews for evaluation one year after the preliminary study were conducted. The social, political and historical setting at FSB Germany with regards to the research and evaluation environment were explicated. It was tried to explicate the factors of this setting (principle of contextualization).
Research contributions	This research makes three contributions: (1) the operationalization of variety for the measurement of complexity of organizations and information systems and the application of the law of requisite variety are novel and unique. The law shows to be important when designing information flows within organizations, for instance, IT-based reporting structures. Certainly, there are other possible ways to operationalize variety in other contexts and situations (principle of contextualization). (2) Accordingly, the field study approach was extended and it was shown that using conceptual models for generating an interpretative understanding is a valuable and meaningful way perfectly in line with the philosophical assumptions presented in Chapter 2. (3) The conceptualization of information systems as language communities proved to be useful. It was shown that variety and language are closely related in social systems.
Research rigor	Within the project, research and evaluation methods that comply with field studies and design science were applied, for instance, open interviews, semi-structured interviews, workshops, and joint design and discussion of conceptual models. Moreover, hypotheses based on the interpretive understanding were formulated, and the interpretive findings were matched to the law of requisite variety as a theory. The design of the prototype in the preliminary study reflected these findings.
Design as a search process	While searching for effective artifacts this study sought to utilize all available means to reach the desired ends. The use of MetaMIS for conceptual modeling tries to explicate the multiple stakeholders' interests in a common language for analysis and documentation (principle of multiple interpretations) as well as the researchers' interests (principle of interaction between the researchers and the subjects).
Communication of research	This study tried to address both technology-oriented and management-oriented audiences by focusing on the problem, using MetaMIS to bridge the communication gap between both audiences and by iteratively publishing the results on conferences with different focus and audiences (principle of contextualization).

Source: adopted from Niehaves (2007), p. 10.

Table 4.1: Application of Research Guidelines to Action Case Study

coordinatory mechanism. The reduction and consolidation of technical language terms (items) resulted in a more suitable terminology for IT controlling.

- The VSM was a valuable modeling language for analyzing the organizational structure of FSB Germany and helped to identify problem areas. However, the analysis of a specific information channel (i. e., the IT controlling and reporting system) became only possible once variety was operationalized by counting the technical language terms in the conceptual models of this information channel. The VSM and the law of requisite variety do not provide a modus of operation or procedure model, that is, they provide no guidelines on how to make variety visible in social systems.
- Moreover, it is unclear how exactly the resulting changes have to be implemented. This is also a limitation of the field study since the effects of the new IT controlling and reporting system on the employees have not been studied in depth.

4.2 Organizational Design at Arvato Services Healthcare

4.2.1 Case Overview & Business Processes

Arvato, part of the Bertelsmann group, is an international service company and a global provider of supply chain management. With more than 52,000 employees, Arvato generated revenues of Euro 4.9 billion (in 2007). The business unit Arvato Services Healthcare is a third party logistics service provider and focuses exclusively on the healthcare industry. In 2005, Arvato Services Healthcare acquired a European competitor with facilities in Germany, France, United Kingdom and Belgium. In Germany, the former general manager retired in December 2005 and was replaced by a site manager from the original Arvato organization. The German facility is now known as *Arvato Services Healthcare Germany*. Six month before, the former operation manager left the company and a new operation manager was hired and trained.

Arvato Services Healthcare Germany acts as a third party logistics service provider for the world-wide dispatch of temperature controlled medical products, instruments and spare parts mainly to clinics and laboratories. At the time of the study, Arvato's services were provided to five different customers (A-E) within four different temperature intervals. In 2005, more than 21,000 different article numbers were stored at the warehouse, approximately 145,000 delivery notes were executed with an average of three lines per delivery note and approximately 240,000 parcels were handled by on average 46 employees. Arvato possesses the know-how for different transport solutions within the healthcare industry, bundles quantities for its customers and constantly evaluates different transport solutions provided by these specialized carriers. The organizational chart shown in Figure 4.9 gives an overview of the different functions at the site.

The replenishment process at the site typically consists of inbound transport, goods-in and warehousing. The order fulfillment process deals with the product delivery to clinics and laboratories. Customers submit their order either by e-mail, facsimile, telephone, letter or web front-end to the medical products producer or directly to Arvato. After the order has been transferred to Arvato, the corresponding products are picked and packed. Each

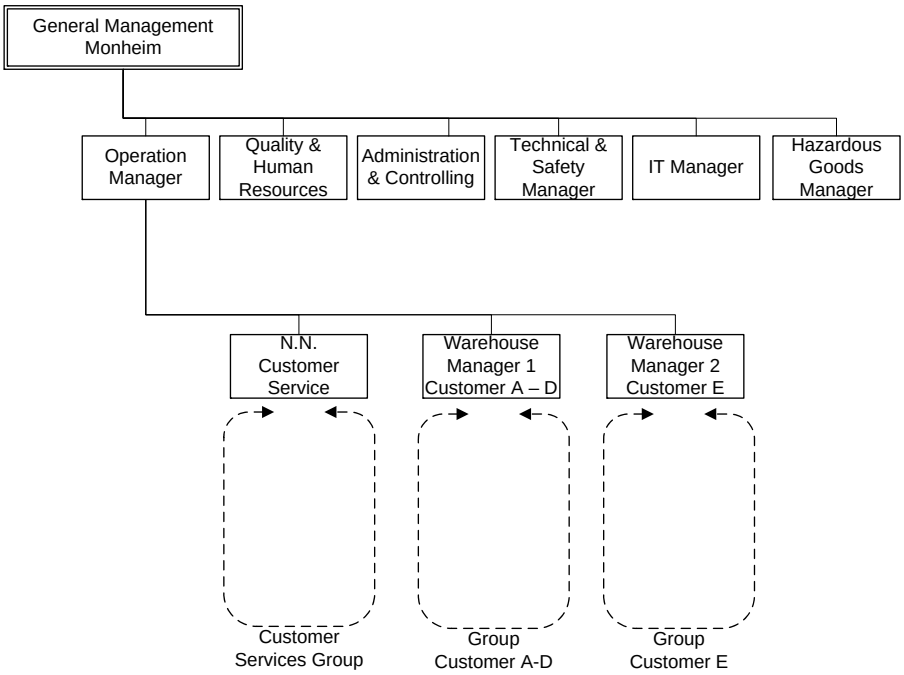


Figure 4.9: Organizational Chart of Arvato Services Healthcare Germany

shipment is double-checked, signed and confirmed in the warehouse management system or client system. All shipping documents are printed out and optional customs documents are included before the products are handed over to the carrier. Figure 4.10 summarizes both processes as value chain diagrams.

The strategic task of the new site manager was (1) to retain existing customers, (2) to acquire new customers and (3) to focus on the extension of business with existing customers. However, during his first few weeks, the new site manager was totally occupied with internal

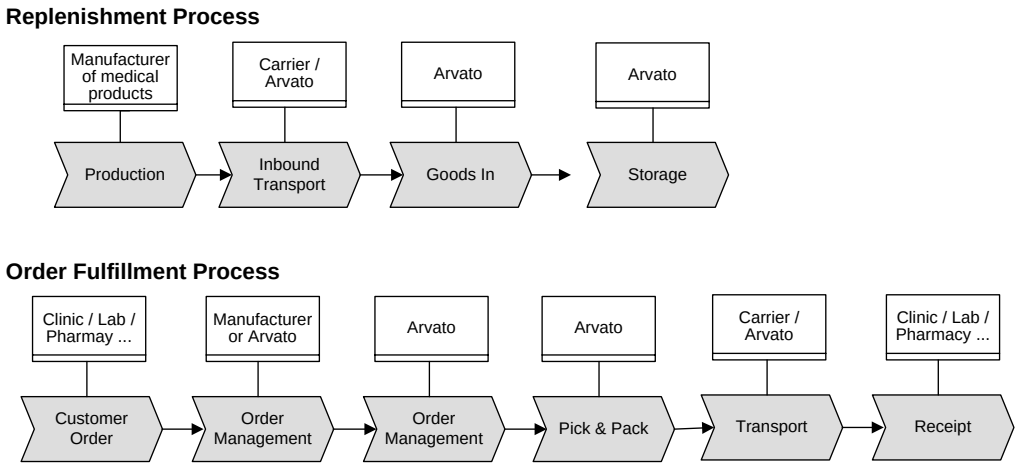


Figure 4.10: Exemplary Replenishment and Order Fulfillment Processes

operations, reporting and internal communication, and was interrupted many times during the day by uncoordinated face-to-face meetings. It was difficult to get decisions implemented quickly, communication seemed uncoordinated and non-effective and there was no time left to implement the predefined strategy. As a consequence, the site manager decided to analyze, review and redesign the organizational structure and information channels within the organization. Furthermore, he decided to engage the information systems research group at Goethe University in this project.

4.2.2 Research Methodology

Action Research as Research Method

In this situation, an organizational analysis and design project was initiated as a part of this research.[680] The author was involved in an analysis of Arvato Services Healthcare Germany's organizational structure and information channels. From a practical perspective, this research engaged in a rigorous and systematic analysis and design of the information channels of a real organization. From a research perspective, this study was interested in solving the practical problem in a manner that contributes to the existing body of knowledge about organizational analysis. The project was seen as an opportunity to conduct exploratory approach in order to create subjective and interpretive understandings of organizational situations, and to explore the usefulness of variety for organizational design by matching the findings to the law of requisite variety. Therefore the overall research goal of this field study was to explore whether the VSM as a language for describing organizational structures and the law of requisite variety would help in diagnosing and designing a real organization. Furthermore, this study was interested in observing if the conceptualization of organizations and information systems as language communities would lead to any interesting findings. In order to satisfy those objectives, the project was conducted as a *participant action research study*.[681]

Participant or participatory action research realigns the roles of researcher and subjects into more collaborative and synergistic forms, sharing the responsibility for theorizing with client participants.[682] Action research usually is a five phase, cyclical process.[683] The approach first requires the establishment of a client-system infrastructure or research environment. Then, five identifiable phases are iterated:[684]

- *Diagnosing*: this phase corresponds to the identification of the primary problems that are the underlying causes of the organization's desire for change. Diagnosing involves self-interpretation of the complex organizational problem, not through reduction and simplification, but rather in a holistic fashion. This diagnosis develops certain theoretical assumptions (i. e., a working hypothesis) about the nature of the organization and its problem domain.

[680] Excerpts of this case have been previously published as Laumann, Rosenkranz & Kolbe (2007) and Rosenkranz, Laumann & Holten (2009).
[681] E. g., Susman & Evered (1978); Baskerville & Wood-Harper (1996); Baskerville (1999).
[682] Baskerville (1999), p. 17.
[683] Baskerville (1999), p. 13.
[684] See Baskerville (1999), pp. 15 ff., in the following.

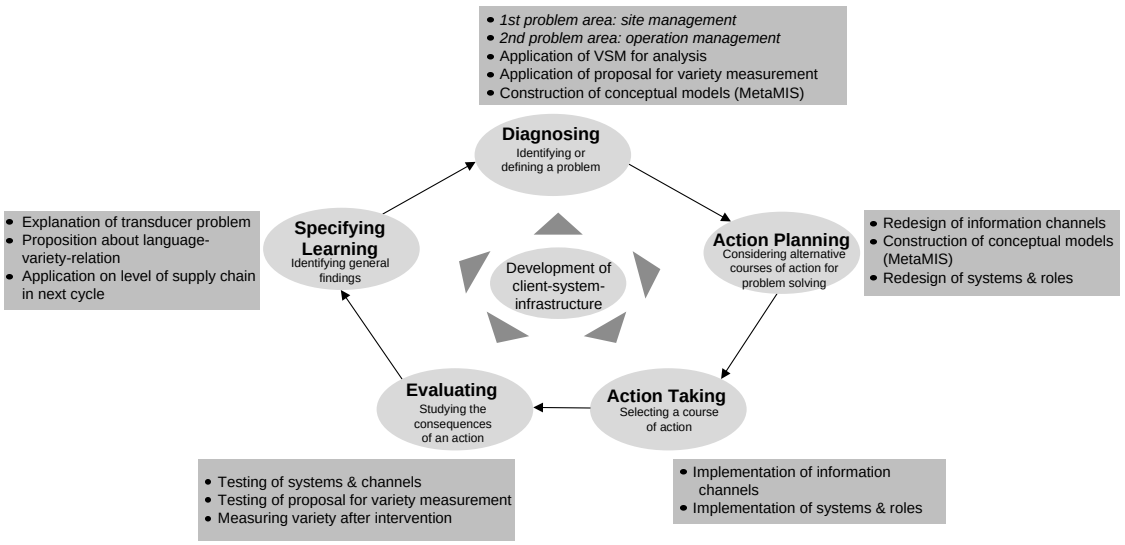
- *Action Planning*: this process specifies organizational actions that should relieve or improve the identified primary problems. The discovery of the planned actions is guided by the theoretical framework, which indicates both some desired future state for the organization, and the changes that would achieve such a state. The plan establishes the target for change and the approach to change.
- *Action Taking*: this phase then implements the planned action. The researchers and practitioners collaborate in the active intervention into the client organization, causing certain changes to be made.
- *Evaluating*: after the actions are completed, the collaborative researchers and practitioners evaluate the outcomes. Evaluation includes determining whether the theoretical effects of the action were realized, and whether these effects relieved the problems.
- *Specifying Learning*: while the activity of specifying learning is formally undertaken last, it is usually an ongoing process. The success or failure of the theoretical framework provides important knowledge to the scientific community for dealing with future research settings. The action research cycle can continue, whether the action proved successful or not, to develop further knowledge about the organization and the validity of relevant theoretical frameworks.

Again, the selected approach mirrors the general research framework of this thesis introduced in Chapter 2 as applied to an individual case level. Firstly, based on exploratory research, an interpretive understanding of an existing organization was created. Secondly, based on the VSM, the law of requisite variety, and the conceptualization of organizations and information systems as language communities, a positivist understanding was created in order to match this interpretation to possible causes of perceived problems.[685] The designed actions were intended to address those causes. The conducted action research study followed the action research cycle as described in Figure 4.11. Four cycles in total were conducted and the VSM was applied at the level of Arvato services healthcare Germany as the system in focus.

Data Collection & Actions

As Silverman argues, information systems researchers would do well to think a long time before rushing into yet another interview-based study, for decontextualized accounts of "meanings" are very limited guides to the complexities of human-computer interaction.[686] Instead of focusing on how people "see things", researchers should focus on how people "do things".[687] Following this, the action research study focused on how the information systems and information channels at Arvato services healthcare Germany actually worked in practice. Therefore it was deliberately decided not to engage into structured interviews this time, but to rely on observations made by the project team, subsequent actions, and observation of the results of these actions. Moreover, from a practical perspective, this

[685] Lee (1991), p. 351.
[686] Silverman (1998), p. 19.
[687] Silverman (1998), p. 3.



Source: adopted from Baskerville & Wood-Harper (1996), p. 238

Figure 4.11: Action Research Cycle at Arvato Services Healthcare Germany

study was interested in how design decisions based on the diagnosis and the law of requisite variety would actually influence the behavior of organizational members. Since one member of the project team was the site manager, this study had full access to the organization's operational processes, information systems and reports. Documents, work descriptions and field notes were collected in a project diary, which served as the main source of data for the following interpretation. Additionally, the MetaMIS approach was used for designing conceptual models of the reporting information system and for measuring the transmitted variety of this information channel, since this approach proved to be reasonable in the previous field study.[688] In combination with an application of the VSM, the models allowed the researchers to generate an interpretive understanding of the situation, and to assess the variety of the reporting information system.[689] Primarily, the VSM was used as a framework for describing the observed problems and for deriving possible causes in the diagnosing phase and the action planning phase with respect to the law of requisite variety.[690]

4.2.3 Exemplary Action Research Cycle for Site Management

Four action cycles were conducted during the action research study in total: two for site management and two for operation management. In the following, one of the four conducted action cycles for site management is exemplarily sketched in detail.

Diagnosing

As a first step during the analysis of this cycle, the organizational situation at arvato with respect to site management was interpreted and mapped with the help of the VSM. The

[688] See Chapter 4.1.
[689] Stowell (2000), p. 180. See Harnden (1989) for a related discussion regarding the VSM.
[690] Davison, Martinsons & Kock (2004), p. 74.

medical product manufacturers (customers A-E) were chosen as the first recursion level in the VSM for further diagnosis because it was decided that a customer-oriented analysis was required. This is reflected in the chosen recursive dimension. Figure 4.12 sketches the resulting VSM before any intervention had been carried out. The sub-systems of the first recursion level are labeled in capitalization (e. g., System 1 as "ONE"), whereas the second recursion level uses numbers (e. g., System 1 as "1").

Possible problem areas with respect to site management and evidence for them in the sub-systems and information channels were sought after modeling the organizational situation with the VSM. As a first indicator, the *amount of time used for coordination and communication tasks* by the site manager was applied as a measure for the diagnosis of variety at instance level.[691] The analysis showed that the site manager spent much time for the coordination of subordinated staff and operational issues. The most time-consuming daily activities of the site manager at the beginning of 2006, measured during a two month period, are presented in Table 4.2. Measured in time, the variety was very high and added up to almost 100% of the available daily capacity for the site manager. As a consequence, there was no time to really focus on the future development of the organization (System FOUR). Furthermore, nobody for business development and sales was at hand, and nobody focused on the development of existing customers (System 4). In addition, the internal reporting was not standardized at all (System TWO). With respect to all observed problems, the hypothesized causes with regard to the law of requisite variety were deducted with the help of the VSM as summarized in Table 4.3, including an analysis at type level for the variety of the company-wide reporting information system using MetaMIS. The lower part of Figure 4.13 gives an example of these conceptual models.

Task	Description	Avg. h per day
(1)	Meeting with the operation manager in order to discuss the actual work-load in the warehouse and customer service and to define appropriate corrective actions.	~1.5 hours
(2)	Analyze different operational reports received by e-mail and answer, write and forward e-mails.	~3 hours
(3)	Have many different face-to-face meetings with departmental heads.	~3 hours
(4)	Carry out regular visits to the warehouse, since all employees were expecting the site manager to visit the warehouse once per day.	~1.5 hours
Total		**~9 hours**

Table 4.2: Tasks of the Site Manager

[691] This was proposed as a measurement instrument in the previous field study in Chapter 4.1, but was not applied there.

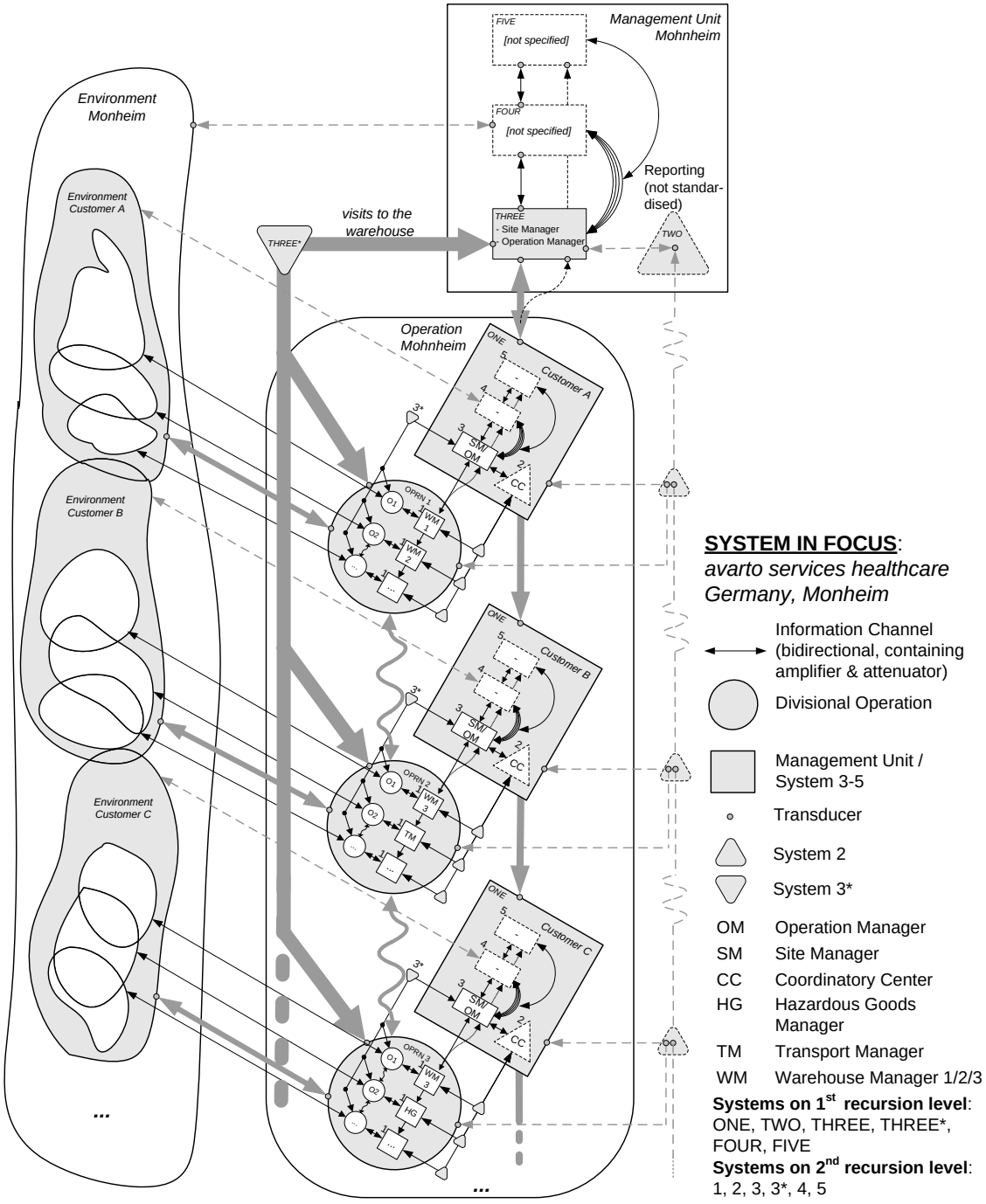


Figure 4.12: The Viable System Model of Arvato Services Healthcare Germany before Intervention (Two Recursion Levels)

Problem	Hypothesized Causes with respect to VSM and the law of requisite variety
(1)	The old job descriptions, responsibilities and reporting had become obsolete after the integration into the Bertelsmann group. The site manager was too involved with internal stability and daily operations (System THREE / System 3). The daily meetings between site management and operation management were not required, since daily operation entirely belonged to the responsibilities of the operation manager (as System 3). In addition, the frequency of meetings and number of interactions (System THREE / System 3) was too high and consumed a lot of time for both employees. Daily operational issues were not solved in a decentralized, autonomous manner but automatically communicated up the hierarchy. Furthermore, the operations manager was not able to focus on extending business with existing customers, since he was too involved with internal communication with the site manager (System 4).
(2)	Since reporting consumed a lot of time, the MetaMIS approach was used to model the actual reporting information system and to get an overview of the company-wide reporting (see lower part of Figure 4.13 for an excerpt). To sum it up, the variety of the reporting information system on the type level was proliferating. The main findings (System TWO/System 2-Operation-channel and Operation-THREE-channel) concerning the variety were: • Some reports provided a non-appropriate level of aggregation (e. g., detailed report of to be replenished deliveries per day). • Some reports were not showing the required dimension scope (e. g., the profit and loss reporting was not available on a customer basis). • Some reports were provided too frequently (e. g., outstanding shippers report per day). • Customers had different "internal" operational reports showing different key performance indicators and/or different dimensions. The comparison of operational reports of different customers was therefore not possible. • Based on the divisions defined within the VSM (second recursion level) some key performance indicators and/or entire reports were not monitored for services provided by Arvato (e. g., transport management). • Alarm channels had been defined, but responsibilities, backups and interactions had not been defined clearly enough.
(3)	The many daily interactions between the site manager and the departmental heads (i. e., divisional management) produced unplanned interruptions. Some of the daily interactions concerned minor or non-urgent issues. Moreover, many of these interactions required new interactions, since involvement of other employees became necessary. An appropriate channel for a standardized and coordinated exchange of information was missing (no System TWO / no System 2).
(4)	System THREE* as the audit channel had been established by former general management as an essential part of running the company. The frequency of warehouse visits (audits) was very high and consumed a lot of time. In addition, the daily warehouse visit partly served to establish a System FIVE / System 5 (feedback culture).

Table 4.3: Hypothesized Causes of Problems based on Analysis of the VSM

Action Planning & Taking

With respect to the causes of the problems as theorized with the VSM and the law of requisite variety, the diagnosis for the site manager found that variety was not balanced enough with regard to the law of requisite variety. Accordingly, a number of actions were planned and subsequently taken. First of all, the Bertelsmann group and the new overall strategy were presented to all employees at the beginning of 2006 (new site manager acting as System FIVE). In order to quickly establish a balance between the internal and external eye of the site (responsibility of System FIVE), the site manager decided to hire a new employee for sales activities and business development (System FOUR). Additionally, interns were hired for market research purposes. A diversity of further actions that were planned and carried out to address the problems are described in detail in Table 4.4. Figure 4.14 sketches the resulting VSM after the intervention.

Problem	Description of Action	Effects on Variety (V)
(1)	Job descriptions and responsibilities were updated, discussed with each employee and signed afterwards. The functions and corresponding responsibilities were defined according to the new role of each employee within the VSM. For instance, the operation manager became fully responsible for operation management (System THREE / System 3). Therefore, the daily meetings between the operation manager and the site manager were reduced to a weekly basis. An operation meeting (a new System TWO) has been established to bundle discussions. However, in case of exceptions (alarm channel), the operation manager is still able to contact the site manager at any time. The operation manager has been enabled to decide autonomously. There is now more time for the operation manager to focus on extending business with existing customers (System 4).	• New resources & responsibilities: V+ (amplification by delegation) • Meetings: V- (attenuation of communication)
(2)	The reporting information system has been completely reorganized corresponding to the new job descriptions. The frequency of reports concerning operational issues provided to site management has been adjusted to a weekly basis and the level of aggregation of reports has been changed to weekly or monthly (e. g., number of shippers, number of lines, outstanding shippers). At the same time, reporting standards have been defined and operational key performance indicators are standardized between customers (System TWO / System 2). This reduced the proliferating variety in reporting (see upper part of Figure 4.13). Financial reporting is now customer-oriented, since operational and financial reports have been set up per customer and an activity-based costing per customer has been implemented successfully (e. g., a profit and loss report per customer now fits with structure of first level of recursion of the VSM). Important new reports for transport management (e. g., number of complaints per carrier, number of on-time deliveries per country per carrier) and goods-in service levels (e. g., number of on-time replenishments per day) have been implemented. Additionally, internal deviations are now documented, categorized and analyzed on a monthly basis. Important alarm channels have been reviewed and extensively been discussed with selected employees to clarify responsibilities and actions to be taken.	• Frequency & aggregation of new reports: V- (attenuation of communication at instance and type level) • Reporting standards: V- (attenuation of communication in System 2 and between System 1 & System 3)
(3)	General rules for communication have been introduced on the highest hierarchy level. If an issue arises, every departmental head first of all has to evaluate if the issue is important and urgent for the entire company before escalating it to site management. If the issue is less important or non-urgent, it is to be discussed jointly within the new established weekly departmental head meeting (new System TWO). Possible solutions are to be prepared beforehand and are presented during the meeting. E-mails are now used more frequently to exchange information and to balance the work load. In addition, upcoming issues are tracked and prioritized by an incident management system.	• Management by exception: V- (attenuation of communication) • Preparation of meetings by development of possible solutions for identified problems: V+ (amplification by delegation) • E-mails: V- (attenuation of communication) • Enabler for e-mail usage: V+ (knowledge about action required = amplification by delegation)
(4)	The frequency of audits (System THREE*) has been reduced. Now, the site manager visits two days per week for one hour the warehouse and customer service. As a substitute, a regular meeting with all employees (System FIVE / System 5) has been introduced to allow feedback.	• Reduction of daily visits: V- (attenuation of communication) • Regular meeting: V+ (amplification of communication)
Legend:	higher variety (V+), lower variety (V-)	

Table 4.4: Implemented Actions during Intervention

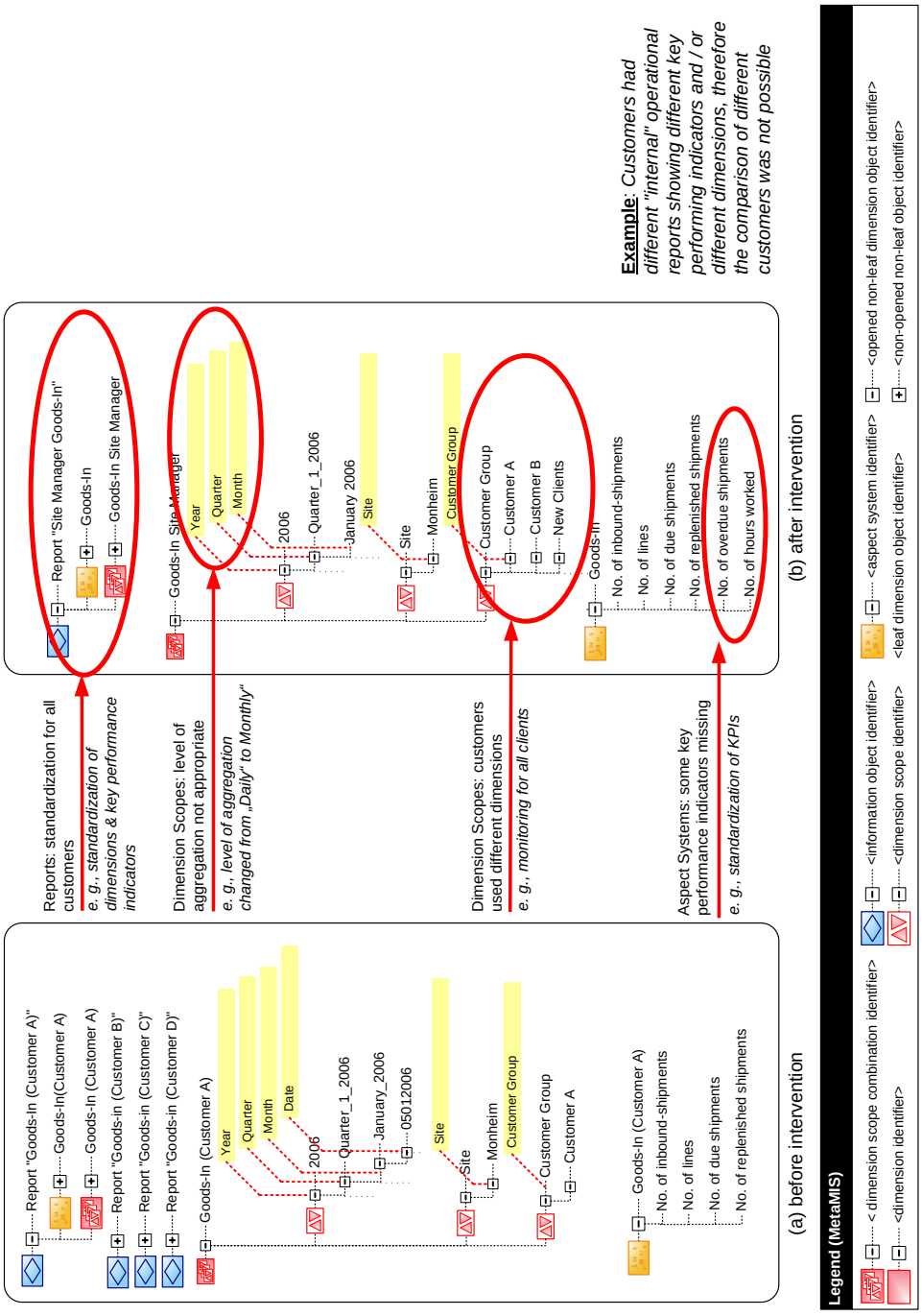


Figure 4.13: MetaMIS Models (a) before and (b) after Intervention for Exemplary Report

Evaluation

Due to the reorganization of the information channels and sub-systems (e. g., weekly operation meeting, no mandatory daily visits to the warehouse, redesign of reporting) and

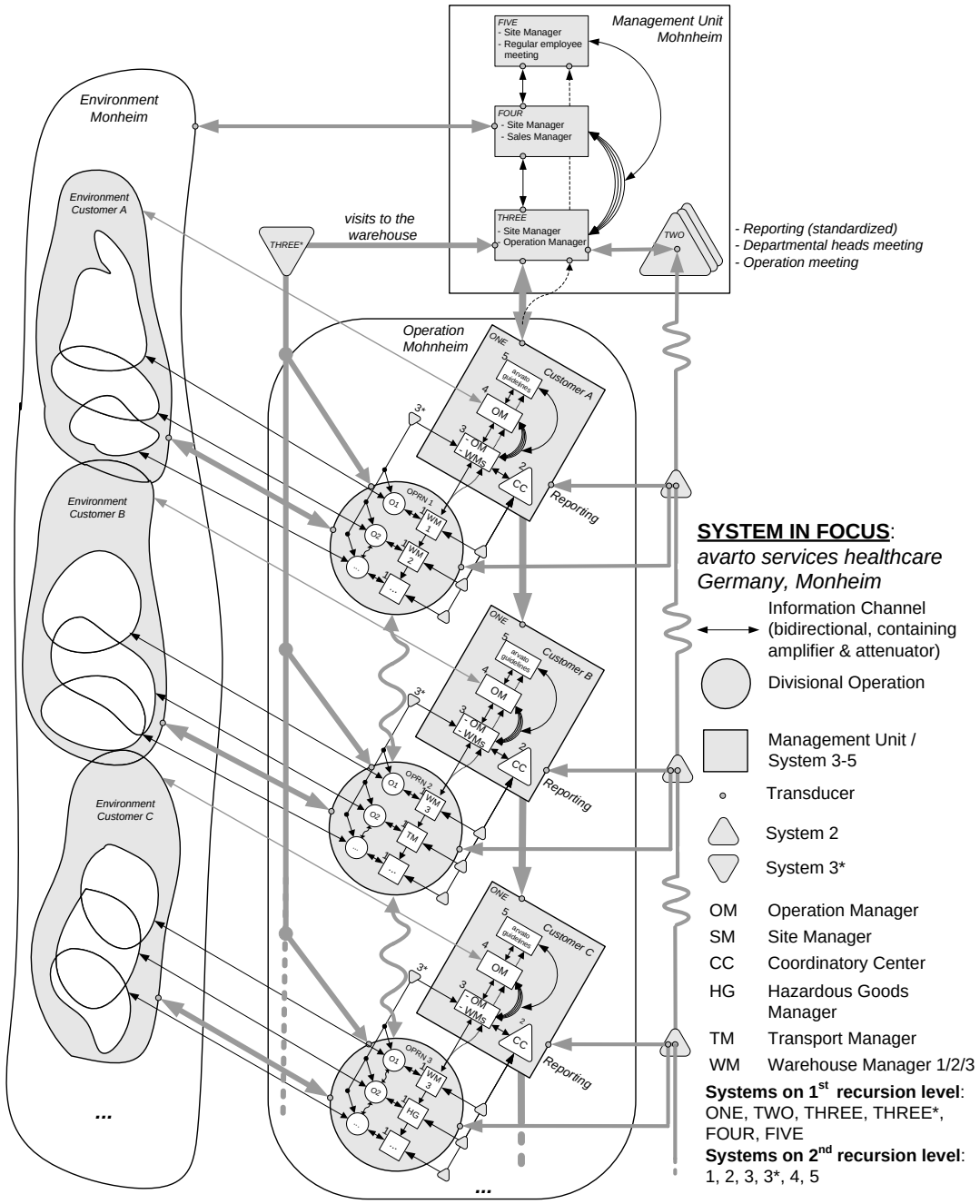


Figure 4.14: The Viable System Model of Arvato Services Healthcare Germany after Intervention (Two Recursion Levels)

a subsequent decrease of transmitted variety for communication tasks and coordination, the site manager was able to spend more working time on the future development of the site (System FOUR) and on the balance between the internal and external eye (System FIVE). Within six months after the intervention, a network of contacts with potential customers

had been set-up, the sales pipeline had been filled and three contracts had been signed (referring to one new customer and two service extensions with existing customers). In addition, based on the market research carried out, the pharmaceutical industry was identified as an interesting future target market. Therefore the application process to obtain a pharmaceutical license for storage and distribution of drugs was initiated to increase the number of possible potential customers to be contacted.

After having set up standardized financial and operational key performance indicators (System TWO / System 2), a comparison of different customers became possible (e. g., in respect to productivity, service levels and profitability). The profit and loss analysis carried out per customer showed an overwhelming dependency on one customer and reemphasized the focus on sales activities to diversify and to balance the dependency between all customers. In addition, Arvato began to monitor the service quality of different carriers for different countries. Goods-in service levels (replenishment time) were documented on a daily basis and analyzed on a weekly basis. Furthermore, the new weekly departmental heads meeting (System TWO) reduced the number of daily interactions, ensured that decisions could be prepared jointly and sped up decision making, since knowledge from different areas is present at the same time in the same room.

An additional consequence of the new reporting has been empowerment. In the past, lower echelons in the hierarchy (e. g., the warehouse managers) were not fully responsible and therefore not fully taking care of daily operations. After having set up standardized key performance indicators (System TWO / System 2, see upper part of Figure 4.13), the warehouse managers now use the daily reports to control their business and to initiate corrective actions respectively (autonomy for System ONE). The site manager now discusses unsolved operational issues only during the operations meeting (System TWO). All in all, the new roles and responsibilities have been accepted and decisional power has been delegated, for instance, for short term resource planning (Management Unit on third recursion level).

However, a subsequent structured interview with the site manager by another researcher, who was not involved in the action research study, conducted more than one year after the organizational changes had been introduced, revealed that the delegation of tasks and the implementation of these changes have been costly and time-consuming: the site manager states that a good portion of project effort was due to discussions with employees after the new job descriptions and the new reporting had been introduced. For instance, the usage of reports and figures had to be learned in concrete situations, which continuously had to be explained to employees. This lead to numerous conversations, and up to an estimated 80% or even more of the total project effort in time. According to this interview, discussion and communication processes were important for the successfull implementation of the changes and the revised organizational structures:[692]

- The revised job descriptions concerned all 46 employees at the site. The new job descriptions were introduced to each employee by the site manager, which took up to 30 minutes per talk. Nearly all of this time was due *to introducing and explaining new terms* which described the revised job. The site manager states that in general people

[692]Interview with site manager in May 2007 (analogously), translated by the author.

understood the revised job descriptions immediately due to their prior industry and working experience.

- The newly introduced operations meeting was originally planned to last 30 minutes a week. In fact meetings took 60 to 90 minutes in the first year after the introduction because the *employees had to learn the meeting's intention*: coordination of their activities.

- It was critical that the warehouse managers accepted the new, adjusted reporting to really control operational activities in order to be empowered. The *joint definition and discussion of reports* for controlling and monitoring business processes was necessary to ensure the latter's acceptance in daily business: the warehouse managers had to see for themselves that the reports were containing the appropriate productivity measures. Operational reports were presented and discussed every week in the operation meeting with warehouse managers in order to get used to the new reporting.

- Revised organizational structures and processes were explained to the employees and implemented by the site manager using *concrete situations and examples*. For instance, differences between urgent and standard situations had to be understood based on instances of actual daily processes. In case a sufficient understanding was not observed by the site manager, actual examples were used to explain differences between urgent and standard situations again. *Again and again, new situations came up which had to be discussed with employees.*

- Completely new situations or problems not experienced before lacked *terms to describe the situation*. The site manager estimates that one year after the first action taking these are about 30-40% of all situations, but he observes are slower growth of new problems with missing terms in the meetings and discussions with employees.

- The site manager estimates that all in all, the learning process for the implementation based on feedback loops – observing the understanding of rules displayed by employees and giving further explanation in case of unintended observed behavior of employees – took up to 80% of the total effort in time of the organizational change so far. *This is compared to up to 20% of effort in time needed for the diagnosis of problems and the specification of new rules.*

Specifying Learning

In order to evaluate an action research study, one major criterion is that the practitioner considers the real world problem facing him or her to be solved or satisfactorily remedied.[693] The action case study certainly satisfies this evaluative criteria. The intervention solved several real world problems.

- On the one hand, the VSM and conceptual modeling, the concept of variety and the law of requisite variety have been successfully combined to diagnose and redesign an

[693] Mårtensson & Lee (2004), p. 219.

existing organization. The VSM helped to structure a given situation, and helped stakeholders and researchers to challenge their previous assumptions regarding the information flow between departments and individuals. Thus everybody was able to see the big picture, and the actual flow of information to and from the functions, and the impact on other systems of the VSM and functions respectively. It highlighted the overload of specific functions and individuals within the departments and allowed to form hypotheses about reasons for problems with regard to the law of requisite variety. The planned actions were designed to address these hypothesized causes and to redesign the sub-systems and information channels. The VSM was no panacea, but provided a language to analyze a given situation in detail and to identify possible bottlenecks within an organization.

- On the other hand, conceptual modeling with the MetaMIS approach helped to analyze and discuss specific information channels in detail. The conceptual models revealed the large number of different, non-standardized concepts in reporting. By counting the diverse number of dimensions and facts represented in the models, the variety transmitted by the reporting information system became visible. To summarize, the methodological combination of VSM and conceptual modeling proved to be extremely meaningful. The described procedure highlighted the overload of specific functions and individuals and allowed the researcher to deduce causes for these problems.

Furthermore in action research, every intervention that the practitioner makes and that follows from the researcher's theory-based diagnosis provides, in the scientific researcher's eyes, an empirical test of a theory. Interventions that yield organizational results that the researcher's theory does not anticipate would provide an opportunity for improving the theory following the researcher's and practitioner's reflections. The theory would be continually improved, following the researcher's reflections, and new interventions would be continually made until the practitioner deems his or her problems to be sufficiently addressed. For the researcher, the product would be a theory that has been improved and that has survived the latest attempts of empirical testing in the field.[694] Regarding the theoretical framework of cybernetic concepts and information systems as language communities, an interesting finding was that empowerment worked out after the new roles defined on the basis of the VSM had been accepted by the corresponding employees. However, the organizational changes due to the new organizational design, such as the new reports, had to be jointly designed and discussed with corresponding employees to achieve this. This had not been expected. The new reporting information system and the specification of the intended organizational design alone were not sufficient (i. e., technical correctness); the employees had to understand its meaning and what actions to take (i. e., social correctness). After the analysis and the specification of new rules and structures by the project team, the organization at Arvato Services Healthcare Germany has been improved primarily by the successful implementation of these rules and the new organizational design based on a feedback learning process of the employees: the organization highly depended on the individual employees willing to or not willing to communicate with each other. According

[694] Mårtensson & Lee (2004), pp. 218 f.

to the site manager, communication of managers and employees has been crucial for the successful implementation.

4.2.4 Discussion & Analysis of Findings

This action research study shows that the VSM and the law of requisite variety are helpful for describing and understanding an organization's information channels with the objective of identifying variety problems. Furthermore, it demonstrates that conceptual modeling is helpful for formally describing and analyzing actions performed in sub-systems and information channels. For instance, MetaMIS was used to analyze the reporting information system regarding its variety. The design of new sub-systems (e. g., empowerment of the lower echelons) and tasks inevitably led to new information channels with new amplifiers and attenuators. For instance, reports typically serve as attenuators and amplifiers, but no report is an attenuator or amplifier per se: what is needed is a *human actor*, since it are acting individuals which understand an operational situation and inform a (superordinated) management system in form of meaningful reports (attenuator), or which use plans codified in reports to carry out operative actions according to directives by a management system (amplifier).

The importance of understanding the *meaning* of new rules for the human actors implementing the changes was also highlighted by the action research study's findings. The correct implementation of the planned changes and new rules relied primarily on (1) *communication* and (2) *correct actions of individual actors*, which implies that these actors interpreted the meaning of the new rules and structure correctly, that is, as has been intended by the site manager as the organizational designer. Accordingly, actors need a correct understanding of a situation in order to carry out correct actions. That is why communication and, in terms of the VSM, the *transducers* come to the focus of attention, for instance, between the site manager and warehouse managers in the joint design and discussion of the new reports.[695] If this transduction is not operating properly or is altering the transmitted variety, the information channel between the two actors is defective. Drawing on the findings of the action research study, this suggests that the *design of transducers* is crucial for organizational design and self-organization, and relies on the ability to translate statements of different actors. This fundamentally restricts the ability to actively balance varieties when designing social systems, as transduction always relies on a correct pragmatic understanding of human actors. For each information channel, a specific situation in a sub-system must be described with necessary detail in the language that is used in this situation. This description must be understandable for both actors that are connected by the information channel. For instance, the reporting information system in the action research study is an example for such an information channel: the warehouse manager as an operational actor (subordinated sub-system) must be able to construct attenuating reports (with less variety) in the language of the site manager (superordinated sub-system). In this case, the warehouse manager needs to understand the languages of both the operational system and the management system. The same applies to amplification: directives in the language of the site manager (superordinated sub-system) need to be translated into the language of the

[695] Beer (1981), pp. 21 ff.; Beer (1979), pp. 101 f.

warehouse manager (subordinated sub-system). Consequently, both actors need to be able *to form correct statements in both languages.* As the action research study shows, actors have to learn this understanding and the meaning of terms and situations in discussions and by practical examples. For instance, the site manager and the warehouse managers discussed newly designed reports. These processes made up to 80% of the total change efforts.

The main findings from this exploratory research can be summarized as follows:

- Organizational design in the action research study had two parts: (1) organizational analysis and diagnosis, resulting in a specification of an intended to-be organizational design, and (2) organizational change, resulting in the implementation of the intended organizational design. The latter proved to be more time-consuming than the first as the meaning of intended rules needed to be communicated and the behavior of organizational actors needed to be changed. Organizational actors could not simply be commanded but needed to be encouraged and controlled in communication-based learning processes.

- A large proportion of the change efforts was due to communication (e. g., explanations, conversations and explaining of new terms). These linguistic actions ensured that the intended meaning was understood and shared by all employees. Accordingly, the organizational change was embedded in language-based communication.

- The site manager controlled the implementation of the organizational changes by giving inputs in form of communication to the employees, observing the actions of employees, and initiating corrective changes. If the site manager did not observe correct actions of employees, for instance, wrong use of reports by warehouse managers, he tried to correct the behavior by discussing the new terms together with employees and by using real work situations.

4.3 Summary of Field Studies & Discussion

4.3.1 Limitations

From a theoretical perspective, the field studies are a building block for knowledge on complexity and organizational design in organizations and information systems. The field studies contributed to organizational design by providing concepts for measuring variety and outlining a measurement method based on conceptual models. If "sound" design of organizations and information systems is among the desired goals, researchers and practitioners may benefit from those insights on how to measure the relationship between variety of elements and complexity. However, the operationalization of variety using conceptual models is just one possible way out of many, and other ways might be meaningful as well.

Qualitative but logical deduction may be used to ensure internal validity, that is, if a relationship between two variables may or may not be causal.[696] In both exploratory field

[696] Lee (1989b), p. 40.

studies, direct observations, collected statements and findings from the conceptual models were compared with concepts from the theoretical framework – the VSM, the law of requisite variety, and the conceptualization of information systems as language communities. The theoretical framework has been challenged with the field studies' data, and its importance for the design of social systems has been shown. However, this was only done to explore the general usefulness of the concepts and not in order to verify or to prove false some theoretical propositions stemming from them. Consequently, the concepts were not operationalized as variables. As such, theory testing was not a goal of these studies and therefore no categorical coding or pattern matching took place.[697] Neither was the generation of new theory the aim, therefore no open or axial coding was conducted as well.[698] With regard to those concepts, this limits the internal validity of the exploratory findings.

4.3.2 Findings

The purpose of the exploratory field studies was to derive learnings from matching the findings to cybernetic concepts (variety, law of requisite variety, VSM) and the conceptualization of information systems as language communities. Table 4.5 summarizes the findings with regard to this intend.

Description of Findings & Suggestions	Field Study FSB	Field Study Arvato
The conceptualization of information systems as language communities proved to be reasonable and thought-provoking. Variety is measurable in time at instance level and in language terms at type level. In social systems, variety manifests itself in the categories and terminologies of language which is used for communication and coordination of individual human actors. For instance, this variety can be seen in the terms used in documentation, conceptual models, or application systems.	✓	✓
The law of requisite variety is important for designing effective and efficient information channels for communication and coordination. The law asserts itself, hence information channels as pairs of amplifiers and attenuators should always be designed with requisite variety in mind.	✓	✓
The VSM helps in order to analyze and diagnose information flows and to identify sub-systems, amplifiers and attenuators. But it gives little help or advise for implementing an to-be organizational design.	✓	✓
Organizational change relies on empractical learning and adaptation of language communities of the individual human members of a social system.	–	✓

Table 4.5: Summary of Field Study Findings

The utility of the law of requisite variety and the VSM for organizational diagnosis became apparent. Both help to identify areas of concerns and possible modes to address

[697] E. g., Miles & Huberman (1994), pp. 170-244.
[698] E. g., Eisenhardt (1989).

those problems in the inter-subjective language of cybernetics. On the other hand, the suggested relation between language and variety was observed in both field studies, as the conceptualization of an information system as a language community helped to identify variety problems in specific sub-systems and information channels. Thus the utility of conceptualizing information systems as language communities has been confirmed as well. However, it also became clear that using such methods for the analysis and diagnosis of organizational phenomena and the specification of an to-be organizational design does not imply any organizational change yet. Instead, the change to a new organizational design relies on the adaptation of individual organizational agents and their individual learning processes. These changes cannot be simply commanded but are slow and time-consuming. Moreover, individual agents might react on (failed) organizational design in an unintended way. In comparison to the simple diagnostic processes, change relies on the understanding and actions of individual human agents of the organization, who can only be guided by the specifications of the organizational designers, but ultimately have to adapt and change their behavior by themselves. In summary, the recipe for successful organizations should be quite straightforward – communicate. This leads to the suggestion that information systems and organizations self-organize by matching their language community to the encountered variety through adaptation of their individual human members' language and speech. The analysis suggests that an effective organizational change process would attempt to strike a balance between variety-seeking (re)construction (i. e., the creation of new categories, terms and codes) and variety-reducing (re)construction (i. e., the consolidation of existing categories, terms and codes). The behavior and language of organizational members changes in response to changes (disturbances) in the environment. Organizations (or, better, their individual organizational agents) have variety, that is, they have a set of categories, terms and codes which they may bring to confront a situation. This behavior seems to be crucial for successful change and implementation of an organizational design.

All in all, this leads to the suggestion that the suitability of an organization or individuals for a task could be evaluated in terms of the variety they possess. Has the organization the variety required to be successful in this task? How fast can the organizational members acquire the necessary, requisite variety? Consequently, very detailed insights into organizational change and organizational learning should be obtainable if enough about the structure of the organization' s language communities and the manner in which those language communities are created is known, and, moreover, if the mechanisms and agents that have the power to bring about changes in those language communities can be identified. This study believes that a language-based approach, which integrates cybernetics and the conceptualization of information systems as language communities, can bring to the study of organizations and organizational change a degree of precision that it has not so far enjoyed. For instance, it would be interesting to examine how, in a given situation, different organizations and different agents will handle and interpret the same phenomenon linguistically, how they will adapt their language community, and what differences in performance and outcome this will create. In order to answer the question of how to measure organizational goodness, this study suggests to start from where traditional methods leave off by focusing attention on how to make the most of the rich language resources that are available within any organizational environment. Based on the theoretical framework, a

theory of self-organization and adaptation and measures for the goodness of organizations with regard to communication and coordination are developed in the next chapter.

5 Language-based Variety Adaptation Theory

The review of the literature and the findings of the exploratory studies lead this thesis to suggest that the combination of three individual strands of theory – cybernetic's concept of self-organization, social systems theory's autopoiesis, and information systems as language communities – might be useful for conceptualizing and theorizing about organizations since they all share the importance of language-based communication and can be leveraged to explain individual agents' behavior regarding adaptation to organizational change. Moreover, these foundations might be useful for providing a measure for the goodness of a specific organization. Therefore, this thesis suggests a theory for explaining organizational change.[699] As regards the research framework introduced in Chapter 2, this chapter belongs to the third role of the researcher. The proposed theory, *language-based variety adaption theory (LAVAT)*, extends the conceptualization of information systems as language communities suggested by HOLTEN and focuses on the interaction between an organization and its environment. Organizations are seen as complex social systems, operating by language and language-based communication of their individual members. LAVAT extends and enhances several areas of organization- and system-related theory, including contingency theory, the perspective of organizations as complex adaptive systems, and social systems theory. LAVAT contains a number of central propositions, stemming from the related work in Chapter 3 and findings from the exploratory field studies of Chapter 4. As such, it is what GREGOR calls a theory for explaining and predicting.[700] The verbal description of LAVAT in this chapter provides all the necessary components of a theory as summarized in Table 5.1 and depicts LAVAT as a process theory.[701]

Chapter 5.1 summarizes the underlying assumptions and axioms of LAVAT. The main logic of LAVAT is represented by a link between patterns and causes of language-based adaptation (Chapter 5.2), types of language-based adaptation (Chapter 5.3), direct effects of language-based adaptation (Chapter 5.4), and organizational outcomes of language-based adaptation (Chapter 5.5). Chapter 5.6 discusses the impact of conceptual modeling on theses processes and Chapter 5.7 summarizes and concludes this section.

[699] In this, the thesis follows the call by Grover et al. (2008) for forward looking theory in information systems research.

[700] Gregor (2006), pp. 626-630. With respect to the remarks in Chapter 2 about the concept of causality, *prediction* refers to the ability to forecast the outcome or occurrence of general patterns, not the appearance of specific and precise outcomes or events.

[701] A process theory attempts to explain the occurrence of an outcome by identifying the sequence of events preceding it, see Markus & Robey (1988), pp. 589-592; Mohr (1982), p. 73. In contrast to a variance theory, necessary conditions alone cannot be considered the cause of an outcome, however, they can comprise a satisfactory causal explanation when they are combined in a process. Consequently, outcomes may be predictable from knowing the process, not from knowing variables. This argument is in line with the philosophical position presented in Chapter 2. Process theories recognize the complexity of causal relationships and are more suited for describing observable patterns. See Markus & Robey (1988), pp. 591, 593.

Theory Component	Definition
Means of representation	The theory must be represented physically in some way: in words, mathematical terms, symbolic logic, diagrams, tables or graphically. Additional aids for representation could include pictures, models, or prototype systems.
Constructs	These refer to the phenomena of interest in the theory. All of the primary constructs in the theory should be well defined. Many different types of constructs are possible, for example, observational (real) terms, theoretical (nominal) terms and collective terms.
Statements of relationship	These show relationships among the constructs. Again, these may be of many types: associative, compositional, unidirectional, bidirectional, conditional, or causal. The nature of relationship specified depends on the purpose of the theory. Very simple relationships can be specified: for example, "x is a member of class A."
Scope	The scope is specified by the degree of generality of the statements of the relationships (signified by modal qualifiers such as "some", "many", "all", and "never") and statements of boundaries showing the limits of gerneralizations.
Causal explanations	The theory gives statements of relationships among phenomena that show – both linear or non-linear – causal reasoning, not covering law or probabilistic reasoning alone (see the critique of the cause-effect model in Chapter 2).
Testable propositions (hypotheses)	Statements of relationships between constructs are stated in such a form that they can be tested empirically.
Prescriptive statements	Statements in the theory specify how people can accomplish something in practice (e. g., construct an artifact or develop a strategy).

Source: adopted from Gregor (2006), p. 620

Table 5.1: Structural Components of a Theory

5.1 Assumptions & Axioms

This study sees adaptive behavior as identical with the behavior of a system in stable equilibrium.[702] The variables of a system are in a dynamic, but stable equilibrium if, when they are disturbed, reactive forces are set up which act back on the variable so as to *oppose* the initial disturbance and preserve homeostasis. If they go with the disturbance then the variables are in unstable equilibrium.[703] That is, homeostasis and equilibrium of a system must be achieved through interaction with the environment. For achieving this, LAVAT is based on three premises: (1) organizations as social systems, (2) necessity of the law of requisite variety, and (3) adaptation of social systems through language. This leads to the following axioms:

1. Basically, an information system forms the communication structure of an organization. But since the information system and the organization it is embedded in cannot be

[702] Ashby (1940), p. 483. See Chapter 3.1.1.
[703] Ashby (1940), p. 479.

separated from each other, in the following, "information system" and "organization" denote the same type of social system.

2. Information systems and organizations are social systems in the sense of social systems theory. Following the first axiom, the conceptualization of information systems as language communities can be transferred to all kinds of organizations (e. g., companies or projects).

3. It has been well documented that the ability to establish a joint attention frame is an important prerequisite for human communication.[704] A joint attention frame is only possible when agents share motives and communicative goals and find themselves in the same (physical) situation in which they can establish joint attention to the same objects or aspects of the situation. This study assumes these prerequisites on the interaction between agents and members of an organization. If not, this will hinder establishment of a joint attention frame.

5.2 Causes of Language-based Adaptation

Following Ashby, "organization" in social systems is the communication between two or more individual agents for coordinating their activities, for instance, their tasks and functions within a company or project. In this sense, a "good" organization must be a self-organizing system. Accordingly, the concrete mechanisms of self-organization in social systems need to be explained, and a measure which yields a degree of self-organization for a given organization must be found, that is, how self-organizing this organization really is. The basic idea of LAVAT is that an organization as a language community is comprised of individual agents and can be viewed as a complex adaptive system which collectively solves the problem of developing a shared organization-specific meaning, understanding, and language. In order to do so, the organization as a language community must reach both levels of agreement on language terms at the schema level: (1) a repertoire of symbols or words and (2) a repertoire of meanings.[705]

What drives language adaptation? Influences on the organization from the environment take the form, not of inputs, but of disturbances that, because they upset the balance of the established stasis of the organization, have to be compensated for, in order that the organization continues to maintain its identity and its autonomy.[706] As a first condition, the criteria that has to be met by any organization in order to maintain homeostasis is that of requisite variety: the organization's individual agents constantly have to match their internal variety to the environment's external variety; thus the law of requisite variety is most important for the design of organizations.[707] As a first consequence of this, how "good" an organization really is depends on how "good" and how fast respectively its agents establish requisite variety.[708]

[704] E. g., Tomasello (1995).
[705] See Chapter 3.7.3.
[706] Taylor (1995), p. 8.
[707] See Chapter 3.3.2.
[708] See Chapter 3.3.2 and remarks by Boisot & MacMillan (2004) on the time dimension of requisite variety.

- First, an increase in the environment's *variety* means an increase in the number of stimuli on the organization as a social system, that is, new and previously not encountered states and connections between states for the organization's agents. For instance, a company faced by the entrance of a new and powerful competitor in its core market has to expect completely new situations and states. Similarly, the introduction of a new application system in an organization causes perturbations, and new situations and states.

- Second, the existence of a higher number of stimuli should lead to an increase in equivocality or ambiguity respectively for the organization's agents. *Ambiguity* means the existence of multiple and conflicting interpretations about an organizational situation, the multiplicity of meanings conveyed by information about organizational activities (i. e., the meaning of a message is unclear).[709] That is, the higher number of stimuli gives rise to higher ambiguity, implying that both the existence and the meaning of a state or variable describing a situation are unclear or possibly even unknown for the agents.[710] For instance, when a new application system is introduced, individual agents in the organization have to cope with these new situations and states. The new application system introduces new categories, terms and processes, that is, a higher and different number of stimuli than experienced by the agents before. Different agents will at first ascribe different meanings and terms to the same states, or the same meaning and states to different terms in their sense-making processes. For instance, one employee might attribute the name of the new application system to a new and previously unknown business process (e. g., "the order management system process") while another employee might call this business process totally different (e. g., "the job processing") and a third employee might not even be aware of it.

- In parallel, higher variety should also lead to a direct increase in uncertainty for the organization's agents. *Uncertainty* means the difference between the amount of information required to perform a task and the amount of information already possessed by an agent (i. e., the meaning of a message is clear, but the amount of information in a message is not sufficient).[711] That is, the higher number of stimuli gives rise to higher uncertainty, meaning that the existence of a state or variable describing a situation is known and its meaning is clear, but its value is unknown.[712] For instance, individual agents have to *know* the meaning of functions and terms in a new application system before they can start to collect information about the value of these variables (e. g., they have to know that the terms "order management" and "job processing" describe the same states and are different from the state described by the term "asset management"). What this also implies is that before uncertainty

[709] E. g., Weick (1979); Daft & Macintosh (1981), p. 211. See Chapter 3.4.1.
[710] Ambiguity is closely related to entropy 3. See Boisot & Canals (2004), p. 63, and Chapter 3.2.2.
[711] E. g., Galbraith (1977), p. 38. See Chapter 3.4.1.
[712] Uncertainty is closely related to entropy 1 and entropy 2. See Boisot & Canals (2004), p. 63, and Chapter 3.2.2.

can be reduced, ambiguity must always be reduced and individual agents have to be knowledgeable.[713]

As a second condition, variety in social systems is directly linked to language and language-based communication: the number of linguistic *terms* that are used by an observer to describe the organization of a social system or its environment is an approximation of the actual variety of this organization or environment from the point of view of the observer. Therefore this study suggests that changes in the environment's external variety must be matched by changes in the *terminology* and communication patterns of the organizational agents' *language communities*. This implies that dealing with ambiguity and uncertainty, both caused by higher environmental variety, should also be related to language-based communication in the case of organizational agents.

5.3 Types of Language-based Adaptation

In line with the previous argumentation, the feedback loop mechanism responsible for self-organization in social systems can only operate by or through language, that is, via language-based communication needed for the coordination of two or more individual agents within the organization. For instance, the organization's individual agents faced by an information systems development project for a new application system have to learn the project's and the application system's domain-specific knowledge by using specific terminology in order to really understand each other. Understanding the meaning of terms – *Verstehen* in the hermeneutic sense[714] – requires individual agents to be part of the information system development project's language community. Following the conceptualization of information systems as language communities, Figure 5.1 illustrates an organization which is conceptualized as a language community.

An *organization as a language community* consists of actual, meaningful *terminological discourse* φ (usage of language and operation of the language community) on the discourse level; the schema level consists of a terminology T (a set of symbols with a shared assigned meaning).[715] The operation of *(re)construction* κ assigns symbols to meanings (generation of language terms and change and maintenance of the language community) and should create or change this terminology and the language community possessing this terminology accordingly, reacting on perturbations and new situations from outside the language community which are external to the organization. This results in a series of terminology modifications on the schema level. Therefore an organization is a closed system at *discourse level*, but an open system at *schema level*. For instance, members of the same organization will share to some degree the meaning of the terms used in an important application system. However, not just one terminology should exist within an organization at any given time, but several (sub-)language communities. An organization may consist of several sub-systems as illustrated in Figure 5.1, each with its own (sub-)language community and terminology. For instance, the IT department (LC_1) will have a different terminology and language

[713] In a similar manner, Taleb (2007) distinguishes between "*known unknown*" – a notion that resembles uncertainty – and "*unknown unknown*" – which is related to what is here called ambiguity.

[714] E. g., Butler (1998); Myers (2004), p. 107.

[715] See Chapter 3.7.3 and Holten (2007) in the following.

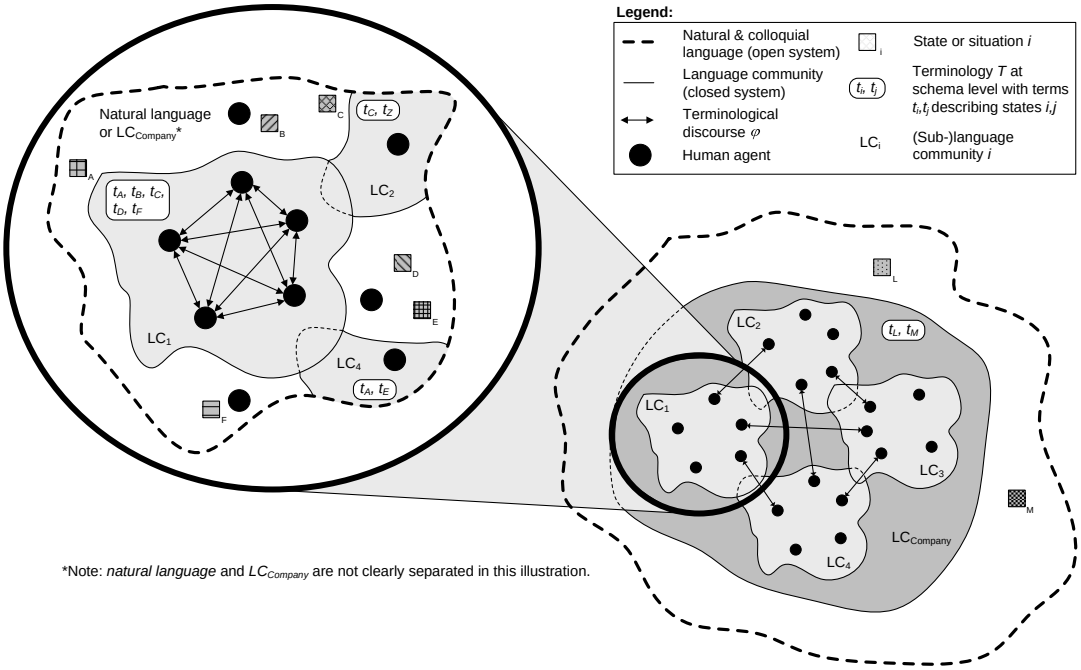


Figure 5.1: Organization as a Language Community

than the accounting department (LC_2), but both will share a terminology common to the company as a whole ($LC_{Company}$). Language communities are thus dynamic and not static systems of symbols, but a practice that evolves over time. Because organizations are composed of distinct communities of practice, any large organization may have multiple coexisting (sub-)language communities, each associated with a field of activity. Hence, there will be not one single language community but rather the interplay of various idiosyncratic systems.[716] This leads to the following propositions.

Proposition 1 (P1): *For every organization, at least one* terminology T *(but possibly more) should exist, directly related to an identifiable set of people (agents) belonging to the language community possessing this terminology.*

Proposition 2 (P2): *For every organization,* terminological discourse φ *among agents of a (sub-)language community should be observable.*

Proposition 3 (P3): *For every organization, traces of developing or revising terminologies by* (re)construction κ *among its agents should be identifiable.*

These propositions are directly inferred from the previous suggestions made by Holten and have also been observed in the exploratory field studies.[717] Moreover, this suggests to examine how well the individual agents of an organization understand each other (so-called *language community quality*) – how efficient and how effective performs their

[716] Taylor & Robichaud (2004), pp. 408-409.
[717] See Holten (2007) and Chapter 3.7.3; Chapter 4.2.

language community? – as a first tentative measure for organizational goodness with regard to communication and coordination. But how can a shared understanding, a language community, among an organization's agents be identified? As noted in Chapter 3.2.1, it may be hard to measure the success of communication on the semantic level, that is, whether knowledge and meaning have been successfully communicated and shared. Besides, this measure cannot be sufficient for determining the goodness of an organization with regard to communication and coordination because it does not take into account the adaptation of the language community and requisite variety.

5.4 Direct Effects of Language-based Adaptation

In organizations as social systems, control and adaptation of the system should take place via language and speech: the schema level is adapted by (re)construction via the discourse level. Consequently, the control and "correctness" of an organization as a social system depends on two factors: (1) linguistic messages are understood correctly (semantic level, i. e., communication works without misunderstandings and the intended meaning is correctly understood by all members of the language community; ambiguity is low), and (2) actions are carried out correctly (pragmatic level, i. e., all members know what they are doing and how to do things; uncertainty is low). An adaptation of the organization's language can only work through *empractical learning* as part of this (re)construction process, that is, experiencing in concrete situations (pragmatics) what the meaning of a term really is (semantics).

First, if the basic conditions in the environment change, new and previously unknown situations and states affect the organization, which should result in higher variety and higher ambiguity. The individual organizational agents have somehow to decide how to react on these perturbations. If necessary, higher variety and higher ambiguity will lead to the usage of new symbols and words in natural, colloquial language to describe the new situations and states in order to be more *effective*, that is, to have more concepts and new categories in order to react to the higher variety of the environment (behavioral route and amplification, increase in internal variety and variety of responses respectively by discourse in natural, colloquial language).[718] If individual agents decide to react on a perturbation, then this should lead to the following conditions which may exist in parallel, each for a different set of agents and of a situation:

1. The situation is *interpreted differently* by individual agents and consequently given different meanings, depending on the individual agents' pre-knowledge and context-situativeness, and is also described by *different symbols* or words.

2. The situation is *interpreted equally* by individual agents and consequently given similar meanings, and is also described by *similar symbols* or words.

3. The situation is *interpreted differently* and given different meanings by individual agents, but could be described by *similar symbols* or words (e. g., homonyms).

[718] See Boisot & Canals (2004), pp. 516 ff., and Chapter 3.3.2.

4. The situation is *interpreted equally* by individual agents and consequently given similar meanings, but could be described by *different symbols* or words (e. g., synonyms).

At first, discourse in natural, colloquial language results in these conditions. This therefore leads to an increase of ambiguity and uncertainty. However, as the individual agents in the different communities of practice begin to use new symbols in discourse in natural, colloquial language, they begin to negotiate the meanings of the symbols and engage into (re)construction. This should subsequently result in the existence of multiple, possibly conflicting (sub-)language communities and (sub-)terminolgies respectively for the different sub-systems and communities of practice. This is illustrated in Figure 5.2 in the case of the (sub-)language communities LC_I and LC_{III}.

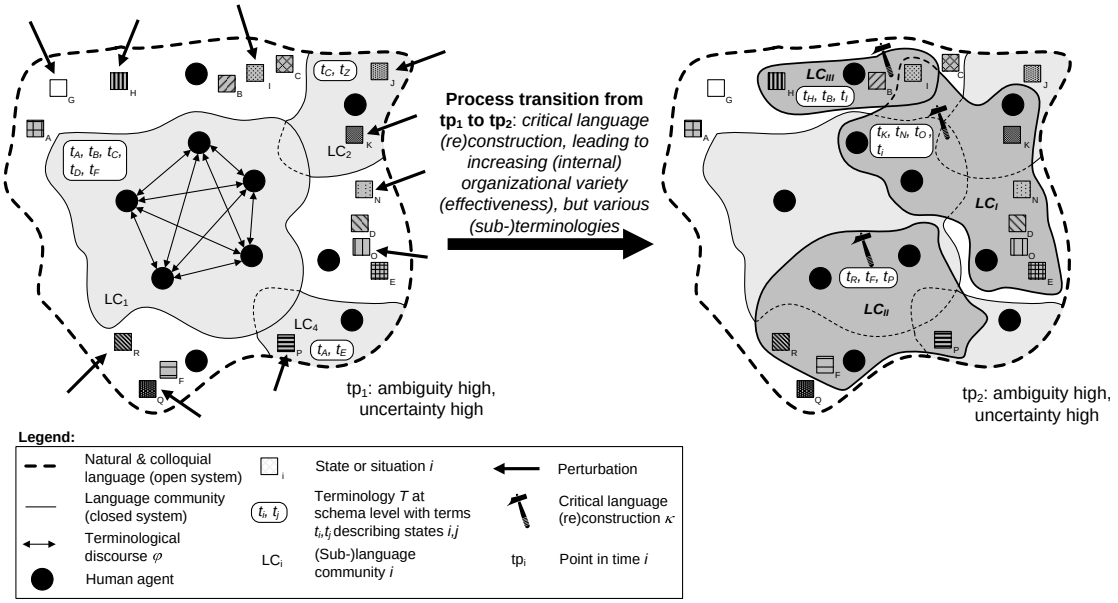


Figure 5.2: Effects of Language-Based Adaptation (I)

For instance, LC_I and LC_{III} might be composed of members of both the accounting department (LC_1) and the IT department (LC_2) who frequently collaborate as co-workers in specific projects or work groups. Individual agents in both LC_I and LC_{III} become aware of the new state I; agents in both (sub-)language communities decide that it is necessary to react on this perturbation by (re)construction. However, the agents of LC_I finally agree to use term t_i while the agents of LC_{III} agree to use term t_I. For instance, members of the first work group (LC_I) might call a new application system by its vendor name (e. g., "SAP CO") while members of the second work group (LC_{III}) use a description of its function (e. g., "the controlling system"). Therefore ambiguity will necessarily be high overall for the whole organization, either because the individual agents still have to rely on natural, colloquial language or because they use different (sub-)terminologies. Although this process will initially increase ambiguity and uncertainty, the new situations and new states which result from changes in the environment need new symbols and terms describing these states so that the organizational agents can establish requisite variety, hence the following proposition.

Proposition 4 (P4): *"Good" organizations, that is, organizations that are self-organizing, achieve adaptation of their language community in case of rising environmental variety; their agents increase internal variety by adaptation of their terminologies and construction of new terms, leading to (at first) sub-language communities.*

Second, if requisite variety is related to the least-effort scale-free theory, which leads to efficient use of language words, then it does not pay to know more words than used in talking or are understandable.[719] Following the least-effort theorem, it is neither advantageous in discourse to use only natural, colloquial language nor to have too many conflicting (sub-)language communities.[720] In comparison, a shared terminology of a language community with a smaller amount of terms as both (1) natural, colloquial language or (2) multiple conflicting (sub-)language communities should allow for more *efficient* communication and action respectively because the meaning of terms does not have to be defined repeatedly.[721] For instance, in order to communicate the information they have to other employees quickly and accurately, agents have to develop precise codes. This also implies that ambiguity is lowered. Consequently, this should lead to the standardization of terms and consolidation of (sub-)language communities overall for the whole organization through the creation of a shared language community (cognitive route and attenuation, decrease in external variety and variety of stimuli respectively by codification and abstraction).[722] This is illustrated in Figure 5.3.

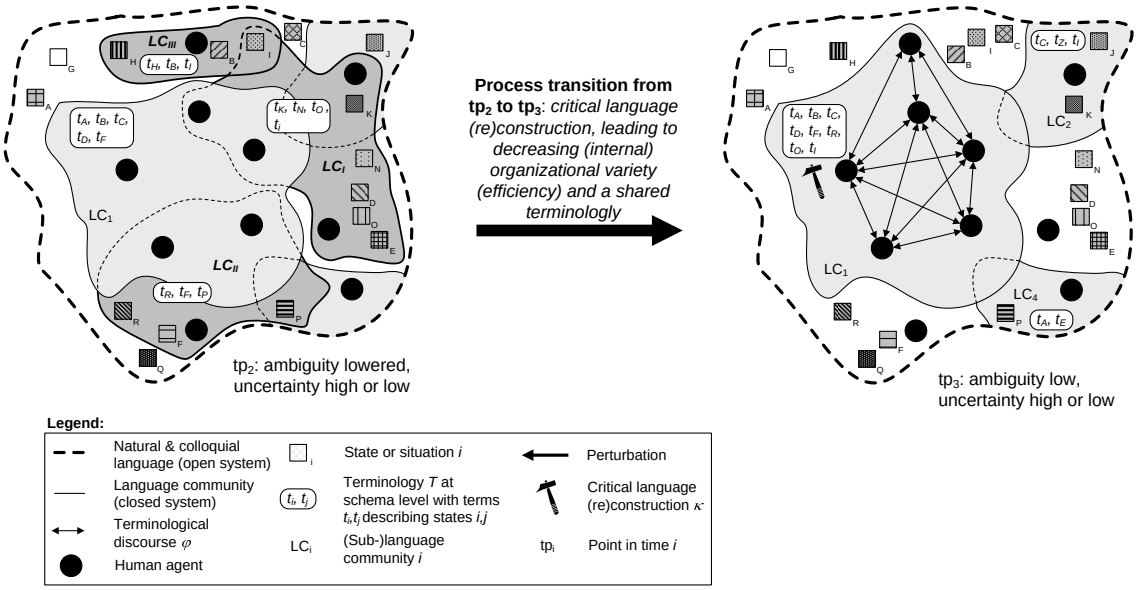


Figure 5.3: Effects of Language-Based Adaptation (II)

[719] Benbya & McKelvey (2006), p. 293; Chapter 3.4.4. See Zipf (1949) for the original least-effort theorem.

[720] Following Lehrberger (1986), pp. 20 f., it can be argued that every sub-language (sub-terminology) is a part of natural language and that every sub-language discourse usually contains some material that does not belong to the sub-language proper.

[721] See Nikolopoulos & Holten (2007) for theoretical cost functions that arise from this understanding.

[722] See Boisot & Canals (2004), pp. 516 f., and Chapter 3.3.2; Boisot (2006).

For instance, members of the IT department (LC_1) that are also members of the work groups (LC_I, LC_{II}, LC_{III}) might negotiate an agreement on the symbols and meanings of the new states for LC_1. The number of members might be enlarged during this (re)construction process (e. g., by integrating experts from other (sub-)language communities). For instance, LC_1 might agree to adopt the term t_I instead of t_i with a shared meaning for state I. If a shared terminology and language community instead of only natural, colloquial language or multiple, conflicting (sub-)language communities exist among agents of an organization, then the meaning of terms describing the states of the environment or organization respectively is believed to be certain by all agents for the whole organization, and ambiguity has been reduced. Afterwards, the variety or number of stimuli that needs to be reacted to by the organizational agents, that is, the number of states of the environment that are perceived as interesting for the organization by those agents, is greatly reduced to a smaller number of states, described by the terms of the terminology; all other states are simply ignored: one can only react to situations for which one has a word or description. Taking these arguments into account leads directly to the next proposition.

Proposition 5 (P5): *"Good" organizations, that is, organizations that are self-organizing, achieve adaptation of their language community in case of rising internal variety; their agents decrease internal variety by reducing the overall number of terms and (sub-)language communities by creating a shared terminology and language community.*

The creation of a shared language community influences the semantic and pragmatic levels: by having agreement on the meaning of terms, ambiguity and uncertainty within the organization should be reduced by each mutual agreement until *entropy of zero is reached*. That is, the meaning of terms which describe a state or situation is unambiguous for all agents, and a situation and its implications is understood in its totality.[723] Every organization thus has an informational entropy which carries it towards a more probable state, and managers and organizational designers need to arrange the processes of language-based adaptation so that the most probable state is the desired state.[724] Moreover, all mechanisms described in Chapter 3.4.1 as suitable for equivocality reduction (e. g., rich, personal media) are in fact mostly facilitators for engaging into language-based discourse and communication. Only if this has been achieved, it is reasonable to start employing mechanisms for reducing uncertainty faster, for instance, IT-based decision support systems or other application systems that allow to transmit and process data faster (i. e., information that is now unambiguous).

5.5 Organizational Outcomes of Language-based Adaptation

As argued before, organizational change cannot be commanded.[725] For instance, a newly introduced standard application system has a specific, fixed terminology. As no manager or organizational designer as an observer will ever be in a position to decree the use of

[723] Here, entropy is understood in the sense of entropy 3 at the semantic and pragmatic level. See Boisot & Canals (2004), p. 63, and Chapter 3.2.2.
[724] Beer (1965), p. 230.
[725] See Chapter 3.4.3 and Chapter 3.5.

this final terminology to the social system, an organization as a language community is a self-organizing system in the sense described in Chapter 3.5, and control of a self-organizing, complex system is disseminated strictly throughout this system itself. Then an organization as a self-organizing social system should be the better *the faster it reaches informational entropy of zero*, that is, (1) the faster an organization creates and adapts a shared terminology to external perturbations from the outside environment (higher variety) in order to cut down ambiguity, and (2) the faster it lowers uncertainty once ambiguity has been reduced. For instance, the faster IT department and accounting department have an agreement and shared understanding on the new application system, the faster future decisions will be taken. Since it is assumed that reduction of ambiguity is a prerequisite for reduction of uncertainty, then the faster an organization adapts its terminology (or sub-terminolgies) in order to react to new environmental states, higher variety, and higher ambiguity, the faster it will be able to decrease uncertainty, and the more "self-organizing" it will be. As a result, a measure for the goodness or quality of an organization as a social system should be *the speed at which the individual agents adapt their language community.* The adaptation of the agents' language (first creating new terms, then reducing and standardizing existing terms) means an adaptation of the organization's internal variety to the environment's external variety. The construction of new terms means to increase internal variety; the consolidation of new and existing terms and the creation and adaptation of a language community means to decrease internal variety. This suggestion for a measure gives rise to the following propositon.

Proposition 6 (P6): *Organizations with a high level of success in coordination by communication and a higher goodness achieve adaptation of a shared language community and common terminology faster then organizations with a lower level of success and lower goodness.*

This leads back to the first proposed measure – language community quality – and the question of how a shared understanding, a language community, among an organization's agents can be identified. As already seen in the case of conceptual models as marks in the exploratory studies in Chapter 4.1, one potential instrument to access agents' "thought worlds", other than through personal interviews, may be through their written documentation, such as conceptual models, reports, memos, or correspondence. One purpose of documentation is to establish and share a *set of marks*, a set of coherent, shared ideas about concepts. Then organizational documentation, authored individually or collectively, is a written expression of the shared understanding of the organization as a language community. Therefore, this joint expression of the language community should capture the shared understanding or yield an impression of how coherent or incoherent the mutual understanding really is, that is, how much ambiguity still exists. Coherence is understood as a degree of semantic similarity, an establishment of semantic connections between concepts.[726] This gives rise to the proposition that coherent organizational documentation should be linked to "good" organizations, and that more successful organizations will establish this coherence faster. Consequently, language community quality can be understood in the sense of coherence.

[726]See Dong, Hill & Agogino (2004), p. 378; Dong (2005), p. 447.

Proposition 7 (P7): *Organizations with higher quality of product and process show a higher degree of semantic similarity and achieve this degree faster than organizations with lower quality of product and process.*

In summary, this suggests that language (and the meaning of words) and how communication is structured over time should account for transforming representations of the perceived situations and states from individual "object worlds" to a "shared world". A primary mechanism for this is language-based communication. Consequently, studying organizational communication by a reliable, transparent, and scalable analysis method could be described as "taking a pulse" of the state of the organization.[727] Thus organizations with coherent communication at a specific point in time are more likely to have better outcomes and higher quality than organizations with incoherent communication.[728] This does not mean that it is better for organizational members to be homogeneous culturally or characteristically, but that it is better with regard to communication and coordination if they understand each other better and faster. Shared understanding does not necessarily imply shared opinions, ideas and world views.

5.6 The Impact of Conceptual Modeling on Language-based Adaptation

The last proposition introduced gives also rise to a number of other theoretical implications. Information systems research offers a broad body of knowledge and ideas for supporting the methodological structuring and specification of problem domains during the information systems development process.[729] In this context, conceptual models are an important element of methods for the development of information systems.[730] For instance, in business process modeling, a process model is typically a graphical depiction of the activities, events/states and control flow logic.[731] In practice, conceptual models are often used for several purposes, for instance, to support the development, acquisition, adoption, standardization and integration of information systems.[732] In order to develop and to control high quality application systems, business requirements need to be identified and modeled from a business perspective. Afterwards, an application system can subsequently be implemented according to these specifications.

Ryan argues that mere understanding of the syntax or even the specific semantics of a specialized modeling language or grammar is not the most crucial factor in information systems development; of far greater significance are the unstated assumptions that reflect the shared ("common sense") knowledge of people familiar with the social, business and technical contexts within which the proposed system will operate.[733] If the stakeholders

[727] Dong (2005), pp. 447-453.
[728] A positive correlation between semantic similarity and team performance has been shown in studies of simulated military missions and studies of design teams. See Dong, Hill & Agogino (2004); Martin & Foltz (2004); Dong (2005).
[729] E. g., Hirschheim, Klein & Lyytinen (1995).
[730] E. g., Kottemann & Konsynski (1984); Karimi (1988).
[731] E. g., Curtis, Kellner & Over (1992); Davies et al. (2006).
[732] E. g., Maier (1999).
[733] Ryan (1993), p. 240.

involved from both business and IT staff can work collaboratively on information systems specifications using the same conceptual modeling method for communication, it is a reasonable assumption that the requirements engineering of application systems can be simplified.[734] For instance, empirical studies in the financial services industry have shown that in the presence of up-to-date process documentation, the link between shared knowledge and cognition is weaker than it is when the level of documentation is low: while good process documentation enhances the client organization's outsourcing readiness by fostering knowledge transferability, tacit knowledge is also important for IT provider flexibility even in cases where a comprehensive and up-to-date documentation is available.[735]

As shown in Chapter 4.1, conceptual models can be used as a formalized way of stating the inter-subjective consensus of a language community. Conceptual models should provide a starting point for communication as the written expression of the shared understanding of the language community that is part of every organization according to LAVAT. However, just "looking" at conceptual models designed by others should not be as effective as jointly designing conceptual models in order to structure a situation and create a shared understanding. Following LAVAT, an organization coexists with an environment. The complexity of the environment evolves (in part through the impact of the organization), in turn requiring the organization to evolve. The lesson is that design should be thought of as ongoing process, not a predictive or contingent one, and that the current develop-from-scratch techniques that dominate development thinking in information systems research must eventually give way to techniques that emphasize construction from reusable building blocks.[736] In the long term, methodical systems will always disappoint as they do not allow internal variety to evolve with the environment. Organizational change by means of communication and not of command (as is the implicit assumption of the usual reengineering projects) should be a slow process; irritations generated by managers or organizational designers towards the organization have to change the organization's agents and the shared mental models in a way that self-organizing energies are released.[737] Therefore, this thesis suggests the following propositions.

Proposition 8 (P8): *The joint conceptual modeling and discussion of actual situations helps to build a language community faster, that is, if actors discuss together and create conceptual models and specifications in their discussions, a language community is created better (i. e., more coherent) and faster.*

Proposition 9 (P9): *Only "looking" at conceptual models or specifications created by another person does not lead to the creation of a language community that is as good as the joint creation and discussion of conceptual models.*

Proposition 10 (P10): *The concrete instance of modeling language used is not important, as long as the language community is created better (i. e., more coherent) and faster.*

[734] Gemino & Wand (2004), p. 80.
[735] Martin, Wagner & Beimborn (2008), p. 14.
[736] Lycett & Paul (1999), pp. 132-134.
[737] Schuhmann (2004), p. 616.

5.7 Discussion & Implications

Table 5.2 summarizes the main constructs and Figure 5.4 summarizes the process of LAVAT. The model suggests that the speed of adaptation of the language community is an important pattern for measuring the "goodness" of self-organization and hence the quality of an organization with regard to communication and coordination. LAVAT theoretically explains human agents' characteristics in organizations with regard to self-organization capacity and language. Meaning is understood to be not just in the mind, in the way people think, it is rather manifested in the way people act. The basis of thinking is terms and concepts, which are expressed in words which derive their meaning from the way they are used in daily life; rather than looking for abstract representations of meaning in the mind, from a discursive point of view one looks for patterns in the use of terms and words.[738] From this point of view, organizational change is the process of constructing and sharing new meanings and interpretations of organizational activities through language. In that sense change must not be thought of as a property of organization; rather organization must be understood as a property of change – the attempt so simplify and stabilize a dynamic experience of change.[739] When an organization changes as a result of environmental disturbance it is the structuring of the relationships of the agents that is undergoing evolution.[740] What this suggests is that disturbances are not a sometimes, exceptional circumstance leading to crisis, but *a necessary condition for the maintenance of organization*: it is disturbances that permit the organization to display its variety, and thus sustain its viability, at least until the disturbance becomes so great that the organization's agents have no possible behavior or do not establish new behaviors in their repertoire that are viable.[741]

This suggests that most of the complexity encountered in organizations should be controlled by the dynamic process described by LAVAT. To be successful and viable in the long run, an organization must exhibit a level of shared understanding of the organizational domain. For instance, incompatible viewpoints among organizational members and failure to negotiate different perspectives and specialties in forming a language community may result in a breakdown of shared understanding, ineffective communication, and hampered coordination and collaboration. If an organization or information system is conceptualized as a social system, control and adaptation of the system can only work through language, that is, adaptation of the schema level by predication at discourse level. The findings of the action case at FSB Germany are directly compatible with LAVAT: too many terms in the terminology of IT controlling to be efficient, resulting in an inefficient information channel.[742] The action research study at Arvato Services Healthcare Germany showed the importance of empractical learning and (re)construction for understanding the meaning of terms and organizational change.[743] Both studies have shown that variety and language indeed are closely connected in social systems, and that the consequences of the law of requisite variety are important for organizational design.

[738] Tsoukas (2005), p. 98.
[739] E. g., Tsoukas & Chia (2002).
[740] Taylor (1995), pp. 10 f.
[741] Taylor (1995), p. 24.
[742] See Chapter 4.1.
[743] See Chapter 4.2.

Construct	Description
Variety	The number of possible states (a) of the environment or (b) of a system, as perceived by an observer of the environment or system.
Ambiguity	The existence of multiple and conflicting interpretations of information about the states of a system; the multiplicity of meanings conveyed by information about a system's states.
Uncertainty	The difference between the amount of information required to perform a task and the amount of information already possessed by an agent.
Agent / Actor	Individual (human) member of a system who is responsible for a specific task or function. Every agent is also an observer of the system of which she or he is a member.
Concept (meaning)	A concept denotes the perceived meaning a state or variable has for an observer (semantic convention). Concepts are not directly observable outside the "mental world" of agents.
Symbol	A symbol is a sound image (audible) or mark (visuable) which can be perceived by an agent (syntactical convention).
Term (sign)	A term is is a union of a concept and a symbol perceived by an agent. Given a term, a concept is the meaning of the term and a symbol is its representation (semantic and pragmatic convention).
Language community	Agents that are members of a language community share the knowledge and mutually understand the same meaning of terms that form the terminology (domain-specific language) of a language community.
Terminology, language as schema	Language in the sense of schema; terms found a language and thus a schema. An organization as a language community is an open system at schema level.
Language as discourse	Language in the sense of linguistic action; actualized usage of terms. An organization as a language community is a closed system at discourse level.
(Re)construction	A new term is introduced by explicit agreement with respect to its usage and meaning by agents that are members of the same language community. This agreement leads to a relation of concept and term and is shared by a language community as the knowledge of using this term.
Colloquial discourse	Usage of terms of natural, colloquial languages (e. g., ordinary English and German) in discourse (behavioral route to requisite variety).
Terminological discourse	Usage of terms of a terminology (e. g., project or company-specific terms) in discourse (cognitive route to requisite variety).
Empractical learning	To align meanings of terms in language communities, living and acting together is required. This is called empractical learning and is thus a part of the (re)construction process.

Table 5.2: Main Constructs and Concepts of LAVAT

The (re)construction of a language community and the making of a consensus in meaning respectively eliminates ambiguity through each defined term and uncertainty through each decision made respectively until entropy of zero is achieved. A language community and a terminology respectively with a lower number of terms than colloquial language ensures more efficient speech, actions and decision-making. Variety (i. e., the number of states of

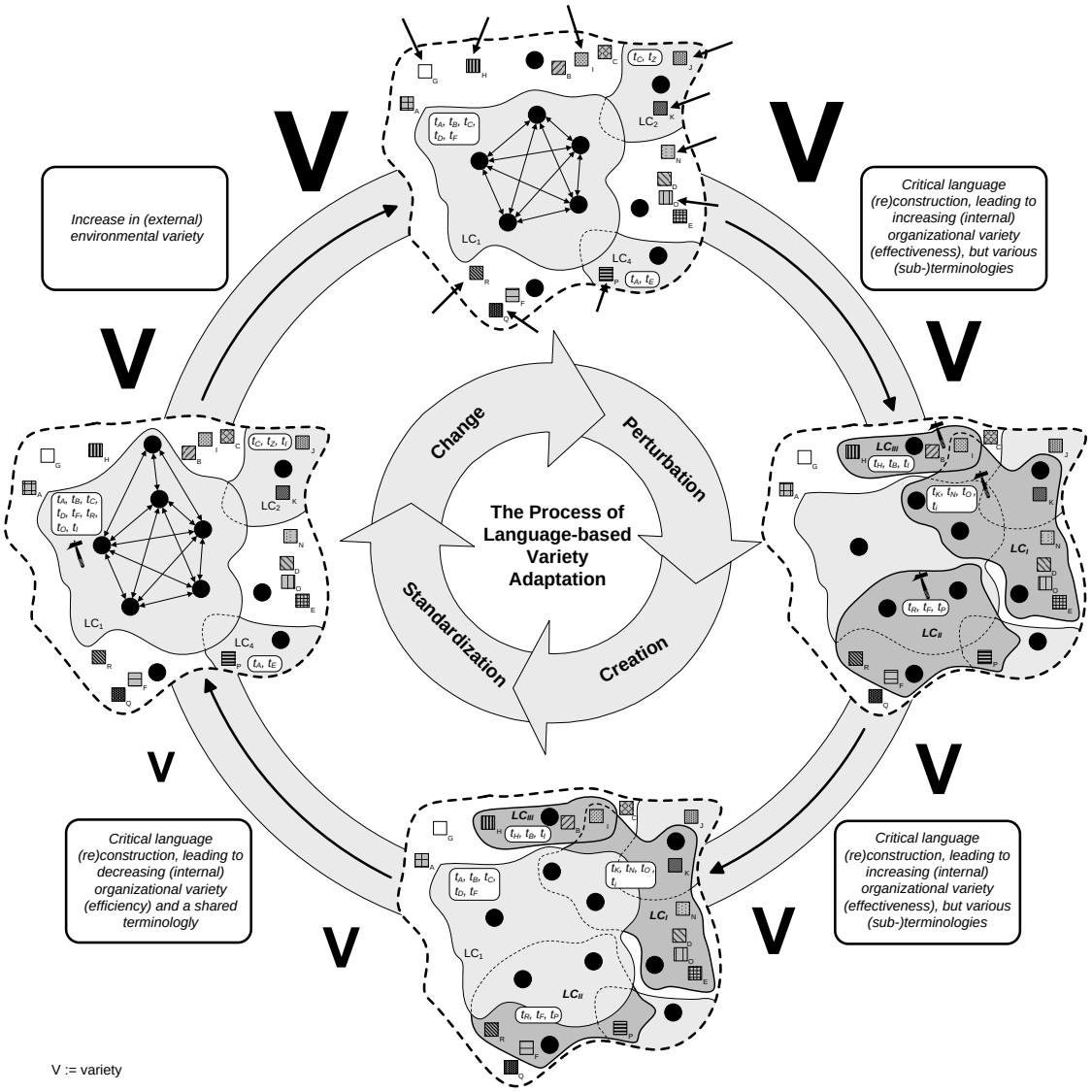


Figure 5.4: The Process of Language-based Variety Adaptation

the environment on that the organization must and is able to react) is reduced. Following the argumentation in Chapter 3.3.2, the variety of a decision situation, quantified in the number of language terms of a language community, presents the number of integral decision alternatives for the members of this language community; the decision space is the totality of these alternatives.[744] The variety of this decision also gives the uncertainty which has to be removed in searching for the completed specification of the decision situation; this measure is an entropy of selection.[745] By summing the selection entropies appropriate to each variable or state, a measure of the uncertainty that has to be eliminated in reaching

[744]See Chapter 3.3.2, Beer (1965), pp. 228 ff. and Beer (1965), pp. 229 f., in the following.
[745]Beer (1965), p. 229.

the decision is obtained.[746] "Reaching the decision" means achieving entropy of zero. But since the quality of an organization cannot be measured with regard to an infinity of possible purposes, described by different observers, one can only measure how good the organization's process of self-organization is, that is, how fast it adapts to changes in its environment.[747] If the purpose or goal of the organization changes (e. g., changing basic conditions in the environment), new variety, ambiguity and uncertainty respectively affect the organization. The *faster* entropy of zero is achieved (the faster a language community is initially created or subsequently adapted), the *better* an organization is.

Another issue for discussion is how LAVAT is related to the so-called *IT artifact* that is argued by some researchers to form the core of information systems research.[748] IT artifacts are the application of IT to enable or support some task embedded within a structure within a context. It is logical that IT usage speeds up the transmission of data. However, before that can take place, ambiguity has to be reduced so that data is "common" and information inferred from this data is interpreted equally by all involved stakeholders connected by IT artifacts. The relation between LAVAT and IT artifacts is illustrated in Figure 5.5 and described in the following.

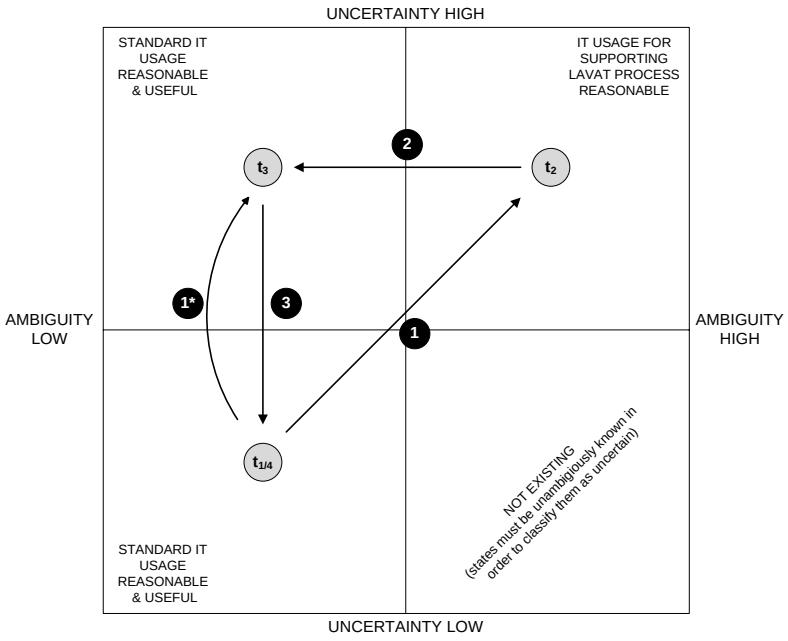


Figure 5.5: LAVAT and the IT Artifact

1. Transition path ❶→❷→❸:
   - *Transition from t_1 to t_2*: first, at time t_1, perturbations in the external environment can lead to increasing external variety and an increase in the number of

[746] Beer (1965), p. 229.

[747] Of course, not always the fastest self-organizing organization "wins". However, it is a reasonable assumption that an organization that has adapted to changes in the environment fast will also adapt to new changes in the environment, e. g., if a competitor arrives at the scene.

[748] E. g., Orlikowski & Iacono (2001); Benbasat & Zmud (2003).

states, that is, the nature of variables describing a situation is unknown (high ambiguity, high uncertainty). Therefore, according to LAVAT, higher internal variety and new terms become necessary in order to be able to react effectively to these new situations (❶).

- *Transition from t_2 to t_3*: in case of rising external variety, however, rising internal variety ultimately leads to the standardization of terms through (re)construction in order to increase effectivity. If LAVAT is correct, this transition from t_2 to t_3 reduces ambiguity (❷).
- *Transition from t_3 to t_4*: then, at time t_3, if agents have a shared, mutual understanding about a situation and the relevant states, they can collect data and information in order to gather enough information for decision-making, that is, to reduce uncertainty (❸).

2. Transition path ❶*→❸:
   - *Transition from t_1 to t_3*: second, perturbations in the environment need not lead to increasing external variety, but only to a rise in uncertainty so that agents do not have enough information for a decision (low ambiguity, high uncertainty), that is, the value of a known variable suddenly is unknown due to external disturbances (❶*).
   - *Transition from t_3 to t_4*: then the agents can collect data and information in order to gather enough information for decision-making, that is, to reduce uncertainty (❸).

Consequently, the general utility of IT becomes only reasonable once ambiguity has been reduced. IT artifacts thus can help in the following two ways:

1. to reduce uncertainty by speeding up information processing once it is clear what information will be required (indicated in Figure 5.5 by the transition from t_3 to t_4 (❸) from upper left to lower left quadrant);

2. to reduce ambiguity by facilitating and supporting the communication-based process of LAVAT, for instance, group support systems[749] or other computer-supported cooperation tools which support the creation of a language community or the negotiation of meaning (indicated in Figure 5.5 by the transition from t_2 to t_3 (❷) from upper right to upper left quadrant).

What is more, the implementation of every IT artifact influences the organization or information system: it is in itself an external perturbation, leading to an increasing variety, ambiguity and uncertainty, and the system as a language community will react accordingly to this disturbance. Through the lens of LAVAT, it is clear that the adoption of an IT

[749] E. g., Zigurs & Buckland (1998); Davison (1998).

artifact and its accompanying terminology cannot be commanded; managers can only act indirectly by influencing the processes of LAVAT.[750]

To summarize, LAVAT satisfies the four requirements to be satisfied by all scientific theories. Firstly, it is falsifiable (e. g., LAVAT would be falsified if a researcher observed adaptation of organizations despite the fact that no language community is created or adapted). Secondly, its logical consistency is known through the mutual compatibility of the different predictions that the propositions consider. Thirdly, it can be confirmed by observations (e. g., through case study research, experiments, surveys, et cetera). Fourthly, and most importantly, it yields predictions that can be observed to succeed. In crafting LAVAT so that it satisfies the four requirements, this study tries to attain its specific research goal of explaining the quality of different organizations with regard to communication and coordination. It must be emphasized that the conclusions drawn by LAVAT are only tentative at best. No scientific explanation – whether LAVAT or a theory of physics – may ever be conclusively proven true. According to the logic of the deductive testing of theories, a theory can only be shown to be false, or not (yet) false.[751]

In contrast to existing traditional organization theory, LAVAT does not look for "contingency factors" in order to assess and evaluate the quality of an organizational design with regard to coordination and communication. Instead of providing a variance model, identifying some contingency variables as causes of organizational change, LAVAT describes the patterns and process of organizational adaptation and recognizes the complexity of causal relationships. LAVAT has no misleading anthropomorphic image of the organization as a separate entity or single being[752], in contrast, it embraces the complex, adaptive system perspective and regards organizational design largely as resulting from the individual behavior of organizational agents. Moreover, this thesis suggests that LAVAT is very simple and almost natural in its underlying logic and embracement of language as fundamental for organizational analysis, rather more so than many contingency theory approaches. If social systems do indeed rely on communication as being the major difference to "human" systems, then language and communication should account for much of the patterns and effects encountered where organizations are the unit of analysis. The patterns suggested by LAVAT should allow to examine and measure the patterns of organizational change in much more detail than has previously been possible.

[750] Of course, a multitude of other individual, technological or social factors influence the adoption of IT, e. g., Katz & Shapiro (1986); Eckhardt, Laumer & Weitzel (2009). LAVAT just focuses on visible language-based communication, see Weber & Camerer (2003) for a similar argument and the remarks in Chapter 3.7.1.

[751] Lee (1989b), pp. 38 f.

[752] See the critique in Chapter 3.4.3.

6 Case Study Report and Test of Language-based Variety Adaptation Theory

According to the research framework presented in Chapter 2, LAVAT presents a newly generated theory (positivist understanding) which subsequently needs to be tested in confirmatory research in order to get corroborated or refuted.[753] This thesis conducted *multiple case studies* to examine the propositions of LAVAT made in Chapter 5. Chapter 6.1 introduces the research method and discusses the research design. Chapter 6.2 presents the case study narrative and analysis. Finally, Chapter 6.3 discusses and analyzes the case study with regard to empirical findings and methodological rigor.

6.1 Research Method and Research Design

Case studies are ideally suited if the investigator has limited control over events and boundaries of a phenomenon (e. g., self-organizing behavior of organizational members via language-based communication) and if the phenomenon and the context in which it is investigated (e. g., social systems such as companies or information systems development projects) are unclear or closely related.[754] Challenges of language-based communication and variety adaptation in social systems certainly satisfy these criteria.[755] Furthermore, since they focus on well grounded, rich descriptions and explanations of processes occurring in local contexts, case studies are well suited for studying theory on emergent phenomena at the micro-level, including communication and understanding.[756] Since this study wanted to test the propositions previously made, a priori definitions were subsequently used in interviews. Therefore, the research followed a more deductive pathway guided by the propositions with the aim of testing them.[757] Such an approach depends on the plausibility of the logical reasoning used in describing the results from the cases, where generalization is the movement from a concrete situation to the social totality beyond the individual case.[758]

[753] LAVAT has been formulated by building on conjectures which have been formed based on the exploratory studies. A conjecture is a proposition or a set of propositions which is presumed to be true or real, but is mainly based on inconclusive grounds; in contrast, a hypothesis is a testable statement based on accepted grounds. See Popper (1965).

[754] E. g., Yin (2003); Eisenhardt (1989).

[755] Social systems are inherently interactive and open and it is difficult to artificially close or control them in a laboratory, which makes it difficult to test theories, since predicted effects may or may not occur depending on a multitude of factors. Moreover, the possibility to measure the phenomena are very limited since "meaning" cannot properly be measured and compared, only understood and described. See Mingers (2004b), p. 387.

[756] Miles & Huberman (1994), p. 15.

[757] This is consistent with Lee (1989b). When a proposition is connected to an empirical measurement instrument, it is called a hypothesis. See Chapter 4.1.

[758] Orlikowski & Baroudi (1989), pp. 13 f.

Case Selection

The first decision that was taken was to determine what is to be studied, that is, the *unit of analysis*. Two case selection criteria were applied. First, the researchers decided to focus on information system development projects in the financial services industry, since this domain is especially affected by the changes that IT introduced due to the nature of their marketable products, which are mainly immaterial. For instance, the production process of a bank mainly consists of information processing, and IT has become one of the main factors of production in banking. To be more precise, it was decided to focus on *financial data warehouse projects*. The observation of projects as a unit of analysis has a long history in organizational research.[759] Furthermore, studies give evidence of a tremendous increase in the application of project-based structures in many industries for bridging the "divisions" of traditional organizations.[760] Additionally, projects in Europe are often conducted with the help of external consultants.[761] An associate and collaborator of the author worked for more than seven years for a German consultancy (CONSULT, fictitious name) which focuses on IT in the financial services industry. He therefore had broad experience with working in financial information system development projects, first as a consultant and later as a project manager, enabling him to establish contacts and to get in touch with the key informants. The selected cases are typical for recent projects in the financial services sector. Especially large banking groups with foreign subsidiaries have to deal with increasing regulatory demands, for instance, IFRS[762] or Sarbanes-Oxley Act[763]. The trigger for all selected projects was the supervisory requirements known as Basel II.[764] These regulations demand specified risk calculation and risk treatment processes that have an impact on the whole structure of a financial service provider. As these were developed by the Basel Committee on Banking Supervision (BCBS) until 2005 and have, following slight adaptation, been released as European Union directives 2006/48/EC and 2006/49/EC in June 2006, they became law in most member states of the European Union in 2007.

Secondly, statements about specifics of financial data warehouse projects have suggested that they are arguably closely related to the propositions of LAVAT and indicate that financial data warehouse projects show the characteristics of self-organizing social systems and language communities:[765]

[759] E. g., Tushman (1979a), see Chapter 3.4.1. The focus on projects might contribute to the understanding of organizations by looking at the "organizational meso-level", i. e., a level that traditional organization theory not normally focuses upon and to which team or group research does not pay greater attention. See Söderlund (2004), p. 663.

[760] Whittington et al. (1999), p. 587. During the 1990s, project-based structures have become more pervasive, with 51 % of firms placing a greater emphasis on them in 1996 compared to 1992: 42% of firms placed much or great emphasis on project structures in 1996, against only 13% in 1992. See Whittington et al. (1999), p. 590.

[761] A recent survey of the European management consultancy market showed that the marekt size for consultancy is around 74 bn. EUR and that the consulting intensity, measured as the contribution by the sector to the European GDP, has increased from 0.58% in 2005 to 0.62% in 2006. See FEACO (2006), p. 9.

[762] E. g., IASB (2008).

[763] E. g., SOX (2002).

[764] E. g., BCBS (2006).

[765] See Behrmann & Räkers (2008), pp. 7-9, in the following.

1. *Financial data warehouse projects have to deal with several business domains and fields of knowledge.* This leads to different domain knowledge in different departments and subsidiaries and specific fields of knowledge arise. To build up a centralized and integrated data warehouse, a common understanding between all involved departments and subsidiaries has to be reached.

2. *Financial data warehouse projects are characterized by a high semantic complexity.* Several business domains can occur within a single financial institution. Due to the different fields of knowledge a high number of context-dependent homonyms (e. g., limit, facility, book value, market price) and synonyms (e. g., debt security, bond, obligation) can be observed. Due to this variety, the definition of terms (e. g., dimensions and measures) is challenging.

3. *Specification-based approaches are not sufficient in financial data warehouse projects.* Additional methods are required beside the specification, for instance, face-to-face communication.

4. *Financial data warehouse projects require knowledge transfer methods and strong interaction.* For a successful implementation, a common understanding between all involved project members has to be ensured. This cannot be reached by merely interchanging a written specification.

In line with those arguments, six financial data warehouse projects conducted with the help of CONSULT for various banks in Europe were selected, which offered access to members of all stakeholders involved, that is, internal project members from IT departments and business units of the client organizations, external IT and business consultants, and project managers. Consequently, an *embedded multiple case study design* was selected.[766] Table 6.1 gives an overview of the selected cases.

Data Collection and Data Analysis

Since this study intended to investigate and test the adaptation of organizations to external variety through language within a real-life context, this research chose to directly engage with project team members to test the propositions of LAVAT. The involved researchers consisted of the author and the collaborator from the consultancy. Since at the time of the interviews most of the selected projects or related successor projects were still ongoing, this minimized the risk that participants displayed retrospective bias or that they had already forgotten something in their interactions with other team members. It was decided to engage into a triangulation mode as often as possible, especially for the larger cases, that is, to interview both project managers and project workers. Therefore, data was collected from various data sources and with the help of different data collection

[766] Embedded case studies involve more than one unit of analysis. This occurs when, within a single case, attention is also given to a subunit or subunits. Although the specific projects represent the main unit of analysis, the individual project team members represent a subunit. Any subunit is part of/or embedded in the larger system (i. e., project) and it is important to understand the subunits in the larger system. See Yin (2003), p. 49.

	Bank A	Bank B	Bank C	Bank D	Bank E	Bank F
Natural languages used	German, English	German, English	German	German	German, English, French	German, English
Scope	Europe	Europe	Germany	Germany	Germany	Germany
Project duration	> 5 years	> 2.5 years	> 2 years	> 1.5 years	> 2 years	> 1.5 years
No. of team members	> 100	> 150	> 20	> 25	> 15	> 25
No. of countries	> 13	> 5	1	2	2	> 5
No. of subsidiaries	18	6	–	–	–	15
Balance value[a]	100 bn. EUR	70 bn. EUR	7 bn. EUR	4 bn. EUR	2 bn. EUR	230 bn. EUR
Person-days (for CONSULT)	about 100,000 (about 12,000)	about 40,000 (not available)	about 5,000 (not available)	about 4,000 (about 1,000)	about 7,000 (about 900)	about 3,000 (about 2,500)
New core banking system	no	yes	yes	no	no	no
Perceived complexity[b]	very high	high	medium	very high	medium	high
Quality ranking[c]						
- product	6.	5.	4.	3.	2.	1.
- process	6.	5.	3.	4.	2.	1.

[a] in billion (bn.) EUR [b] collectively determined on a scale from 1 (very low) to 5 (very high) during the focus group meeting of all involved project managers [c] collectively ranked from 1. (best) to 6. (worst) during the focus group meeting of all involved project managers

Table 6.1: Case Overview & Comparison

methods, enabling this triangulation.[767] Unstructured and semi-structured interviews, structured self-estimation surveys, project documentation, and e-mail exchanges were used to generate data. Administrative documents (e. g., organization charts, project handbooks, project plans with estimated budgets, time lines and assigned employees), work descriptions (self-recordings of manager activities), print-outs of project reports from various points in

[767] Eisenhardt (1989), p. 539. In addition, it was tried to interview team members from both consultancy and client organization as well. However, this was only possible for two of the six cases and may be a source of possible bias.

time, interview transcripts and field notes of the researchers were collected in a case study diary.[768]

The collection of the case study data was started in March 2007 and ended in December 2008. 17 interviews were conducted by the researchers, 15 with consultants and 2 with client team members, spread over all six projects (see Table 6.2). The interviews, which were controlled by a semi-structured interview guideline designed to test the propositions (see Appendix C), were either conducted by phone if the informants worked at the time in geographically remote locations or in face-to-face sessions at the organizations' site.[769] The interviews were held in German, allowing informants to speak in their mother tongue, and increasing their comfort level, so that they would share their views and ideas. The interview guideline was not shared with the interviewees and was only used by the researchers as a checklist and outline. The aim was to encourage the interviewees to provide a narrative of their experiences as freely as possible, without restraint from the interview guideline. The interviews lasted between 45 and 120 minutes and were all recorded and transcribed.[770] Follow-up e-mails were sent to request clarifications and to offer informants the possibility to provide feedback and comments. Furthermore, a structured self-estimation survey regarding work time spent on activities was answered by most interviewees (see Appendix D). Finally, a focus group meeting of all involved project managers discussed similarities and differences between the projects. This discussion was observed by both interviewers. Furthermore, the project managers were asked to collectively assess the complexity of the projects and rank the projects regarding perceived process quality and product quality (see Table 6.1).

Following Lee, *natural controls and treatments* that were already in place were utilized in the research design for testing the propositions.[771] For instance, focusing on persons which were participants in more than one of the cases held constant the people factors while comparing projects. The treatment in form of a variation in the environment is considered by the move of those people from one project to the other, interviewing the same person for different cases. Therefore control in the research design was already in place. Other examples of natural controls are the scope of the project and the parallel implementation of a new core banking system.

The research followed the framework presented in Chapter 2.2 (illustrated in Figure 2.1) as applied on an individual study level. Consequently, the researchers formulated an interpretation of the patterns that occurred at the case studies' project teams and matched it to the positivist understanding of LAVAT for testing. The first analysis occurred in parallel to the data collection. The researchers wrote down field notes while conducting the interviews, transcribing the tapes, and reading the transcripts and feedback of the interviewees. These were subsequently discussed after each case was completed regarding

[768] Yin (2003), p. 102.

[769] The interview concept and guideline were checked against Bouchard (1976) and Mishler (1986). The guideline was especially checked regarding the sequence of questions; however, since the interviews were basically open, as few direct questions as possible were asked and leading questions were avoided. See Loftus (1975) regarding the problematic of leading questions.

[770] This resulted in about 130 recorded transcript pages. The original interviews were conducted in German. Hence, the questions from the interview guideline and the reported excerpts from the answers of the interviewees in the following sections have been translated by the author using the back-translation method as described by Brislin (1970).

[771] Lee (1989b), p. 39.

Case	Name & Details*	Organization	Role	Date (MM/DD/YY)
Bank A	*Mr. JS*, 27 years old, 4 years experience as consultant	Consultancy	Team Member	08/20/2008
	Mr. BK, 32 years old, 4 years experience in industry, worked as IT consultant before	Client	Team Member	08/20/2008
	Mr. WB, 31 years old, 5 years experience as consultant & project manager	Consultancy	Project Manager	09/01/2008
	Ms. SK[a], 46 years old, 17 years of experience in consultancy and industry	Consultancy	Team Member	09/20/2008
Bank B	*Mr. TE*, 32 years old, 7 years working experience in industry	Client	Team Member	03/22/2007
	Mr. TA[b], 40 years old, 8 years experience as consultant & senior project manager	Consultancy	Project Manager	09/12/2008
	Ms. SK[a]	Consultancy	Team Member	09/20/2008
Bank C	*Mr. VC*, 29 years old, 3 years experience as consultant	Consultancy	Team Member / Project Manager	10/31/2008
	Mr. JD[c], 29 years old, 3 years experience as consultant	Consultancy	Team Member	11/10/2008
Bank D	*Mr. TA*[b]	Consultancy	Project Manager	09/12/2008
	Mr. SK[d], 32 years old, 5 years experience as consultant & senior project manager	Consultancy	Project Manager	10/30/2008
	Mr. DF[e] 32 years old, 4 years experience as consultant & project manager, 6 years of experience in industry	Consultancy	Team Member / Project Manager	12/03/2008
Bank E	*Mr. SK*[d]	Consultancy	Project Manager	10/30/2008
	Mr. MK, 28 years old, 2 years experience as consultant	Consultancy	Team Member	12/03/2008
Bank F	*Mr. SK*[d]	Consultancy	Project Manager	10/30/2008
	Mr. JD[c]	Consultancy	Team Member	11/10/2008
	Mr. DF[e]	Consultancy	Team Member	12/03/2008

*For reasons of confidentiality, abbreviations are used. [a]Member of projects in Bank A and Bank B. [b]Member of projects in Bank B and Bank D. [c]Member of projects in Bank C and Bank F. [d]Member of projects in Bank D, Bank E and Bank F. [e]Member of projects in Bank D and Bank F.

Table 6.2: Overview of Interviews

different impressions and interpretations of patterns in the data. In the following phase, the emerging interpretations were connected and matched to the propositions. Coding techniques and checklists were used to connect data with the propositions.[772] Controlled deductions were made by the researchers involving the several different, verbally expressed predictions from the verbally expressed theory (LAVAT) as applied to the verbally expressed facts of the situation at the organizations in focus.[773] The researchers ensured that the concepts were relevant across multiple interviews and cases. Each of the researchers reread and recoded the interview transcripts several times to link empirical evidence to the propositions. After each interview cycle concerning a single case, regular phone and face-to-face sessions among the two researchers and both instant messaging and e-mail conversations were used to discuss the cases in order to resolve differences in interpretation and matching to the propositions. In applying the same theory (i. e., LAVAT) and propositions to a different set of initial conditions (i. e., the facts of the situation at Bank A to Bank F), the investigators ensured replicability by working each time with a new prediction.[774]

The tradition of presenting basic data is deeply ingrained in reports of qualitative data analysis and the typical report contains a mixture of full-scale narrative text with "thick" description, cross-case displays, and associated analytic text.[775] The following narrative tells the reader which factors count most and which relationships are especially meaningful by keeping the analytic text and the displays together, moving back and forth between them and including specific illustrations from written-up field notes and interview transcripts

[772] E. g., Yin (2003), pp. 109-138; Miles & Huberman (1994), pp. 170-244. However, as Mishler (1986), pp. 4-6, points out, coded data have no meaning in themselves; they are the result of a gradually built-up understanding among the researchers. See also Scheurich (1995) for a postmodern critique on coded data as accurate or valid representation. Following this thesis's philosophical position presented in Chapter 2.1, this critique is acknowledged; observations always are subjective and depend on the interpretation of the researcher. But by coding, a researcher may indicate which data she or he links – by interpreting the situation – to a specific proposition. This makes her or his interpretation available for inter-subjective analysis and discussion. *Pattern coding* achieves this and may help to classify data by content of the basic phenomena; hence, a specific code was assigned to each proposition and data was linked to these codes, see Miles & Huberman (1994), pp. 57 f. MaxQDA (http://www.maxqda.com/) was used for coding the interview transcripts and linking additional documentation from the project diary.

[773] See Lee (1989b), p. 40. Logical deductions like this in the general case do not require mathematics. A case study that performs its deductions with verbal propositions (i. e., qualitative analysis) therefore only deprives itself of the convenience of the rules of algebra; it does not deprive itself of the rules of formal logic, to which it may therefore still turn when carrying out the task of making controlled deductions. With regard to logical form, this study's deductions involving verbal propositions based on LAVAT are identical to and no less valid than, the deduction of the verbal proposition, "Socrates is mortal" (the prediction) from the two other verbal propositions, "All men are mortal" (the theory) and "Socrates is a man" (the facts or initial conditions). This case is a classical example for deductive logic. For instance, in Darwin's theory of evolution or Smith's theory of economics, the medium of logical deduction was words and sentences, not numbers and mathematics.

[774] For instance, "A terminology exists at Bank B," as opposed to the original prediction, "A terminology exists at Bank A" is new; even though the prediction is different, it is still the same theory being tested, attempting to replicate the observations made in the the other cases. Consequently, even though the observations in a particular case study are non-replicable, the case study's findings (that a particular theory is confirmed or disconfirmed) are replicable over the set of cases. See Lee (1989b), pp. 40 f.

[775] Miles & Huberman (1994), p. 243.

which are genuinely representative exemplars of the presented conclusions.[776] The reader can thus reconstruct how the analysis developed, how the explanation is grounded in the data, and determine the logical validity of conclusions.[777]

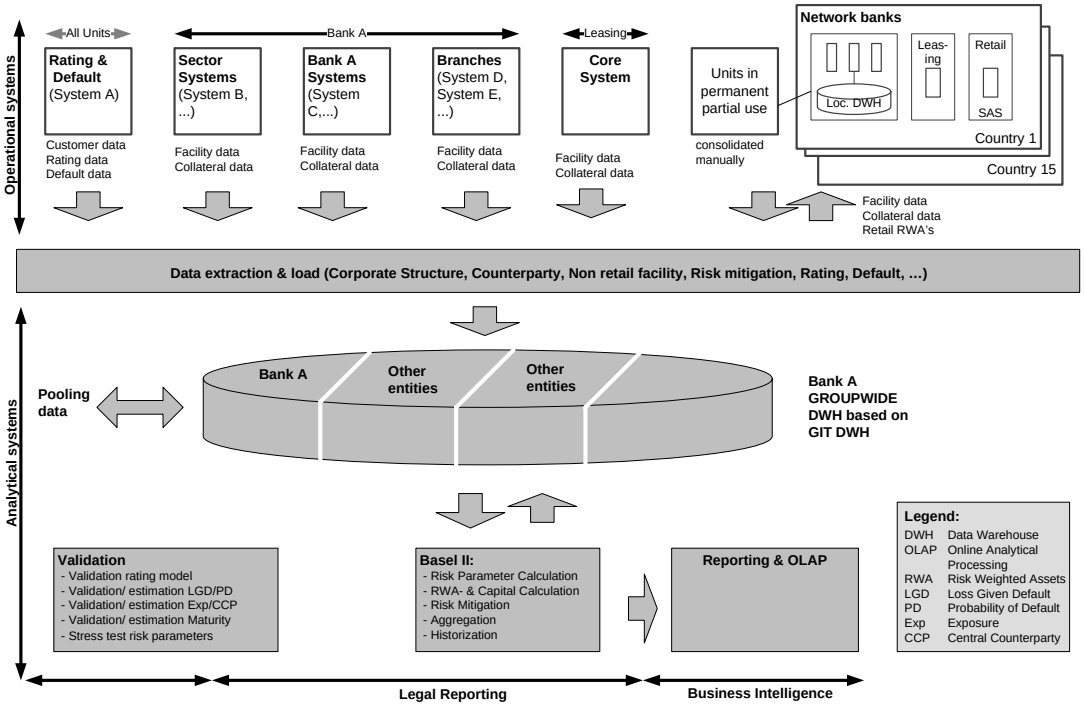
6.2 Results: Case Descriptions and Explanatory Analyses

6.2.1 Bank A

Bank A is an international banking group and consists of a head office and 15 major subsidiaries in different European countries. The financial data warehouse project at Bank A started in 2001 and ended in December 2007 in order to develop a system which meets the regulatory requirements of Basel II. To fulfill the requirements and to enable a group-wide calculation of the required values according to the so-called credit risk "standardized approach" (KSA) and "internal ratings-based approach" (IRB) for Basel II[778], one main task of the project was to implement a central data warehouse. The business concepts and technical concepts for Bank A's implementation were being created and realized with the support of CONSULT. The focus of the project lay in determining the relevant amount of capital required for credit risk for the total international bank portfolio of Bank A. All project results were being generated in the English language to enable international implementation. The project included three basic parts: (1) technical and implementation concepts, (2) data warehouse concept and (3) functional integration. The construction of the logical data model and the requirements for the physical data warehouse of Bank A, including the specification of the interfaces from the operational systems into the data warehouse, were determined as the most important goals. Primarily, data of transactions, collaterals, customers and rating information of both head office and subsidiaries had to be delivered into the central data warehouse. To achieve this, each subsidiary had to develop extraction jobs for their local databases which create specification-conform flat files that were then sent to head office and imported into the data warehouse. Figure 6.1 sketches the intended data warehouse architecture, the involved application systems and stakeholders, and their interdependencies.

At the beginning, the core project team at headquarters, which consisted of consultants from CONSULT and Bank A's experts from business and IT, had designed a detailed data model for Basel II and specifications for data loading interfaces in XML Schema Definition (XSD) format which were sent out to the project members in the subsidiaries (i. e., network banks) as a documentation. Afterwards, this data model and the specifications were given to GIT (fictitious name), a wholly-owned subsidiary of Bank A which renders banking-related ancillary IT services for all subsidiaries. In the project, GIT was responsible for developing the data warehouse and implementing it at the subsidiaries. At the beginning of the project, an initial training workshop was conducted where the XSD format was explained to representatives of the subsidiaries.

[776] Miles & Huberman (1994), p. 243.
[777] Krathwohl (1998), p. 316.
[778] The terms "standardized approach" and "internal ratings-based approach" refer to a set of credit risk measurement calculations in the Basel II requirements. See BCBS (2006), p. 19 and p. 52 respectively.



Source: adopted from project presentation slides

Figure 6.1: Architecture of Data Warehouse Solution (Bank A)

Since the specification was assumed to be unambiguous by the project managers at the head office due to the use of XSD, it was sent to each subsidiary via e-mail at the beginning of 2006. Furthermore, the project managers believed that employees in the subsidiaries would share the same knowledge about the banking domain as employees at head office, that is, that the meaning of each of the used words and descriptions would be understood without any problems. During the first implementation phase, a contact person at head office was nominated for each subsidiary to clarify misunderstandings and technical problems. Support was realized by using several communication channels including e-mail and telephone. Since after the distribution of the specification all support requests of the subsidiaries could be satisfied by the contact person, the head office team assumed that each subsidiary had understood the specifications in the intended way and implemented it accordingly.

However, completeness checks of the flat files that were delivered by the subsidiaries in the first quarter of 2007 showed several problems resulting from a different understanding of the meaning of terms. It seemed as if employees from head office and subsidiaries each spoke different languages, since the interpretations of the published specification varied to a considerable degree, although the required data and data structures were believed to be formalized unambiguously due to the use of XSD and additional textual descriptions. However, the XSD specifications were not as unambiguously and self-explanatory as the head office team had believed. The reason for most discrepancies in understanding was that several technical language terms were not immediately interpreted in the same way by

all involved stakeholders from head office and subsidiaries. This included terms from the domain of Basel II and risk management.

> "*A typical example is the 'Buchwert'* [German: book value]*, which is really interpreted differently by each department. Whether this are people from risk management or the controlling people, or also the different units, everybody understands something a little bit different, so whether some interests are included or not or whether these are outlined separately [...].*"[779]

Furthermore, at the beginning of the project, IT-related terms of Bank A were totally unknown to the consultants and partly unknown to project members from business units. Thus, in addition to the obvious Basel II domain vocabulary, other distinctive sub-terminologies or jargons were observable for different stakeholders and communities of practice. Basically, the new regulatory requirements, coupled with the existence of multiple quasi-independent subsidiaries with different environmental situations, resulted in increasing variety. A lot of discussion evolved around the meaning of terms, for instance, pertaining the context of specific Basel II requirements or different types of businesses in Bank A.

> "*I can think of the entity 'contagion' off the top of my head, as in 'Vergiftung'* [German] *[...] Ultimately this means that if a customer's deal fails then all other deals of this customer are also affected [...]. That was something that was not existing before, this had to be explained in parts. [...] This was for our project, which actually was a retail project, also difficult at the beginning.*"[780]

Consequently, internal variety at Bank A was increasing as well, observable by a number of different understandings, meanings and conceptions which were discussed in this context within Bank A and within the project while employees tried to make sense of the new situation. The existence of various meanings and interpretations caused ambiguity and uncertainty among all project members and other involved stakeholders. For instance, the technical terms describing the banking products where a problem for the project since they were not clearly defined, which in turn caused a lot of ambiguity and uncertainty respectively for the project members.

> "*That emerged on and off, as I said, especially these discussions about terms, some were discussed until into 2007, when I got in again in detail and attended to Poland and Slowakia. And later, in an Ukrainian bank, there it also surfaced again, what do you exactly mean by this, what is a limit according to Basel II, what is relevant for this, what do I have to deliver?*"[781]

Therefore, one of the core problems and reasons for discussions was the matching of the different meanings and concepts used in the business units and subsidiaries to the terms used in the detailed data model and specifications of the data warehouse.

[779] Interview with Mr. BK, translated by the author.
[780] Interview with Mr. JS, translated by the author.
[781] Interview with Mr. BK, translated by the author.

> "*In fact, there are really thirteen data warehouses that have to be loaded identically, but which weren't loaded identically because how should one load them identically if nobody takes care that this happens? This was the case in the first implementation phase, that one just gave the documents to everybody and everybody did interpret them. And the result were thirteen interpretations. [...] This only surfaced in the discussions later [...]. There it made kind of 'Click! Ah, that is why so very much is not working here!'*"[782]

After this problem surfaced and the first release of the data warehouse had already been implemented, traces of developing and revising a shared project terminology and adapting it for daily use are observable. For instance, additional workshops were conducted in 2007 once the project management team realized that the sent XSD specifications were not enough for ensuring a shared understanding. During the workshops, changes to the data model in subsequent releases were introduced and the meaning of terms and concepts was discussed in detail with all involved stakeholders of business units and subsidiaries.

Patterns of (re)construction and terminological discourse are traceable once the existence of separate sub-terminologies and jargons had been understood and accepted, and those sub-terminologies began to be consolidated into a joint language community by the project team.

> "*[...] one simply used examples to reach an agreement if possible, and then one came out of the workshop. And then, naturally, every time there were callbacks and further inquiries, one met on the floor. Thus it was not concluded with the workshop; but then, it always was* this *special business case, and then they called us by phone or we met somewhere and they say 'By the way, I have another question' and 'How do we do this exactly?', and we discussed this together. One has to say, the opinion about the meaning still is dynamical on both sides, because we didn't think all special types of business cases through in our model, naturally, but this 'Do we get this somehow reproduced so that it still makes sense?', there one had to play this through and discuss this.*"[783]

What is noticeable in this context is that ambiguity and uncertainty were also existing at head office at the beginning of the project in 2001, but that discussions and (re)construction took place between nearly all involved project members and stakeholders at head office earlier and faster than at the subsidiaries.

> "[At head office] *we had early internal workshops concerning changes of the data model et cetera, on the one hand by the model creators and the IT provider, but also the persons in charge for data mapping at head office. Thus, at least in the second release, all changes and the completeness of the data model, all mappers were invited directly, so to speak, and then we just looked through everything together.*"[784]

[782] Interview with Mr. JS, translated by the author.
[783] Interview with Mr. WB, translated by the author.
[784] Interview with Mr. WB, translated by the author.

The joint discussion and clarification of terms at head office were time-consuming, but perceived as necessary for reducing ambiguity and uncertainty. But that this problem would also exist with employees of the subsidiaries was not perceived by the project management team until the beginning of 2007 when the subsidiaries delivered their first flat files.

> "*What one did notice, the descriptions of the data fields, those were really rudimentary in the XSDs at the beginning, and therefore, everybody could in principle interpret them the way he wanted. [...] in principle, we didn't have proper descriptions per field before. Perhaps someone banged out a phrase, if it even was a full sentence [...] At this point we noticed that this is not enough, in every case. [...] And if you have 15 network banks, you cannot handle this anymore, definitely [...] because everybody interprets it somewhat differently and delivers a different amount and value. [...] you don't know, what stands in which field, and what do I have to calculate now, and what do I have to add or not.*"[785]

The subsequent additional workshops which were conducted in 2007 with employees from the subsidiaries explained the planned data loading scheme and the XSD specification again and again, using examples from daily business.

> "*The next step was to create a first description of how the data warehouse is loaded. So we created slides, which were about describing how to feed the data warehouse, using relatively many examples. There, we often used some business cases, which we went through in the workshops in April, May* [of 2007] *[...], 'With that customer, how would you load this?' So that one really forces the people to think about that for themselves.*"[786]

But as with the handing-over of the XSD specifications to the subsidiary employees, neither did the additional workshops by themselves suffice to generate a mutual, common understanding of terms between all project members in headquarters and subsidiaries alike. Ambiguity and uncertainty were still perceived as comparatively high.

> "*This was certainly difficulty with the Poles, because they filed it in a very complicated way in their operative system. There, it was very hard to find out what means a limit according to Basel II, what is the relevant amount according to Basel II? In that case, it was a fact that the Basel II requirements were a great challenge for the people, because at the beginning, they didn't really understand the meaning of what we have to deliver.*"[787]

This only changed after Bank A's management decided to allow the project to employ on-site visits at the subsidiaries for the data warehouse developers and the consultants in order to personally discuss and explain the data load concept to employees in the subsidiaries. At this point in the project, the project managers explicitly decided to switch

[785]Interview with Mr. BK, translated by the author.
[786]Interview with Mr. JS, translated by the author.
[787]Interview with Mr. BK, translated by the author.

from written specifications to direct face-to-face communication and physical inspection.[788] Consequently, once it was realized that the delivered data quality was still not satisfactory, the project managers decided to employ local visits of head office project members at problematic subsidiaries.

> "*At one point in the project [...] it was recognized that the specification must be improved and refined [...] then one realized that these XSDs are not enough, then one created the data delivery concept, and drove out to the subsidiaries to explain this. This were points where one noticed that they needed a little more support, but the real turning point, where this issue had full management attention, came actually in April 2007, where one said the data delivery does not work at all [...] and only then one saw what a shit this was [...] and then did decide that we need so-called task forces, and only then I came back to the project, very different persons now became involved, who really were on-site* [at the subsidiaries] *and went through the data with them weekly, looked at the data fields and discussed every single thing. This actually was one of the greatest turning points for me. There, the upper management realized 'Now we have to do something, and we have to spend money, and now we involve all externals in this, and we don't care about travel expenses either'.*"[789]

The on-site visits and the discussions with all project members and subsidiary employees finally succeeded in reducing ambiguity by establishing a shared, mutual understanding of terms. Ambiguity was mostly lowered by the personal face-to-face discussions of daily business situations between employees of the subsidiaries and project members from head office. Based on assessments of the self-estimation surveys, these changes in the procedure doubled the time spent on communication and also doubled efforts for on-site meetings. By conducting expensive on-site meetings, a shared terminology and a common understanding regarding project issues was finally built. After those changes, project members state a perceived increase of efficiency in the project in later phases compared to earlier phases.

> "*Absolutly, it became apparent that the number of questions which one brought back from the countries and the on-site visits, that by looking at these one saw that many open questions existed and once we had those, we could clarify those. [...] because up to a certain part, there had been questions in the workshops, and we didn't have answers right then for those.*"[790]

The meaning of fundamental terms gradually became clear for everybody. Afterwards, for instance, only very complex calculating relationships became a topic for discussion.

> "*There are still questions, but these questions are much more difficult to answer because most of these require much more detailed knowledge. Also it didn't run like it's on rails afterwards, directly, but I think the amount of questions which had been clarified in this certainly justified this* [the on-site visits]."[791]

[788] See Chapter 3.7 and Pondy (2005), p. 132, who expects physical inspection in poorly structured areas.
[789] Interview with Mr. BK, translated by the author.
[790] Interview with Mr. JS, translated by the author.
[791] Interview with Mr. JS, translated by the author.

Comparing the subsidiaries where project members from different countries showed similar English language skills, it was running more smoothly in those subsidiaries where employees had understood the meaning of the terms faster. The native language was not perceived to be the important factor influencing a fast establishment of a common ground and mutual understanding. Thus subsidiaries that were performing better (i. e., delivering better and more correct data and in a more timely manner) achieved a faster adaptation of their language community and terminology and thus reduced ambiguity faster.

> "*Partly, this were those countries were we had much more discussions on the one hand. But on the other hand, we had those discussions because the counter party did notice that they had a different understanding of a concept as we had specified. So the countries which weren't really good on the professional level, those just implemented something in case of doubt, something that maybe didn't make any sense. The other countries that noticed that they had a different understanding, those directly made inquiries. Of course, this partly resulted in delays in the project. But the total sum, or the quality of what those did deliver, was much better, definitely.*"[792]

During the course of the project, variants of conceptual models were used for documentation and during discussions, for instance, entity-relationship (ER) models.[793] Specific issues concerning data mapping and interrelationships between data fields could be clarified in the discussions using these conceptual models. This especially helped to speed up discussions about ambiguous situations and to generate a shared, mutual understanding.

> "*It helped if one had a question, you could always fall back to the concept and discuss this single slide. That was really more simple than saying 'OK, just look into the [...] Word documentation [...] We noticed that in Word, we can write and document more, but the people don't necessarily read more.*"[794]

The so-called data delivery concept was a Microsoft Powerpoint presentation, which incorporated excerpts of those ER diagrams and was used during discussions in workshops and at on-site visits to clarify mapping issues and ambiguities, such as how a special type of business has to be delivered, which tables are affected by this, which data fields are important, and what connections exist between data fields.

> "*I used those for myself, because in the end, not everything was clear to me either, I had to break in again into the work when I returned to the project in 2007, and we used the models frequently for the purpose of visualization, because in the models [...] the interrelationships were well described. So one rummaged around and took out this special slide for a point of discussion and looked together, well, how must those things be connected, and which things have to be filled.*"[795]

[792] Interview with Mr. JS, translated by the author.
[793] The ER model has been originally proposed by Chen (1976).
[794] Interview with Mr. JS, translated by the author.
[795] Interview with Mr. BK, translated by the author.

In the end, the discussions using this data delivery concept were more useful than just looking at the documentation. Moreover, ad-hoc models were used during those discussions, for instance, cash flows for types of businesses were drawn in order to discuss necessary connections and calculation chains between data fields. The use of a specific modeling method was not perceived as necessary for project success.

> "*That is to say, I believe, the discussion about methods is a little bit overrated, because in the end, nuances in the modeling, that is, whether I take Tool A and an ERM, or whatever else, or Tool B or whatever such tools are named [...] this won't make a big difference.*"[796]

The following interpretation summarizes the findings of the case:

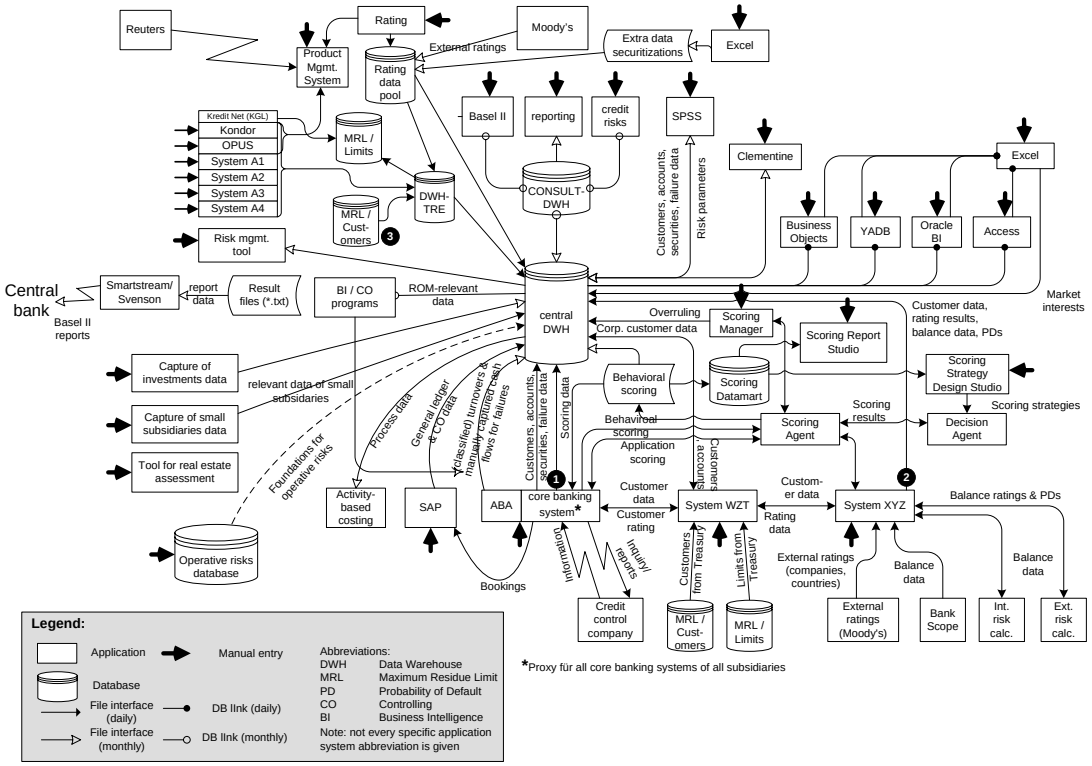
- Variety and ambiguity were high due to the new regulatory requirements and different situations in foreign subsidiaries. Several sub-language communities were observed during the course of the project.
- The project managers consciously shifted the procedure from a specification-driven approach to a more communication-driven approach once the problem of misunderstandings and different interpretations was realized.
- Empractical learning was observed in face-to-face communication during workshops, discussions, and personal inspections. This reduced ambiguity and finally created a language community for the project.
- Those subsidiaries that earlier became a part of the project's language community were performing better and delivering higher quality of data.
- Conceptual models helped to discuss differences in understanding and interpretation.

6.2.2 Bank B

Bank B is a large European banking group with foreign subsidiaries, mostly in Eastern Europe.[797] In order to deal with the new regulatory demands of Basel II, Bank B put up a multi-million Euro data warehouse project together with CONSULT. The project started in 2005 and officially ended in 2007, although a follow-up project is still ongoing. One major task of the project was to extend the existing data warehouse by detailed data from foreign subsidiaries to achieve a group-wide view on risk details according to Basel II regulations. Higher management positions were staffed simultaneously by a bank employee and a consultancy manager to assure that the whole project knowledge remained within Bank B after the project ended and to reach transparency throughout the whole implementation of Basel II. Figure 6.2 gives an overview of the the intended data warehouse architecture, the involved application systems, and data flows. Overall, relevant data for Basel II is stored in many distributed application systems. For instance, relevant customer data has to be extracted, integrated and processed from three separate application systems (indicated in

[796] Interview with Mr. WB, translated by the author.
[797] Parts of this case have been previously published as Räkers & Rosenkranz (2008).

Figure 6.2 by ❶, ❷, and ❸). This heterogeneous application system landscape results in a very complicated data warehouse architecture design.



Source: adopted from internal project documentation

Figure 6.2: Architecture of Data Warehouse Solution (Bank B)

All departments of the bank were involved in this project because the necessary adjustments influenced not only operational application systems but also changed the daily business. In addition, Bank B was in a post-merger situation and was the target of an acquisition during the project. Moreover, besides the Basel II-related data warehouse project, another large project was conducted in Bank B at the same time: a new major operational system, intended for daily use for most of the bank's employees (i. e., a new core banking system), was developed and switched productive during the second half of 2006. So nearly every department was involved in two large and important projects at the same time while doing the normal daily work as well. The whole value chain of the bank was touched and partly redesigned. From operational systems over the central group-wide data warehouse to the reporting and supervisory systems, nearly every application system and business process was affected. All in all, Bank B was undergoing enormous organizational changes, and the changing environment heavily influenced the project. Inquiries of the supervising authority made demands on the employees' time, and the acquisition process stressed the bank's staff.

At the beginning of the project, it became clear quite early that different sub-terminologies and jargons with different understandings were used by different project team members and stakeholders regarding concepts from Basel II, business and IT.

> "*Technical terms* [had to be] *defined during the project [...]. But different levels of those do exist. Sure, there are technical terms in this sense, in the narrower sense, which really deal with the subject, for example, very specific Basel concepts, which naturally are only known within this project [...]. At the beginning you have those lovely abbreviations such as PD, LGD, EAD, CCF. Everybody who deals with Basel knows these abbreviations. But if you step outside the Basel world, at the beginning [...] one initially has to discuss what those are, so that CCF stands for 'credit conversion factor'. And that you initially have to produce a common understanding, in the first place, what lies behind a term.*"[798]

> "*First, there are bank-internal system descriptions which you have to learn in the project [...] what functionalities do these offer [...] of course for us, for the business side, this is always a matter of subject, one always skates on thin ice. One really has to be careful with this, so I always try to adapt the terminology of the customer which exists in the bank and I don't try to to import my own technical terms because this naturally is an evolved thing [...] for example, this database which they original had, 'Merkmalsdatenbank'* [German: attribute database]*, this was a really bank-specific word. And this you initially have to really understand, what this really is.*"[799]

This was also due to the parallel implementation of two large projects – Basel II data warehouse and new core banking system – which had to work closely together. Both projects showed different understandings and interpretations of concepts.

> "*A nice example is always that for testing, they use such concepts as 'module test', 'system test', 'integration test', where from experience, the borderline between which is what, in each bank, in each sub-project is different. So in our case, we had the effect that we had a parallel project that introduced a new core banking system. This was supported by another IT provider, who naturally had their procedure, their nomenclature. And there, naturally, different concepts were used at the beginning, so that the different understandings of both projects had to be addressed.*"[800]

During the course of the project, a shared understanding between both projects was created, for instance, about the meaning of test phases or project phases. The meaning of terms and concepts was learned in specific working situations and through repeated discussions.

> "*It wasn't the case that we asked explicitly 'What is the meaning of this? What stands behind it?' [...] Because first, it usually took quite a while until you found the right contact person for the respective system. And then, you did't get complete information, if you worked with half-complete abstract concepts and didn't really know what hides behind this.*"[801]

[798] Interview with Mr. TA, translated by the author.
[799] Interview with Mr. SK, translated by the author.
[800] Interview with Mr. TA, translated by the author.
[801] Interview with Mrs. SK, translated by the author.

In general, the external variety for the project was very high since (1) Bank B faced new, previously unknown regulatory demands, (2) Bank B was target of an acquisition, and (3) a new core banking system was implemented in parallel to the Basel II project. Since the new core banking system was still in development, the meaning of important concepts was not clear, even to experienced bank employees. So to begin with, ambiguity and uncertainty were perceived as being high due to the existence of several sub-language communities in the project, business units, IT department, other projects, and subsidiaries.

> "*The whole thing was dominated by the core banking system, the definitions, the terminology [...] so in part, this was really incomprehensible for me. Because a) nobody from the side of the bank really knew this, the functionalities of the core banking system [...] and the processes and in particular the interfaces to the global data warehouse, that was something for us, yeah, this had been explained to us, everybody from the bank new a little bit about it. But nobody had a good, complete picture of the whole thing. This certainly got better during the course of the project, one can say that, but misunderstandings always occurred. [...] And when you descended deeper with your torch, you also noticed, OK, then the computing organizers start to argue with you, what do they understand by this, technically.*"[802]

During the course of the project, due to high work load in management tasks, sight was lost of the important direct information channel between business employees, IT developers and employees from subsidiaries. The high workload resulted from higher external variety and circumstances external to the project but influencing the project staffing, and requiring permanent replanning, tracking of resources and quality of work. Caused by non-project activities, a couple of times the staffing of bank employees had to be adapted by the managers, which added more tasks to the position than calculated upfront.

Besides, as there was no formal specification of a permanent direct communication between business division and IT department pertaining to requirements, the exchange of conceptual modeling ideas over time was not really taking place. In addition, business view feedback was given mostly in an individual style. For instance, contents of a data warehouse release were harmonized by a bunch of e-mails. As a result, there were late requirement changes, which led from human resource shortage to loss of functionality and reduced time for documentation.

The formal project goals were specified by the project management team as (1) business requirement documents, (2) a software product and (3) a technical documentation. Project participants tried to at least fulfill all of these in pragmatic ways, because there was no time to discuss documentation contents deeply. The documents were read, interpreted and implemented by the developers having only little discussion with the business division. The following example clarifies this behavior and resulting problems due to lack of communication. One requirement was to calculate the group-wide exposure of customers within the extraction, transformation and loading (ETL) process. The business requirements did not cope with technical issues like inactive or closed deals which were needed for other analyses in the data warehouse. Having these additional deals within the calculation, the runtime of the data warehouse had become unacceptable. Consequently, the responsible business employee

[802] Interview with Mrs. SK, translated by the author.

and IT manager were directed to form a task force to solve the situation together. It took only a few hours to reduce the relevant amount of deals for the calculation to a half, which brought the runtime back in line. The business employee had no chance to consider this case upfront since technical knowledge was required.

> "*So, if you would imagine it* [i. e., the process]*: 'business department defines, throws it behind them and IT implements this.' Naturally, this is relatively difficult in certain situations, especially if you have such complex projects such as Basel II. [...] Especially if you, for example, do parameter estimations, or rating system implementation just now, then you always have new insights from business during requirements and implementation phases. [...] so we had some exciting situations because the divisional head or IT project leader naturally always said 'Are these now all the data fields you need or is there something incoming yet? Because you can forget new requirements, we have only those data fields for this release.' And this was a difficult situation on the side of the business units [...] and this also led to breakdowns [...] in the losses definition for example, I think, where we saw that this wasn't implemented correctly.*"[803]

Once a language community gradually began to emerge between all involved stakeholder, especially between members of both large projects, ambiguity and uncertainty were drastically reduced and decisions were taken faster.

> "*Yes, where did we have this? Yes, there was this nice module, that was called ABA, 'Antragsbearbeitungsapplikation'* [German: offer processing application] *[...]. Under this term, one can imagine quite a lot, and there we had a lot of discrepancies between both projects, even concerning the question where this is positioned with regard to IT, technically. And then we had different coordination meetings where one said 'OK, what really is the content of this system?' so that later you really could clarify the business activities and could limit responsibilities and interfaces relatively well.*"[804]

Adding to this situation at head office, the creation of a shared understanding between head office and subsidiaries proved to be difficult as well. On the one hand, the interfaces to the subsidiaries' operational systems and the core banking system were extremely complex. On the other hand, the types of businesses in Eastern Europe were fundamentally different from businesses at head office, leading to an even greater variety and more ambiguity for the project, which was not perceived as a problem at the beginning; the project managers just did not imagine that different understandings and meanings for the same concepts were existing in Bank B.

However, as this proved to be the case, the procedure for dealing with those problems changed as the project progressed. For instance, so-called task forces were established for subsidiaries that had not been able to deliver data on time because their interfaces did not work properly. As at Bank A, the project managers at head office voiced concern that just sending out the interface specification had not been enough to clarify the meaning of all important concepts, and that personal face-to-face contact and even physical inspection were necessary for solving these misunderstandings.

[803] Interview with Mrs. SK, translated by the author.
[804] Interview with Mr. TA, translated by the author.

> "*Yes, I believe that verbal contact was necessary for explanation, but what I don't understand – or I do understand, but don't find OK how it was handled – [...] we had long meetings with the subsidiaries at the beginning, for instance, we had two complete days with SUBSIDIARY DWY* [fictitious name] *alone where Tom* [fictitious name] *had been with us and we went trough every data field. That is, a sufficient understanding of meaning should have been developed by this because he had two days time to ask questions.*"[805]

> "*This then changed from the initial procedure of 'We send you a concept, look what you got and send us back the results' to a much more workshop-oriented procedure. So one did say 'We have to support you much more, we come over to you and look everything through in workshops together with you' and in a second step one conscripted the colleagues respectively and said 'We let our project member sit with you and he will support you for the next days and weeks'.*"[806]

Consequently, the specification and the workshops were not enough to generate a shared understanding. The technical face-to-face coaching on-site was very important so that employees at the subsidiaries understood the requirements and to analyze if the requirements that were specified at head office really were reasonable and meaningful for every subsidiary. Whereas the first project phase had been specification-driven, this second project phase was communication-driven. For instance, the self-estimated efforts for on-site meetings were three times higher during the second phase than before. Therefore the creation of a language community by intensive face-to-face communication and physical inspection was one of the central factors for project success and the handling of high variety, high ambiguity and uncertainty within the project.

> "*[...] with the employees of CONSULT, for instance, John* [fictitious name]. *That we really were on site, for instance at SUBSIDIARY DWY* [fictitious name], *and that we drove them, drove them, drove them, yes. If you only take this effect, that somebody is on-site and the people see and know that this is important, that counts for a lot of things. [...] and if we look at John, for instance, that is somebody who notices by himself which questions as regards content are really burning and has the ability to find answers to those at our side very, very quickly because he knows whom to call and ask.*"[807]

As reported earlier, there was no predetermined method for specification and business view feedback was mostly given in an individual style. During the workshops, Microsoft Powerpoint slides or ER models were used as a basis and outline for discussions of specific problems. However, the usage of a specific modeling method was not perceived as necessary for project success.

In summary, the following interpretation was generated from the facts of the case:

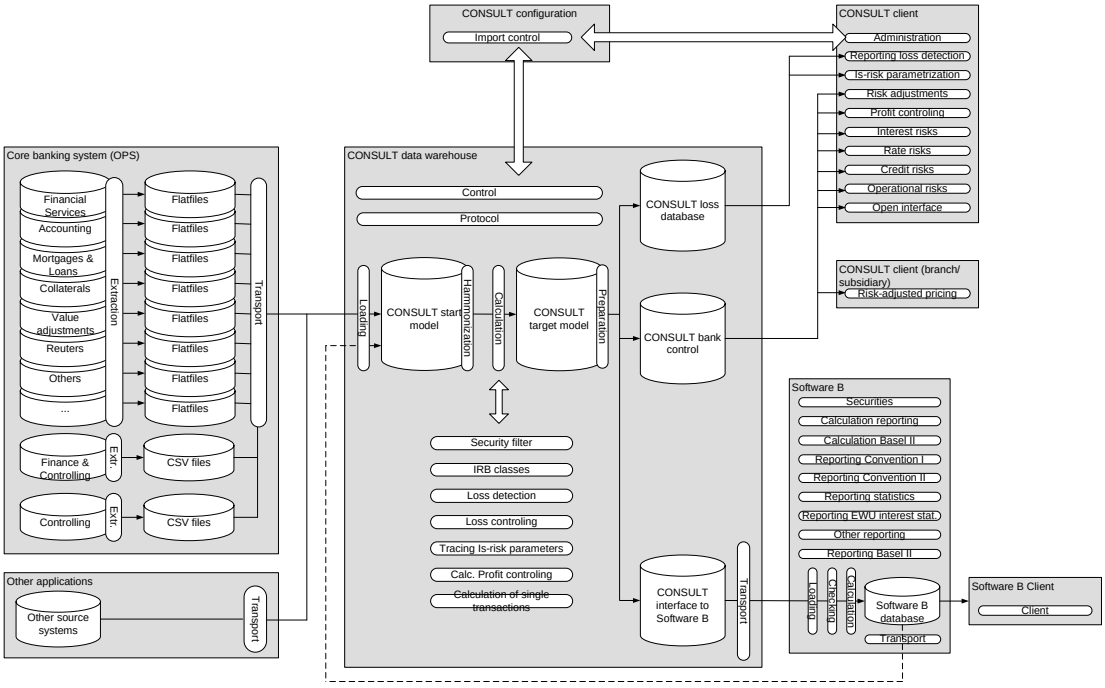
[805] Interview with Mr. TE, translated by the author.
[806] Interview with Mr. TA, translated by the author.
[807] Interview with Mr. TE, translated by the author.

- The project at Bank B was faced by high variety and ambiguity. The project managers realized that many problems were due to differences in understanding and interpretations.
- The project managers consciously shifted the procedure from a specification-driven approach to a more communication-driven approach once the problem of misunderstandings and different interpretations was realized.
- A language community emerged in the project over time due to increased communication in face-to-face situations and learning in discussions the precise meaning of terms. This reduced ambiguity for all project members.
- The existing sub-language communities were consolidated and a shared understanding of all involved stakeholders was created.
- Conceptual models helped to speed up discussions about differences in understanding and interpretation.

6.2.3 Bank C

Bank C is a national financial service provider which specializes in customers from the domains of social services and healthcare. In order to meet the regulatory requirements of Basel II and future strategic requirements, Bank C decided to implement a new integrated controlling system based on a central data warehouse. The project took place between 2005 and 2007 and was realized with the help of CONSULT. The project was also influenced by the parallel implementation of a new operative core banking system which lasted until 2006. Due to two related but different main goals, the project was split into the two modules "regulatory reporting" (Basel II, loss database) and "control" (operational and business control). The to-be-developed data warehouse was intended as an integrated database for both project modules. Consequently, changes in one area had significant impacts on the other area, which had to be taken into account. During the project, three different consultant teams were in action at Bank C and had to work closely together: Team A was responsible for implementing the new core banking system (OPS, fictitious name), Team B conceptualized and implemented the regulatory reporting system (Software B, fictitious name), and Team C (from CONSULT) conceptualized and implemented the central data warehouse. Since the data warehouse team had to build interfaces to and integrate data from both other systems, this was deemed one of the most important tasks for project success. Figure 6.3 gives an overview of the the intended data warehouse architecture, the involved application systems, and data flows.

External and internal variety were both perceived as very high by the data warehouse project team due to environmental factors (e. g., new regulatory requirements) and the organizational situation (e. g., implementation of a new core banking system). However, no subsidiaries had to be taken into account. At the beginning, the presence of three teams was hindering the project due to the existence of several sub-language communities. On the one hand, the teams had quite separate IT-related jargons. On the other hand, the teams had also different meanings and understandings of banking-related and Basel



Source: adopted from internal project documentation

Figure 6.3: Architecture of Data Warehouse Solution (Bank C)

II-related technical terms that were important for the overall project. This proved to be very difficult during most of the project's running time. Between those sub-language communities, misunderstandings occurred quite frequently. This was perceived to be caused by the different meanings ascribed to terms in the different teams.

> "*The example 'validierter Saldo'* [German: validated balance] *strikes me on this level. [...] this wasn't a problem at the beginning of the project, which could have been due to my personal situation as a newcomer, but something that happened at some time during the project [...] for us it was clear, this is an established term and means the actual capital disbursed [...] but in the core banking system team, they understood it differently, or in the core banking system the data field with this description yields something different respectively, namely the* original *capital disbursed [...] this led to many bad coordination loops and to costs on our side because we had to adapt the data history.*"[808]

> "*So what attracted my attention at Bank C was that [...] because they have OPS as the core banking system, that a specific department that is associated with the core banking system, for example, the credit department, there they simply borrowed the terms from OPS, and you had to translate this for yourself again in your own language.*"[809]

[808] Interview with Mr. VC, translated by the author.
[809] Interview with Mr. JD, translated by the author.

Examples like this led to bad data quality, several errors in the tests after the first implementation phase, and several misunderstandings and problems in the project.

> "*Definitely, so what did strike me, I had to deal intensively with the collaterals affair, and . . .mmmh . . .the OPS world has really different terms after all. So [. . .] what was the name of this again? How did they call it? Well, they simply called it 'Zuweisung'* [German: assignment] *and we called it . . .I have to think about it, but then I'll remember it [. . .] At any rate, you noticed at Bank C that you had to get into the habit of using the OPS language, actually.*"[810]

Since the new core banking system had been implemented in 2006 and Team A had left the bank at that time already, a lot of consolidation of technical terms and corrections in the operational systems, core banking system and extractors had to be done by IT developers of Bank C. Time and time again, the project team members had to meet and discuss problems and differences in understanding. Gradually, a language community emerged between the remaining project members, which consolidated the existing sub-language communities.

> "*[. . .] And the total system landscape – CONSULT data warehouse, Software B, OPS with different modules – implicated that members of the project team created a specific common base of terms so that somebody new to the project had difficult times, because if they started to talk about any OPS modules or specialties of Software B, this wasn't really easy. [. . .] You really had to learn the ropes for specific technical terms, especially in the area of Basel II, referring to some reports, keeping one's nose to the grindstone and observing what happens.*"[811]

> "*Yes, definitely, so this arrived, that you know about what you are talking. [. . .] To a great extent, you learned it by getting data which you tried to interpret, and you noticed that you didn't arrive at a meaningful result with this interpretation, and you started, you tried, started to search for this in the core banking system. And while doing this, you noticed that specific things are totally different in OPS than you'd expect them to be, and then you launched a discussion with the persons in charge for this. So it was a really more iterative process, as in 'If we understand it this way, we'd expect a delivery to look like this'.*"[812]

This consolidation and the intensive discussions of all involved stakeholders reduced ambiguity and uncertainty subsequently as well, and finally led to better data quality. As stated by project members, the project was perceivable running more smoothly once ambiguity had been reduced or when it was noticed that a different understanding of a term was existing.

> "*When you sat down and talked this through together, then you had no discrepancies. In certain circumstance, it wasn't clear for single data field, because our software has its requirements and if you don't name them explicitly, they are hard to infer from the*

[810] Interview with Mr. JD, translated by the author.
[811] Interview with Mr. VC, translated by the author.
[812] Interview with Mr. JD, translated by the author.

> *field names or field descriptions. [...] you have to address such things explicitly if this was somehow lost in the torrent of data requests. [...] Such things are very important, meaning the precise description of data requests or technical contents. In my judgment, this accounts for more than half of project success in such an IT or data warehouse project.*"[813]

As in the previous projects at Bank A and Bank B, the overall procedure was consciously changed after the project management team realized those problems in order to deal with ambiguity more effectively, to create a shared language understanding, and to reach the project goal on time. For instance, according to data from the self-estimation surveys, the efforts for communication became three times as high as before.

> "*[...] In the first phase, one had the attitude that we didn't actually want to understand the core banking system, but that we wanted to have interfaces filled and that is why one provided the data request catalogues respectively and hoped that this somehow will be matched. Then we had this second phase [...] 'OK, this is not quite working, we sit down with them together and try to understand their basic problem to some extent'. And in the last phase I had the feeling that one actually rather looked in the core banking system oneself a little bit, where is the information, discussed this more or less again with bank employees and the interface developer [...] so that you got another view, searched for and finally got an access to the core banking system.*"[814]

According to all interviewed project members at Bank C, conceptual models and conceptual modeling were neither employed in order to create a mutual understanding in discussions nor for documenting any specification of the data warehouse. However, Microsoft Excel was used for documenting data requests.

To sum up the findings, the following interpretation was generated from the case:

- Variety was high due to new regulatory requirements. The simultaneous action of three different teams led to even higher variety and ambiguity in the project due to the use of distinct sub-terminologies. This led to misunderstandings and severe communication problems.
- The project managers consciously shifted the procedure from a specification-driven approach to a more communication-driven approach once the problem of misunderstanding was realized.
- A language community gradually emerged for the project team by empractical learning in face-to-face discussions. This reduced variety and ambiguity for all project members.
- Conceptual models were not employed for discussions or documentation.

[813] Interview with Mr. VC, translated by the author.
[814] Interview with Mr. JD, translated by the author.

6.2.4 Bank D

Bank D is an independent subsidiary of a larger national banking group and focuses on instalment credits for private clients. It offers an integrated business and processing platform for the entire credit business to both group members and cooperating partners including banks, insurances and special financing companies. The production bank platform of Bank D enables largely automated processing of instalment credits from acquisition to settlement phase. Tailored scoring procedures allow complete assumption of the credit-rating risk for Bank D as well as client screening based on buying behavior for the systematic exploitation of cross-selling potential. In order to be capable of addressing the challenges of the market resulting from the strategic positioning as a product bank – for instance, swift and accurate automatic credit decisions or the calculation of risk premiums depending on credit rating for covering and taking over the individual risk of default – and due to the current Basel II requirements, Bank D decided to implement the new supervisory regulations for the parent group and for cooperating partners as well. Therefore, CONSULT was commissioned at the beginning of 2005 to check and adapt the existing approaches at Bank D in relation to compatibility with this strategy and Basel II in order to prepare the risk management system of Bank D for the increased operational and regulatory challenges. The project implemented a data warehouse and accompanying reporting systems for both KSA and IRB approaches, and officially was finished at the end of 2006. Small successor projects for connecting new banking products to the data warehouse were still ongoing until 2008. Figure 6.4 gives an overview of the intended data warehouse architecture, the involved application systems, and data flows.

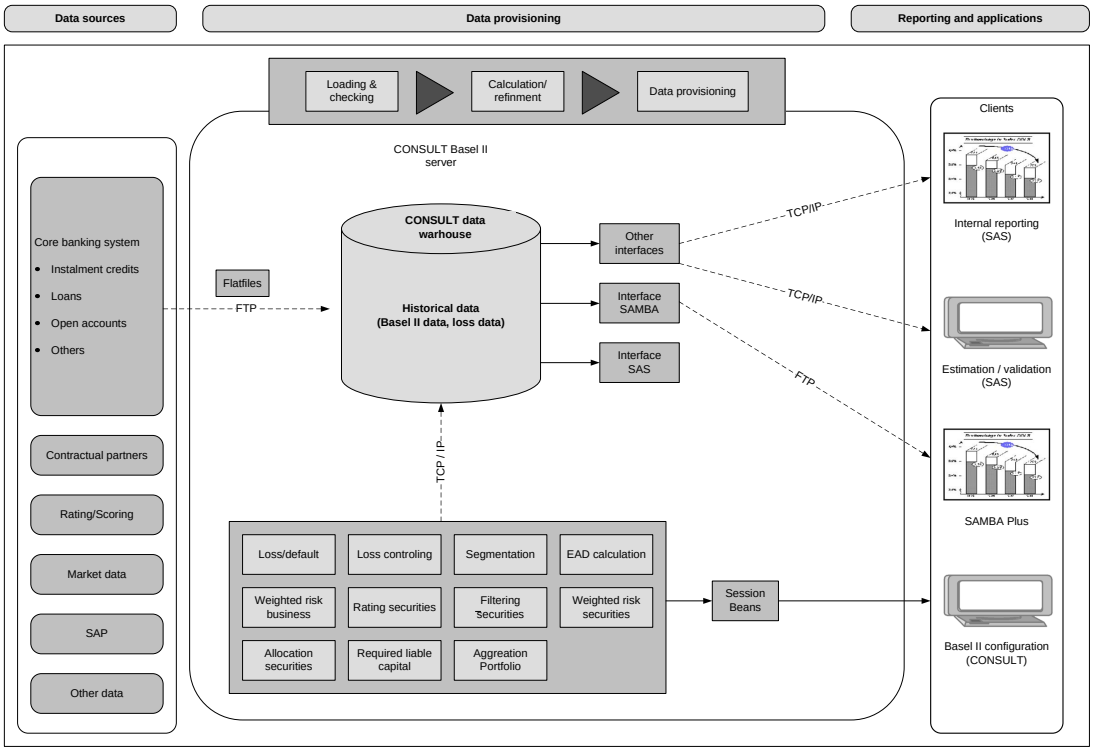
The general procedure model differed slightly from the cases introduced before. Generally, in the previously described three cases, CONSULT directly built interfaces for the source systems and later tried to match the data to a target data model. At Bank D, the project members engaged into an initial joint preparation and planning phase in order to get an overview about the situation in the environment and Bank D.

> "*Typically, we have a prearrangement where we [...] clarify the products with the customer for now, that is mostly done by e-mail correspondence [...] and the source systems of the customer, and then you have a matrix, which source systems have collaterals and something like this [...] when I know which source systems he has and which products they contain, then I make a standardized data request, quasi, for each source system and product, and prepare the structure for the persons in charge for the particular combination in order to match the mappings later.*"[815]

After this matrix had been completed and employees who were responsible for product/application system combinations at Bank D had been identified, a coordination phase started in which CONSULT consultants met with those experts in order to discuss face-to-face the data requests required for the data warehouse.

> "*Usually, these are one or two persons in charge on the technical side* [of the source systems]. *Those generally know the products quite well. And on the business site, you*

[815] Interview with Mr. SK, translated by the author.



Source: adopted from internal project documentation

Figure 6.4: Architecture of Data Warehouse Solution (Bank D)

> *actually have a classification per product, and those* [employees] *have to participate in the coordination. [...] If you don't know the right person, then you might speak to someone that tells you some nonsense [...] there are between five and ten appointments and we coordinate everything in a first round. Then I have gaps, open issues that couldn't be solved yet, where they are not sure. Those are marked in the data request catalogue, and in a second phase I would focus on those fields.*"[816]

Besides a different general procedure, several sub-language communities existed at Bank D at first as well, which had different understandings and meanings of important IT-related and business-related technical terms.

> "*[...] so yes, I'd say there are differences, depending on how specific technical terms have to be understood, so what one understands completely under 'offener Zusage'* [German: open limit]*, for example, or under other conceptions which play a role in Basel II. One really has to precisely paraphrase this or describe this to oneself in order to realize that one is talking about the same thing. Whereby the conception itself, from the choice of words, is nearly the same* [at each bank]*. But what is understood under this is partly different. [...] So concretely, I remember that at Bank D we had problems concerning demarcations of conceptions, what really is meant by turnovers*

[816] Interview with Mr. SK, translated by the author.

> *and settlements of accounts in the context of . . .in connection with credit cards. There, they always understood it differently in parts because you can definitely argue 'Is the disposal on the credit card a turnover or is it not a turnover until I have the credit card debit booked to the account?'"*[817]

However, during the course of the project, a shared understanding and terminology emerged due to the daily interactions of all project members and stakeholders. The employed procedure relied on the initial workshops of all involved stakeholders, and a lot of direct face-to-face communication ensured that ambiguity gradually was reduced.

> "*The* [initial] *workshop really was efficient since it coordinated the rough structure and the required data fields. And as a consequence, only a few requests were made concerning single data fields, that one said 'This or that I don't understand completely, what value has to be entered in this?' And then you could clarify this bilaterally. OK, we had one situation again, that something fundamentally wasn't clear, there, we did another new workshop and said 'Now it has reached a level where we don't come out with a simple phone call, now we have to clarify this fundamentally', and then we sat together and explained things [. . .]*"[818]

Due to the environmental situation, variety and ambiguity were perceived as high but attackable and controllable by the procedure previously described. The procedure model helped project members to initially reduce ambiguity. Most of the time was spent for exactly specifying the required data requests in very fine detail in face-to-face communication.

> "[This procedure] *makes it easier in the implementation phase, but is more complicated during the coordination of data requests. [. . .] Because you have to discuss this longer so that they understand it correctly, that you make the point. [. . .] And that's why the coordination just took months, especially those events concerning loss control, this is so complicated, till you understand that yourself and because they had to implement that in the source system themselves, this took ages.*"[819]

> "*Since we had a really manageable context and the number of contact persons is really small, it usually sufficed that, if one noticed that differences in understanding . . .in the understanding of terms, that one talked about this, what do we now understand by this, and 'I see', and then we as CONSULT adopted the conceptions and the custom of the bank and then used their terms, like they wanted them.*"[820]

Conceptual models were used on several occasion during the course of the project for discussions with the customer. This helped in clarifying misunderstandings and reducing ambiguity. Moreover, conceptual models were used for documenting the specification. The use of a specific conceptual modeling language was not considered to be important.

[817] Interview with Mr. DF, translated by the author.
[818] Interview with Mr. DF, translated by the author.
[819] Interview with Mr. SK, translated by the author.
[820] Interview with Mr. DF, translated by the author.

> "*That I did a few times, at Bank D for example, well, the loss database, this was really complicated, and there we used data models to explain snapshots, at which moment what happens. And what our developers of course have to do if we build view constructs, then they always have to document the single views, and this the customer sees as well, but he only looks at this in times of examinations, nobody really works with this. [...] the customer doesn't really need the model for himself, but rather we want to want to know something from him, indeed, quasi in order to accomplish the commission.*"[821]

To summarize the interpretations generated from the findings of the case:

- Variety and ambiguity were high at first. Several sub-language communities existed at Bank D.
- A different procedure was employed than in the previous cases. This procedure was more communication-driven and coupled an initial planning phase with an intensive coordination phase which relied on communicative situations and face-to-face discussions.
- A shared understanding and terminology emerged due to empractical learning in this face-to-face communication.
- Conceptual models helped to discuss differences in understanding and interpretation.

6.2.5 Bank E

Bank E is a national retail subsidiary of a larger foreign banking group. In addition to the regulatory requirements of Basel II, Bank E had to cope with numerous additional challenges in the structure of its risk management. The challenges due to the specific business portfolio of Bank E and the associated IT infrastructure were compounded by the general requirements of an internationally operating parent company. Against this background the bank decided to establish a central data warehouse for the integration of the various operational systems. At the beginning of 2007 Bank E assigned to CONSULT the overall responsibility for the functional and technical implementation of Basel II reporting according to the KSA approach as well as a risk-taking capacity concept and a feasibility study for a subsequent IRB approach. The overall implementation schedule to accomplish these tasks was only about ten months. It was the responsibility of the joint project management that consisted of a CONSULT manager and the bank's Head of Finance to achieve the project goals on schedule and on budget until the beginning of 2008.

In general, the procedure model of the project is comparable to that at Bank D. The first project phase compared all activities required for the implementation of the KSA approach for Basel II as well as the minimum requirements for risk management to the as-is status at Bank E. This was followed by a comprehensive expert coordination phase, in which all issues regarding the adequate reporting of Bank E's products in the future, the risk mitigation techniques, the definition of default and loss as well as the analysis of possible approaches for assessing operational risk were detailed and defined in discussions and workshops taking

[821] Interview with Mr. SK, translated by the author.

place with Bank E's business and IT experts and CONSULT consultants. After specifying the general framework of the future IT architecture, the technical implementation phase began in parallel to the expert meetings. Based on standardized data requests gathered from the coordination phase, the first implementation loop consisted of configuring and loading the data warehouse. In contrast to all previous cases, CONSULT accompanied the complete course of the project by using the prototype of a newly developed data request (DRQ) / data quality management (DQM) tool.[822]

Bank E had no subsidiaries and only had one major source system. However, this was developed and managed by the foreign parent company. This and the external variety created by the new regulatory requirements caused ambiguity, which could be observed by the existence of different sub-language communities and misunderstandings in meaning.

> "*[...] this whole part ...so is-parameter, calculations [...] search me! Is-PD calculation, is-CCF calculation, is-LDG calculation, naturally, you have to explain this quite a few times, how this is working in detail. I mean, roughly, everybody has an understanding of this, at the customer as well, but if you are looking at concrete cases, you naturally have to, well, explain it a few times more often.*"[823]

> "*At Bank E this took seven, eight, nine circles on one matter. I mean, this are especially problems, for example, with 'offene Zusagen'* [German: open limits] *[...] then you sat together seven times in two weeks with the person in charge because they couldn't get their act together.*"[824]

External variety was perceived as high, but not as high as in the previous cases. Due to the employed procedure and the communication-intensive preparation phase, a shared terminology quickly emerged. This was also achieved due to experiencing and discussing in concrete situations the meaning of important terms.

> "*And that at this point didn't work well in parts because the customer had to deliver a lot more business input, and possibly had to know a lot more about, well, terms, what is behind those. And one naturally had to explain this again and again to him in detail a lot more, what is the meaning of this, as at the beginning where you did everything by yourself and presented the results, and then the customer simply could say 'Yes, well, everything is understood so far, everything is OK' than if he really has to do these things by himself. Then he has to inquire more often, naturally.*"[825]

After the first coordination phase, additional meetings and discussions of consultants, developers and business experts became necessary, for instance, if data field descriptions had to be supplemented in order to make the meaning of terms clear and to reduce ambiguity.

> "*This occurs in the discussions. Because the customer says 'I have this field here, but this also includes interests, do you want interests or don't you want them?' Then you*

[822]The DRQ/DQM tool had been commissioned and specified by Mr. SK based on his experiences at Bank D and had been implemented by CONSULT's internal software development department.
[823]Interview with Mr. MK, translated by the author.
[824]Interview with Mr. SK, translated by the author.
[825]Interview with Mr. MK, translated by the author.

have to give thought to this, do you want them or not. [...] Or at loss events, if they didn't exactly know which fields are necessary for this and which are not, then you had expert circles with three, four, five, six people, because then nobody knows exactly how the loss could be defined in a source system [...]"[826]

Basically, the project followed a similar communication-driven procedure as at Bank D. However, the new DRQ/DQM tool was used intensively for specifying data requests in the coordination phase and for quality checks in the testing phase.

"*At Bank D the tool was not existing, this made me so sick that I let them develop it. [...] At Bank D we had Excel sheets containing the data requests, and there not two persons could work simultaneously, you have version conflicts. Then in customizing a lot of people work with views, and data quality management is in the views and nobody knows why, if an error occurs [...] And that's why I figured it could be useful to have such a tool [...] where you have standard data requests and can describe the mappings.*"[827]

The DRQ/DQM tool also allows for detailed consistency checks in both testing phases and operational loading phases, and generates reports showing errors and open issues. All project members including employees of Bank E used the DRQ/DQM tool for specifying the business view mappings according to source systems. Moreover, all project members used the tool for checking the consistency of the data fields and to mark open issues and problems. The use of the tool, coupled with an intensively workshop-oriented initial procedure, facilitated the creation of a language community and a shared terminology within the project. During the coordination phase and the accompanying discussions, the DRQ/DQM tool proved to be extremely useful in order to really understand the situation and relationships at Bank E. The tool documented a kind of history of the language community creation and all project team members could refer back to it and use it as a guideline for open issues, problems and misunderstandings.

"*So, the DRQ tool, we basically enter all data requests that we have into it. [...] So not just we from CONSULT's side, but it is employed by the customer, too. And DQM we really use for all data that we get delivered by the customer, until we, well, check the data fields in the end . [...] So basically we entered our data requests, the customer said what fields he needs. Then in the next step, this was specified in more detail, what the customer understands by this, from the business department side, which data he wants to have. And in the next step, for each source system, a specialist [...] looked where he could get those data fields in his source system. And then you naturally always had inquiries [...] by setting a status marker accordingly and by sending the questions regarding those fields back to the business department, who could really use the DRQ tool for directly giving the answers. And the next step was that those who should get the data out of the source systems, into the data warehouse of the bank, again looked into the DRQ tool and there they found their ...yes, they quasi found the mappings already described there and could implement them relatively quickly.*"[828]

[826]Interview with Mr. SK, translated by the author.
[827]Interview with Mr. SK, translated by the author.
[828]Interview with Mr. MK, translated by the author.

Basically, the tool allowed for semantically mapping the meaning of terms at Bank E to data fields in the data warehouse and the operational source systems and to engage into clarifying discussions about understanding issues. This simplified the creation of a shared understanding and sped up the process of sense-making. Open issues could be tracked and questions regarding meanings of terms could be sent to the business department. Employees in the business department tried to answer those questions directly in the tool and afterwards, the IT developers could continue directly with those fields. This was perceived as an enormous simplification of the procedure.

> "*Eventually, if you make such alignments, then this leads to the uncovering of any errors or that we ask any questions, and than they* [the employees of the bank] *give thought to those issues and then new solutions appear, so 'you don't really need this, this possibly is still wrong in our system', so you get more clarity in this, clearly.*"[829]

Specific conceptual models were not used during the project at Bank E, and the necessity of a specific modeling language was not perceived.

> "*So we didn't really employ any concrete models, but one tinkers with some Powerpoint charts and such alike and, well, then you possibly have a flow chart or block diagram or so, but that one really uses concrete models, that wasn't the case [...] mainly for ...for illustration and mainly in order to give some examples, yes.*"[830]

In summary, the following interpretation can be generated from the findings of the case:

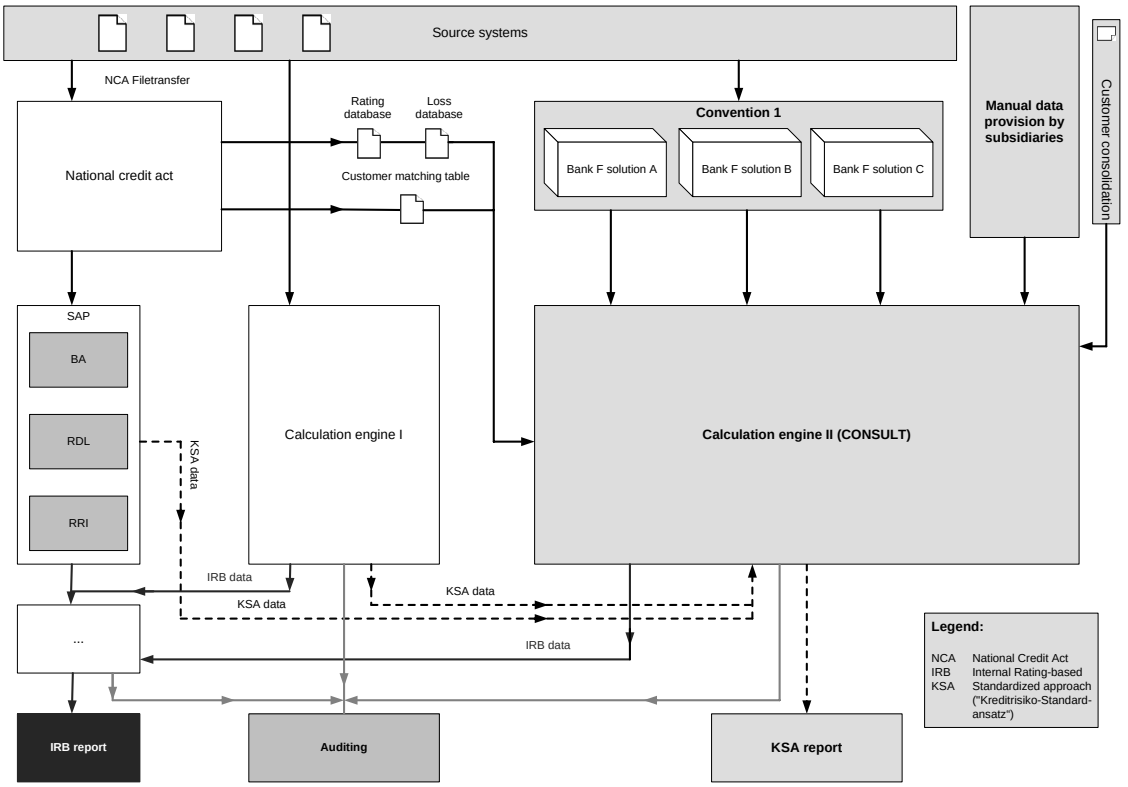
- Variety and ambiguity were high as the project faced the same regulatory requirements as the projects in all other cases. Several different sub-language communities existed.
- A communication-driven procedure supported empractical learning in face-to-face discussions and helped to create a shared understanding and language community.
- This procedure was supported by the use of the DRQ/DQM tool for negotiations and tracking of open issues.
- Conceptual models were not employed for discussions or documentation.

6.2.6 Bank F

Bank F is a major international financial institution with a very diversified portfolio of products. The bank specializes in retail banking and has many million customers throughout Europe. Moreover, Bank F provides transaction banking services for other financial partners. At Bank F, CONSULT implemented the calculations according to Basel II for selected, complex parts of the German product portfolio (e. g., derivates and bonds) which the bank's standard application system was not able to handle. Therefore, an already existing reporting system for Basel II had to be extended. CONSULT was commissioned to build interfaces and integrate different source systems for a data warehouse, perform the necessary

[829] Interview with Mr. SK, translated by the author.
[830] Interview with Mr. MK, translated by the author.

calculations in the data warehouse, and deliver the resulting calculations back to the existing reporting system. Since employees of Bank F explicitly had no time and were not interested in having this knowledge in-house, CONSULT was commissioned to do the mappings of source systems to the data warehouse by themselves. Figure 6.5 gives an overview of the the intended data warehouse architecture, the involved application systems, and data flows.



Source: adopted from internal project documentation

Figure 6.5: Architecture of Data Warehouse Solution (Bank F)

As in all previous cases, different sub-terminologies existed within Bank F and the project.

> "*[...] I mean, of course, yes, one has specific other languages there ...it is clear that if I am at a different bank and there, other IT systems are used, that then I have other conceptions for those IT systems and to extract or to enter data for a term, this are always other conceptions which are used in this.*"[831]

However, the procedure model at Bank F differed sharply from all previously described cases since the consultants of CONSULT were mostly working alone during the coordination and implementation phases. Only in the subsequent testing, employees of Bank F became involved more intensively. Basically, the consultants took the data of the existing reporting system, accumulated those data with around 15 other files that were necessary for the complex calculations, and subsequently had to calculate the results and check everything.

[831] Interview with Mr. DF, translated by the author.

> "*At Bank F, we had to do everything on our own. There, we called in the customer in certain situations, if uncertainties came up or so, this happened rather rarely. There, we did the mappings by ourselves and let the customer look over it. But at the bottom, the testing phase at the end was the factor for checking everything, the consolidation [...].*"[832]

Consequently, employees of Bank F were not involved in developing the data requests. Only if the consultants encountered severe problems in understanding they tried to contact an expert of Bank F. Instead, all data was delivered by an already existing and standardized interface which the project team members could use. This interface came with a thorough and good documentation. Consequently, the internal variety was perceived as high, but ambiguity and uncertainty as not very high.

> "*OK, technically, this wasn't easy because this ...this specification of SAMBA* [the standard interface] *again has its own language and wasn't known to us before. So we initially had no know-how concerning SAMBA files, insofar we had to work this out and this really required some know-how transfer within our team in order to figure out how this specification has to be understood. [...] And what really helped in this was that we had finished results due to the previous SAMBA processing. And we compared these finished results to our results and we could see if we quasi had the same result and if this was right. In doing this, one practically only had to have in mind that there was an amendment of principle I to Basel II, but certain amounts were the same, as a rule, so that one could assess if one had taken the right book value. [...] Therefore, this was possible without interaction with the customer.*"[833]

The DRQ/DQM tool was employed again in this case and helped in keeping track of which fields of the source systems were mapped to which fields in the data warehouse, and consequently helped in reducing ambiguity. Previous reports and results from the bank's standard application system were compared against the newly generated results and analyzed witn the help of the DRQ/DQM tool for differences, and how to explain those or not.

> "*[...] At Bank F, we didn't discuss a lot with the business department concering the data that we integrated. Practically, we got those and had a complete specification, what is contained in those data ...via the SAMBA interface, this were SAMBA input data [...] and we mapped those data. At the beginning, we did this nearly without contact to the business department so that we didn't require much coordination at this point. Later, during the project course, we naturally talked to them concerning certain things. But concerning conceptions ...there weren't so many, not so many disagreements.*"[834]

Conceptual models were not used at Bank F for engaging into discussions but only for documentation purposes.

To sum up, the following interpretation gives the findings of the case:

[832] Interview with Mr. SK, translated by the author.
[833] Interview with Mr. DF, translated by the author.
[834] Interview with Mr. DF, translated by the author.

- Variety due to new regulatory requirements was high. However, due to an already existing standard interface which included a documentation, ambiguity was not as high as in the other cases.
- The procedure differed strongly from that of all other cases since employees of Bank F were only involved intensively in the testing phase. Nearly no communication took place before that.
- The DRQ/DQM tool and the previous calculation results helped to test if the consultants had understood the specifications of the standard interface correctly.
- Conceptual models were not employed for discussions and only for documentation.

6.2.7 Cross-Case Description

The aim of studying multiple cases is to increase generalizability, reassuring the researcher that the events and processes in one well-described setting are not wholly idiosyncratic.[835] Therefore in multiple case studies, the result of the explanation-building process is also the creation of a cross-case analysis, not simply an analysis of each individual case. Since several key informants have been involved in more than one of the observed projects, this provides the opportunity to directly address the similarities and differences between them with inter-project comparisons.

Bank A and Bank B

Since both banks faced the same regulatory requirements, the initial external variety and uncertainty due to Basel II were comparable. However, Bank A had a larger number of involved subsidiaries than Bank B. Meanwhile, Bank B was the target of an acquisition during the project and also simultaneously implemented a new core banking system. Al in all, variety and complexity were stated as being comparable in both projects.

> "*Uncertainty in both projects was rather almost equal. At Bank A, it simply lasted five years [...] and had a multiple of effort* [of Bank B]*. So I don't know how many thousand of person-days have run into this, but they certainly started in 2003 in earnest and practically, they now have reported the standardized approach for the first time [...]. They had a much longer project runtime. Fair enough, it is a slightly larger bank with much more subsidiaries, so they have 18 subsidiaries in different countries in Eastern Europe, this is really much bigger in dimension. But they also had to make some real turnarounds and extra loops within the project, concerning the subject of classification: what is market risk, what is credit risk? Where do I represent the credit risk, in which data warehouse, where do I represent the market risk, and so on. They certainly got closer to the target more serpentine. And Bank B was more restrictive in this context, for sure, but you had technical specifications that were more clear anyway [...] And IT was more downstream [...].*"[836]

[835] Miles & Huberman (1994), p. 172.
[836] Interview with Mrs. SK, translated by the author.

> "*Bank B, Bank A are the most complex. [...] I believe that Bank A surely was [...] the most complex. In return, at Bank B, at least concerning our project scope, this was rather more comprehensive, so that our commission was clearly more broader [...]. And at Bank B this was mainly caused by all those subsidiaries...we had to watch out that the subsidiaries deliver the data into the data warehouse. [...] That is the difficult process, and that was one of the success factors at all, or risk factors in the whole project, where we battled until the end, that they deliver meaningful data. Surely, from my perspective, this was ...let's put it this way ...a challenge in these projects. And you just have a wholesale bank with all kind of products that do exist [...].*"[837]

So while external variety, ambiguity and uncertainty that both projects faced due to new regulatory requirements and other external circumstances were comparable, the project at Bank B was perceived to reduce ambiguity and uncertainty faster and better than the project at Bank A. This was achieved by engaging into direct face-to-face communication sooner during the course of the project and thus by creating a language community earlier. Moreover, the overall performance to reach the same goal was much faster – two years compared to six years – and the quality of the processes and product were also clearly perceived as better.

> "[The project at Bank B] *also had a much shorter running time, thus we have now in 2008 reported with the standardized approach, and the project has started in 2006, that is, we have implemented the basic functionality for Basel II in two years [...] the running time compared to the number of resources that have been burnt is certainly much lower than at Bank A [...]. The Bank B project was roughly 40,000 person-days until 2008. And Bank A had around 100, 200 people on average. So I would estimate that they would have around 100,000* [person-days] *But I can't say for sure now.*"[838]

Both projects experienced severe communication problems and misunderstandings at the subsidiaries. While both projects changed during the course of the project from a specification-driven to a communication-driven procedure in order to cope with these problems, the project team of Bank B did this earlier and created a shared terminology better and faster. The predefined goal was met by both projects. However, the final product at Bank B is stated to be much more satisfying and the project's goal was reached with less resources.

> "*Well, it works as well at Bank A, but whether I reckon the whole thing to be efficient, that is something different. [...] The solution is just relatively complex, also in the operation by now, and that expresses itself in the costs, naturally. So they twiddle around manually a lot and only load it once a month. Nevertheless, this is pretty fidgeting. They certainly need a relatively long time.*"[839]

The process in both projects was perceived as being highly chaotic and not of very high quality.

[837] Mr. TA during focus group meeting, translated by the author.
[838] Interview with Mrs. SK, translated by the author.
[839] Mr. WB during focus group meeting, translated by the author.

> "*For Bank B, you can also say: result, I'd say, target is achieved, absolutely in time. [...] regarding the process, that naturally was highly chaotic. ...because we had no contact persons at the bank, precisely nothing, which always were drawn off, there, the surrounding conditions were absolutely crappy and that was mirrored in everything else. Insofar, one just has to accurately distinguish between process and product.*"[840]

To sum up, Bank B is ranked better than Bank A with regard to quality of product and process. The project members of Bank B (1) created a language community better and faster due to an earlier shift to communication-intensive face-to-face discussions and (2) reduced ambiguity better and faster than the project members of Bank A.

Bank B and Bank D

Since both banks at Bank B and Bank D faced the same regulatory requirements, the initial external variety due to Basel II was comparable. However, the project at Bank D was much smaller in scope, had no subsidiaries to consider and the core banking system was not changing, which resulted in both lower external and internal variety and overall in lower ambiguity. However, for CONSULT, it was the first Basel II-related project and the first where they developed a calculation engine for Basel II. Due to this, the project at Bank D was also perceived as being more complex in political and social aspects. In general, the project at Bank D showed better communication, a more concise shared understanding and a higher quality of processes and final product than the project at Bank B.

> "*Somewhere in the middle was the project at Bank D [...] That was a house with its own ideas, own nomenclature, but wasn't so complex with regard to group structure and size. Besides, Bank D is a special institute with a specific business field. That is, the vocabulary that you have to know is not as large and you have to deal with fewer departments, that is, the number of contact persons was lower. And one had only one parallel project for coordination, and two departments and the IT department. [...] at Bank B we had in principle seven, eight, nine departments, with three or four parallel projects, and what makes matters worse, with foreign subsidiaries. [...] Bank D was a project where I would say that communication was fair to middling, but at the same time the most successful of the three named projects* [Bank B, Bank D and at a third project not investigated here]."[841]

To summarize, the project at Bank D was not as complex as the project at Bank B, which resulted in lower variety and ambiguity. However, communication at Bank D was stated as being much better and the processes of higher quality compared to the project at Bank B.

Bank D and Bank E

In general, the cases at Bank D and Bank E were very similar in project scope, variety, and ambiguity. However, the project at Bank E was perceived to be running more smoothly and having reduced ambiguity and uncertainty faster.

[840] Mr. TA during focus group meeting, translated by the author.
[841] Interview with Mr. TA, translated by the author.

> "*Such a statement is really difficult to make, because, for example at Bank D, that was the first implementation of the calculation engine, there was no DRQ tool, there were no real data requests. That is of course a special type of complexity. Per se, if you just simply say that the calculation engine would have existed . . .this would have been a more simple project. But with regard to the fact that it was the first such project, very complex. [. . .] In my opinion, Bank E was a more simple project, if anything. Each has just individual . . .problems.*"[842]

> "*Bank D was likely . . .as SK already said, objectively, it wouldn't have been all-too complex, but it was the pilot project at that time. Insofar, you had to gain experience for the first time. I'd also assess Bank E as relatively simple.*"[843]

Comparing the procedure model of Bank D and Bank E, the DRQ/DQM tool – which was only used as a first prototype at Bank D – especially helped to follow through with the two distinctive phases (i. e., coordination and testing).

> "[At Bank E] *we put a lot of emphasis on the standardization of the data requests, that wasn't that standardized before [. . .] Then you had a better foundation. Especially all these definitions that we supplemented, that really pays off later naturally with the next customer and with the effect that he does understand this better. [. . .] and at Bank E the customer worked with the tool, continuously, and then a process came into life. [. . .] it isn't an agony to consolidate the data requests but a part of the job.*"[844]

Summing up, both projects are comparable in scope and complexity. Both projects are ranked very high and used a communication-driven procedure. The quality of product and process of the project at Bank E was stated to be superior. This can partly be explained by the use of the DRQ/DQM tool, which supported the negotiation of meanings.

Bank C, Bank D, Bank E and Bank F

Comparing the case of Bank F to the previous cases, it is comparable in scope, variety and ambiguity to the projects at Bank A and Bank B. Compared to the cases at Bank D and Bank E, the project at Bank F had a perceived higher variety due to the size of Bank F. For instance, Bank F has around 20 operational systems compared to three to four at Bank D and Bank E. However, a shared language community and terminology within the project at Bank F were created better and faster than at Bank D and Bank E. This was partly due to the fact that the major interface was standardized and had not to be build from scratch. That is, ambiguity was already low and interaction with the employee's of Bank F were kept to a minimum.

> "*Yes, at Bank F I decided myself. Two and a half months, then we had the first connection, the complete system. At the others this took seven, eight months in parts. [. . .] There, we did it on our own, and I could call on business experts from our side,*

[842] Mr. SK during focus group meeting, translated by the author.
[843] Mr. TA during focus group meeting, translated by the author.
[844] Interview with Mr. SK, translated by the author.

those already knew the interfaces from other projects in parts, there it worked best [...]."[845]

Overall, the project at Bank F was characterized by high variety but low ambiguity since (1) a standard interface already existed and (2) experts from CONSULT already knew this interface quite well.

"*Bank F was never ...for me, it never was that complicated* [as at Bank C] *because we had a relatively standardized interface. So we had the SAMBA interface as input interface and as output interface as well, so we did, well, extensions and aggregations, but the interface itself was already highly standardized, so that we could fall back to comprehensive documentations and understood this actually quite fast, what does arrive by this. And which entities, how the entities are cut out. As a result you actually – I don't want to say no misunderstandings, but you basically had a an understanding in principle, of what arrives, how the interfaces are cut out, what characteristics in the fields have which meaning. In contrast at Bank C, actually, one had to built an interface from scratch, on a moving system which wasn't really finally configurated, and that made the coordination more difficult per se. And the data request catalogue, that too, that is how I experienced it, had a large amount of documentation at Bank F, the effect of documentation, so that you knew which fields were converted in what way and then connected how, so that you could attest the data flow [...].*"[846]

Although the standard interface helped to initially reduce ambiguity, the project at Bank F relied strongly on communication about the understanding of terms in the testing phase.

"*[...] So at Bank F we needed more people because we had to implement everything in a shorter period of time and because we couldn't coordinate the data requests but had to to everything on our own. Then, you needed experts of the bank in-betweens, for partial problems, but you didn't need those on the total level, much less effort for the bank compared to Bank E or Bank D. Those really were driven hard, there we had 20 workshops or so, in the total run, or 15 Workshops where we had to coordinate something, and an hour discussions on and off, where we simply sat together, simply so that they fill it in correctly, so that they understand it correctly. [...]* [At Bank F] *we involved the bank in the testing phase quite intensely, but we mapped everything on ourselves, implemented everything on ourselves, and involved the bank intensely in the testing phase.*"[847]

"*[...] merely, overall, at the end, if it is about details, then the interface doesn't get you much anymore, because it always is interpreted individually, how securitization is represented. Then they use any field in this, in order to mark the securitization position [...] and then you have 700 million deviation or 1 billion deviation in the data. [...]*"[848]

[845]Interview with Mr. SK, translated by the author.
[846]Interview with Mr. JD, translated by the author.
[847]Interview with Mr. SK, translated by the author.
[848]Mr. SK during focus group meeting, translated by the author.

In general, all four projects tried to clarify the relevant terms and states respectively (reduce ambiguity) in order to get meaningful values for those states (reduce uncertainty). In contrast to the other three projects, although the variety at Bank F was perceived as being even higher, the project was characterized by low ambiguity and was the best-ranked project overall.

> "*Quite clearly, the project at Bank F was more complex. So this is due to several things [...] you had more persons to contact on the side of Bank F, but also the products that are used by Bank F are really more complex than those which exist at Bank D. [...] so I'd say the project at Bank F was running or is running better than the project at Bank D [...]*"[849]

> "*With regard to the amount of data, the complexity of the businesses, the interfaces, Bank F is one of the more complex* [projects]. *We've had 11 million datasets, we have three different calculation engines which had to be connected, we had to collect the data by ourselves from ten different sources because nobody wanted to help us. I don't know, all in all, with regard to size, with regard to complexity, this was ahead of the list, in my opinion.*"[850]

But the existence of the standard interface reduced a lot of ambiguity from the beginning. Consequently, a language community was created very quickly. Comparing the three projects at Bank D, Bank E and Bank F, the latter is perceived to be running best, but also difficult to compare to the other projects.

> "*I believe that you could describe the data requests reasonably ...concerning the descriptions, concerning language, I am more of the type who believes that you could describe it. Human beings are the problem [...] I believe this depends a lot on ourselves, quasi. So if you do a lot of data quality management checks, and chase every data field [...] then your project success will be ten times greater than if you discuss the mappings a thousandfold, you'll still have a thousand errors in this [...].*"[851]

To summarize, the project at Bank F was one of the most complex ones. This was also in parts due to the non-existing coordination phase at the beginning, but this was mitigated by the existence of a thorough description of the standard interface. Moreover, the project at Bank F could leverage the lessons learned from previous projects and the newly developed DRQ/DQM tool.

> "*By trend, I would say, without giving an ordered sequence, the more complex the project the lower its quality [...] and we had all the tools only finished at this point in time. So DQM, DRQ tool, and we had people which all take care to the extreme that if something isn't working, that one carries on [...] instead of botching.*"[852]

[849] Interview with Mr. DF, translated by the author.
[850] Mr. SK during focus group meeting, translated by the author.
[851] Interview with Mr. SK, translated by the author.
[852] Mr. SK during focus group meeting, translated by the author.

> "*So to put it this way, the communication, the discussion, at one point you always have this. You cannot avoid it or get out of it, eventually, you have to make this matching, what do you understand by this field and what do we understand by this? [...] in the subsequent test, all the special cases will surface again, where they botched. [...]*"[853]

Table 6.3 to Table 6.6 summarize the findings with regard to the propositions of LAVAT in a cross-case display.

[853] Mr. TA during focus group meeting, translated by the author.

	P1	P2	P3
Bank A	✓ Several domain-specific language communities existed within the project. Examples are Basel II-specific terms such as 'limit' and 'contagion', but also bank-specific business terms and IT-related terms.	✓ Terminological discourse within the project was observed, first, in sub-terminologies for the project members from different units (e. g., head office, business units and subsidiaries), later, for the emergent language community of the project team.	✓ Traces of developing and revising the project's terminology were observed. Language (re)construction took place, for instance, during discussions in workshops or during on-site visits.
Bank B	✓ Various examples of technical, domain-specific language communities were observed (e. g., terms for different project phases, Basel II terminology, or project-related IT concepts).	✓ Once a shared understanding of all project members had been created as a common language between both simultaneous large projects, terminological discourse could be observed outside sub-language communities (e. g., departments, other projects or subsidiaries).	✓ The generation of a language community for the project was observed. Language (re)construction took place mostly in face-to-face communication during work situations. The generated terminology was shared by employees from head office, adjoint projects and subsidiaries.
Bank C	✓ Several sub-terminologies existed, especially between the different teams involved with different application systems (e. g., OPS, Software B and CONSULT system terminology).	✓ Once a shared understanding of all project members had been created, terminal discourse was observed within the project.	✓ The project created a shared terminology and language community, consolidating the existing sub-language communities, which mostly were observable between the different project teams.
Bank D	✓ Several sub-language communities existed which had different understandings and meanings of important IT-related and business-related technical terms (e. g., 'open assurance' and other Basel II terminology).	✓ Terminological discourse within the project was first observed in the existing sub-terminologies, then later in the project language community.	✓ During the course of the project, a shared understanding and terminology emerged due to daily interactions, initial workshops and a lot of direct face-to-face communication due to the applied procedure.
Bank E	✓ Different sub-language communities and misunderstandings in meaning could be observed (e. g., pertaining Basel II terminology or source system terminology).	✓ Once a shared language community began to emerge, terminological discourse was observed outside sub-language communities.	✓ Since the employed procedure had a communication-intensive preparation phase, a shared terminology was quickly generated. The DRQ/DQM tool assisted in this process.
Bank F	✓ Different sub-terminologies existed. However, due to the different project commission, this was mostly an issue for the consultants who had to get familiar with the interface specification.	✓ After the interface specification had been understood, terminological discourse was observed.	✓ Due to the involvement of consultancy experts for the interface and try-and-error processes, the meaning of the interface terminology was quickly learned by the consultants.

Legend: ✓ strongly supported; + weakly supported; – not supported

Table 6.3: Clustered Summary Table of Case Studies (I)

	P4	P5	P6	P7*
Bank A	✓ Due to the proliferating external variety, several sub-terminologies were existing which had different meanings and understandings for the same concepts.	✓ Once the existence of sub-terminologies within head office and subsidiaries had been accepted, the consolidation of those jargons began to create a language community within the project team. Afterwards, the meaning of terms and concepts became more clear for all involved stakeholders. Thus, ambiguity and uncertainty were reduced.	✓ Within-project comparison: in those subsidiaries where ambiguity was lowered better and faster, a language community was established better and faster. Employees in those subsidiaries were observed to be more aware of differences in interpretations and meanings of terms and concepts, and earlier became members of the project's language community.	–
Bank B	✓ The project and Bank B were faced with increasing external variety and responded with increasing internal variety. Different sub-terminologies with different understandings and meanings were observed.	✓ During the project, the existing sub-terminologies were consolidated and adapted by the language community of the project team members, and those terms became the standard for interpretation within Bank B.	✓ Between-projects comparison: both projects in Bank A and Bank B reduced ambiguity, and successfully implemented a Basel II-conforming data warehouse. However, ambiguity was reduced better and faster in Bank B's project. Compared to the project at Bank A, the project at Bank B performed faster (i. e., shorter project runtime) and was less costly.	–
Bank C	✓ Due to changes in the market and due to the new regulatory requirements, Bank C was faced with increasing external variety. However, at first, internal variety was rising because different sub-terminologies with different understandings and meanings were created.	✓ During the project, the existing sub-terminologies were consolidated and adapted by the language community of the project team members, and those terms became the standard for understanding within Bank C.	✓ Between-projects comparison: both projects in Bank C and Bank F reduced ambiguity and successfully implemented a Basel II-conforming data warehouse. However, ambiguity was reduced better and faster in Bank F's project due to the existence of a standardized interface. Compared to the project at Bank C, the project at Bank F performed much more faster (i. e., shorter project runtime).	–

* It was not attempted to search of evidence for higher semantic similarity and coherence in documents during the case studies, since the matching of documentation to individual project members was impossible.

Legend: ✓ strongly supported; + weakly supported; – not supported

Table 6.4: Clustered Summary Table of Case Studies (II)

	P4	P5	P6	P7*
Bank D	✓ Due to the environmental situation, variety and ambiguity were perceived as high, which also showed in the existence of different interpretations and understandings of important concepts.	✓ Variety and ambiguity were perceived as attackable and controllable by the procedure employed. The procedure model, incorporating intensive communication, helped project members to reduce the initial ambiguity and create a shared language community.	✓ Between-projects comparison: both projects in Bank B and Bank D faced new regulatory requirements. However, the project at Bank D was much smaller in scope and not changing its core banking system, which resulted in lower variety and ambiguity. However, Bank D's project was reducing variety and ambiguity faster and had a better quality of processes and product.	–
Bank E	✓ The external variety created by the new regulatory requirements caused ambiguity. As a reaction, the existence of different sub-language communities was observed.	✓ Internal Variety was perceived as high. Due to the employed procedure and the communication-intensive preparation phase, a shared terminology was quickly generated. The DRQ/DQM tool tremendously helped to reduce ambiguity.	✓ Between-projects comparison: both projects in Bank D and Bank E are comparable in project scope, variety, and ambiguity. The project at Bank E was perceived to be running more smoothly and having reduced ambiguity faster, in parts due to the fact that the DRQ/DQM tool helped in creating a shared language community faster.	–
Bank F	+ Since the procedure differed significantly from the other cases, the analysis can only be undertaken for the consultants. An understanding of the standard interface had to be undertaken.	+ A language community was already in place due to the existence of the standard interface. This reduced ambiguity. However, the consultants still had to learn this specification trough empractical learning and had to become a part of this language community.	✓ Between-projects comparison: in comparison to projects at Bank C, Bank D and Bank E, a shared language community and terminology within the project were created better and faster due to the standardization of the major interface (i. e., ambiguity was already low).	–

* It was not attempted to search of evidence for higher semantic similarity and coherence in documents during the case studies, since the matching of documentation to individual project members was impossible.

Legend: ✓ strongly supported; + weakly supported; – not supported

Table 6.5: Clustered Summary Table of Case Studies (III)

	P8	P9	P10
Bank A	✓ The joint discussion of conceptual models (i. e., the data delivery concepts which used ER diagrams) and jointly created ad-hoc models (i. e., sketches of cash flows) helped to create a shared, mutual understanding faster.	+ The documentation and specification on its own was not perceived to be useful by most project team members from both business units and IT departments. Instead, the joint modeling and discussion of problematic situations were regarded as valuable instruments for the clarification of misunderstandings, different interpretations and meanings of terms and concepts.	✓ The application of a particular modeling method, tailored to specific purposes, was not perceived to be of any importance. For instance, employees stated that a particular data modeling technique would not yield other results than any other.
Bank B	✓ Microsoft Powerpoint slides and ER models were used as a foundation in workshops and discussions, and ad-hoc sketches were drawn.	+ Conceptual models as reference models and for documentation were not perceived as extremely useful; rather conceptual models served as starting points for discussions.	✓ The usage of a specific modeling approach was not perceived as relevant for process and product quality.
Bank C	–	–	–
Bank D	+ Conceptual models were used on several occasion during the course of the project for discussions with the customer and to clarify misunderstandings.	+ Conceptual models were used for documenting the specification, which was not perceived as useful as the joint discussion of conceptual models.	✓ The use of a specific conceptual modeling language was not considered to be important.
Bank E	+ Ad-hoc models were used for discussing and illustration purposes. Specific conceptual models were not used during the project.	–	–
Bank F	–	–	–

Legend: ✓ strongly supported; + weakly supported; – not supported

Table 6.6: Clustered Summary Table of Case Studies (IV)

6.3 Discussion of Findings

6.3.1 Drawing & Verification of Conclusions

Cases are not "sampling units" as in statistical generalization and should not be chosen for this reason. Rather, multiple cases should be considered as multiple experiments, in which a previously developed theory is used as a template with which to compare the empirical results of the case study. If two or more cases are shown to support the same theory, replication may be claimed.[854] Several conclusions with regard to the propositions stemming from LAVAT can be drawn from the multiple case studies. Table 6.7 summarizes the overall results.

Firstly, with regard to the corroboration of propositions P1, P2 and P3, the case findings indicate that not one single language community exists within each of the project organizations; instead, several sub-language communities or jargons can be found for different communities of practice, with overlappings between them. Nonetheless, those sub-terminologies are distinctive for the observed organizations and show quite unique terms and meanings for concepts. Terminological discourse, language (re)construction and the creation of a shared project language community were observed in all six cases. This was mostly achieved by face-to-face communication in bilateral discussions and workshops. It has to be noted that a double knowledge transfer was observed for each project: the external consultants already had domain-specific knowledge about Basel II and data warehouse projects and tried to transfer this knowledge to the client organization; the bank employees had domain-specific knowledge about the business, the operational systems and IT in their banks which had to be shared with the external consultants.

Secondly, with regard to propositions P4 to P7, external variety was perceived as very high in all six cases, and internal variety in form of terms describing those states increased due to processes of individual and collective sense-making. Afterwards, when situations were understood more clearly, a shared language community did evolve in all cases. It is reasonable to infer that in most of the projects no standard for communication about Basel II-related concepts and states did exist and had to be created. As already identified in prior research, the complexity of a project and its environment was an important factor influencing the quality of both process and product.[855] This is especially true in larger and more complicated organizations and when high external variety meets high internal variety. In such project constellations, IT usage seems to be only reasonable (1) once ambiguity has been reduced or (2) in order to support ambiguity reduction (e. g., by using the DQR/DQM tool). Most of the propositions have been corroborated, with the notable exception of proposition P7. It proved to be to difficult to perform a latent semantic analysis on the projects' documentation since it was impossible to a posteriori determine authors of individual documents – a necessity for measuring document coherence – within a reasonable amount of time. Overall, "quality of a project's process and result" is linked to the speed by which individual human agents of a language community adapt variety

[854] Critics of case study research typically state that single cases offer a poor basis for generalizing. However, the general analogy to samples, as in survey research, is incorrect when dealing with case studies. That is, survey research relies on statistical generalization, whereas case studies rely on analytical generalization. See Yin (2003), p. 38.

[855] E. g., Xia & Lee (2005); Ribbers & Schoo (2002).

Proposition	Result
P1: For every organization, at least one terminology T (but possibly more) should exist, directly related to an identifiable set of people (agents) belonging to the language community possessing this terminology.	Strongly supported
P2: For every organization, terminological discourse φ among agents of a (sub-)language community should be observable.	Strongly supported
P3: For every organization, traces of developing or revising terminologies by (re)construction κ among its agents should be identifiable.	Strongly supported
P4: "Good" organizations, that is, organizations that are self-organizing, achieve adaptation of their language community in case of rising environmental variety; their agents increase internal variety by adaptation of their terminologies and construction of new terms, leading to (at first) sub-language communities.	Strongly supported
P5: "Good" organizations, that is, organizations that are self-organizing, achieve adaptation of their language community in case of rising internal variety; their agents decrease internal variety by reducing the overall number of terms and (sub-)language communities by creating a shared terminology and language community.	Strongly supported
P6: Organizations with a high level of success in coordination by communication achieve adaptation of a shared language community and common terminology faster then organizations with a lower level of success.	Strongly supported
P7: Organizations with higher quality of product and process show a higher degree of semantic similarity and achieve this degree faster than organizations with lower quality of product and process.	Not supported
P8: The joint conceptual modeling and discussion of actual situations helps to build a language community faster, that is, if actors discuss together and create conceptual models and specifications in their discussions, a language community is created better (i. e., more coherent) and faster.	Weakly supported
P9: Only "looking" at conceptual models or specifications created by another person does not lead to the creation of a language community that is as good as the joint creation and discussion of conceptual models.	Weakly supported
P10: The concrete instance of modeling language used is not important, as long as the language community is created better (i. e., more coherent) and faster.	Weakly supported

Table 6.7: Summary of the Results

based on linguistic communication. This seems to be a reasonable measure for goodness of organizations with regard to communication and coordination. If coherence in the sense of semantic similarity is an adequate measure of language community quality still needs to be examined in further research.

Thirdly, with regard to propositions P8 to P10, results are rather ambiguous yet. In some projects, conceptual modeling was perceived as helpful for creating a shared understanding; in others, the effect was perceived as rather weak. Some projects, even of the more successful ones, did not employ conceptual modeling at all. On the one hand, the findings show that specification-driven methods were not intensively employed in all projects. However, the impact of this on the process and product quality cannot be judged. On the other

hand, the projects that were perceived as being better with regard to communication and coordination were the ones that did not use many specifications and favored face-to-face communication. Only with regard to proposition P10, a kind of consensus exists: everybody agreed that a specific conceptual modeling method is not necessary as long as a method is chosen which is understandable by most stakeholders.

Fourthly, the argument that the observed project organizations are a special kind of organization and that conclusions cannot be generalized from this rests on two premises which can be countered: (1) every organization is a special case and this thesis tried to discover patterns which hold across many types of organizations; (2) project organizations are a fact of reality and not some exotic type of organization which is only encountered in special circumstances. However, further tests should be conducted for different types of organizations in other settings, and controlled experiments for testing specific single aspects.

6.3.2 Rigor & Quality of the Research

Generally, rigorous case studies that want to test theories must address four requirements.[856] This research explicitly addresses each of these:

- As a check for *falsifiability*, does the case study consider any predictions through which the theory of interest could be proven wrong? This has been addressed in this thesis by verbally formulating propositions based on LAVAT, which have subsequently been tested against the case studies' data, as interpreted by the researchers.
- As a check for *logical consistency*, are all the predictions considered consistent with one another? The consistency of the propositions follow from the logic of LAVAT. The cases have been selected in order to provide generalizability and to allow checking for consistency.
- As a check for *empirical validity*, does the case study confirm the theory through empirical testing? LAVAT has been confirmed and corroborated.
- Finally, as a check for *relative predictive power*, does the case study rule out rival theories? Because this study was interested in providing first empirical evidence for LAVAT and not in refuting any rival theory, this requirement has not been addressed yet.

Correspondingly, case study research can be strengthened in increasing the *degrees of freedom* for these requirements.[857] Lee mentions three ways in which the degrees of freedom can be applied to describe the analytical rigor of a case study:[858]

[856] Lee (1989b), p. 42.

[857] In quantitative analysis, the concept "degrees of freedom" refers to the number of values in the final calculation of a statistic that are free to vary, i. e., the number of independent pieces of data that are used for the estimation of a statistical parameter, see Walker (1940). Campbell extended the concept of "degrees of freedom" to qualitative analysis in case studies, see Campbell (1975).

[858] Lee (1989b), pp. 42 ff., in the following.

- *Number of predictions the case study considered*: as the degrees of freedom are increased in this category, the theory's degree of falsifiability, degree of logical consistency, and degree of confirmation can all be correspondingly increased, that is, this allows the case study to strengthen the extent to which it satisfies three of the four requirements for rigorous case studies. With the formulation of ten specific propositions, this study has a rather high degree of freedom compared to other studies, where usually only between two to five hypotheses are explicitly tested.

- *Number of cases or organizational settings in which a given theory is tested*: as the degrees of freedom are increased in this category, the theory's degree of confirmation can be correspondingly increased, that is, this allows the case study to strengthen the extent to which it satisfies one of the four requirements. By conducting multiple case studies in six comparable, but organizationally different settings, this study explicitly increased LAVAT's degree of confirmation.

- *Number of rival theories against which the theory of interest is compared*: as the degrees of freedom are increased in this category, the theory's degree of relative predictive power can be correspondingly increased, that is, this allows the case study to strengthen the extent to which it satisfies one of the four requirements. This is a shortcoming of this thesis because only LAVAT has been considered.

As a research design is supposed to represent a logical set of statements, the quality of the selected research design of this study according to certain logical tests and the employed tactics for dealing with these tests can also be judged:[859]

- *Construct validity*: establishing correct operational measures for the concepts being studied. A case study investigator must (1) select the specific types of changes that are to be studied (in relation to the original objectives of the study) and (2) ensure that the selected measures of these changes do indeed reflect the specific types of change that have been selected. For satisfying the first step, this thesis studied the change in (sub-)language communities within projects. For satisfying the second step, three tactics have been followed to increase construct validity. In this case study, *multiple sources of evidence* (multiple key informants) were used and a *chain of evidence* was established (with the help of the project diary) during data collection. Furthermore, all key informants *reviewed draft reports* of the case study. However, since only two client team members have been interviewed, although those agreed with the consultancy informants, this is a source of possible bias.

- *Internal validity*: establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships. Internal validity is a concern for explanatory studies such as this case study, where an investigator is trying to determine whether pattern X led to pattern Y. Basically, a case study involves an inference every time an event cannot be directly observed. Thus, an investigator "infers" that a particular event resulted from some earlier occurrence, based on interview and documentary evidence collected as part of the case study. In

[859] See Yin (2003), pp. 40-44, in the following.

the data analysis of this case study, pattern matching became possible by linking the propositions and constructs to data from the project diary. Furthermore, explicit explanation-building and time-series analysis have been employed (e. g., by linking the procedure models of each case to its events in time). However, as a limitation, only interviews and no direct observations have been conducted.

- *External validity*: establishing the domain to which a study's findings can be generalized. This addresses the problem of knowing whether a study's findings are generalizable beyond the immediate case study. In case study research, analytical generalization is used, where the investigator is striving to generalize a particular set of results (e. g., obtained from projects) to some broader theory (e. g., LAVAT). However, the generalization is not automatic. A theory must be tested through replications of the findings in a second or even a third setting, where the theory has specified that the same results should occur. Once such replication has been made, the results might be accepted for a much larger number of similar settings. This replication logic is the same that underlies the use of experiments. Since this case study was explicitly designed to test the propositions of LAVAT for the domain of financial data warehousing projects, replication logic was used in the setup of multiple case studies. Therefore, the case study design was explicitly chosen to ensure analytical generalization.

- *Reliability*: demonstrating that the operations of a study can be repeated, with the same results. The objective is to be sure that, if a later investigator followed exactly the same procedures as described by an earlier investigator and conducted the same case study all over again, the later investigator should arrive at the same findings and conclusions in order to minimize the errors and biases in a study. One prerequisite for allowing this other investigator to repeat an earlier case study is the need to document the procedures followed in the earlier case. Consequently, for each case in this study, transcripts and protocols from the interviews were collected. Furthermore, a project diary was developed as a case study data base for collecting all relevant data, including further documents, reports, project plans and field notes.

7 Conclusion

This thesis was motivated by the relevance of understanding patterns and characteristics for measuring the goodness or quality of organizations with regard to communication and coordination. In particular, it set out to address three research questions:

1. What criteria can be developed for "good organizations" with regard to communication and coordination?
2. How can the goodness (or quality) of an organization be measured with regard to communication and coordination?
3. What conditions influence organizational goodness (or quality) with regard to communication and coordination?

In order to answer these questions, a multi-method research design was chosen. The study design combined conceptual and analytical studies with exploratory field studies in two companies to develop a new process theory (LAVAT). The new theory enhances and adapts existing theories from social systems theory, cybernetics, organization theory, philosophy of language and information systems research, and provides a comprehensive conceptualization of the process of language-based variety adaptation in organizations on the individual agent level. Thus it highlights the role of communication and language communities for organizational sense-making and coordination and suggests (1) language community quality (or semantic coherence) and (2) the speed of language community adaptation as measures for organizational goodness with regard to communication and coordination. The theory was tested on the basis of case study research carried out to corroborate the theorized propositions. The data analysis and analytical generalization support the general patterns of the theoretical conjectures and confirmed most of the propositions. This chapter concludes the thesis and discusses its outcomes in light of contributions, limitations and implications. Chapter 7.1 presents a brief summary of the study's contributions and limitations. The implications of the study with regard to research and practice are discussed in Chapter 7.2. Finally, Chapter 7.3 gives an outlook for further research.

7.1 Contributions & Limitations

7.1.1 Contributions

This thesis contributes to the body of knowledge by discussing and gathering knowledge about the processes of communication and coordination in organizations on an individual agent level. LAVAT as a theory has been suggested to explain and predict patterns of organizational adaptation and to illuminate some of the factors that lead to certain behavior

patterns in organizations and information systems with regard to communication and coordination. In short, LAVAT hypothesizes that in case of rising variety language and the meaning of words are a facilitator to bridge gaps of knowledge between what individual organizational members know and the larger body of experience held by all organizational members. A primary mechanism by which this knowledge is expressed and then constructed is language-based communication. The empirical test of the theoretical model corroborated most of the propositions. The observed results allow to conclude that there is a relation between speed of language-based variety adaptation and goodness of an organization with regard to communication and coordination. Despite the limits of generalizability of the cases studied, it can be extrapolated that organizational agents with coherent communication at the end of adaptation stages are more likely to have better outcomes than organizational agents with incoherent communication.

Consequently, as the central contribution, this thesis offers an empirically corroborated conceptualization of the patterns and characteristics that influence organizational adaptation and thus the goodness of an organization with regard to communication and coordination. By linking prominent theories from social systems theory, cybernetics, organization theory, philosophy of language, and information systems research both theoretically and empirically, it draws attention to the importance of micro-level behavior for macro-level events. This study developed further theoretical ideas about the mechanisms and operators of autopoiesis in social systems and demonstrated empirically language-based self-organization. In addition to this central contribution, a number of additional contributions are summarized in Table 7.1. The types of contribution (methodological contribution, contribution to empirical results, contribution to theory by providing constructs and models) are outlined along the phases of the research process.

7.1.2 Limitations

Researchers should never be content with mere description, whether it is qualitative or quantitative in nature. This is ever only the first step to understand and explain *why* things are as they are, to hypothesize the patterns and processes that determine observable patterns and events.[860] This study recognizes that a vast array of objects of knowledge exist, each of which requires different research methods to understand them properly. Consequently, understanding a particular phenomenon properly will require a diversity of research methods and a multimethodological approach.[861] However, the beliefs about what comprises the real world have an effect on what is sought to observe, on what subsequently is observed, and on the reasoning processes by which each of these is performed.[862] As researchers usually accept their school of thought's philosophical position as given, this study tried to make its ontology and epistemology as clear as possible. In light of these statements, Table 7.2 and Table 7.3 summarize and discuss the most important limitations of this research along the phases of the research process.

[860] Mingers (2004b), p. 398.
[861] E. g., Mingers (2001).
[862] Lee (2004), p. 6.

Phase of research	Type of contribution	Discussion
Exploratory field studies (Chapter 4)	Methodology	This study operationalized a measurement method for variety analysis based on the interpretation of conceptual models and showed that the combination of VSM (for describing the overall organizational structure) and conceptual models (for describing specific information channels) is reasonable and useful for organizational analysis.
	Results	The conceptualization of information systems as language communities as suggested by Holten (2007) proved to be useful as an underlying framework in the exploratory field studies, as it directly led to the ideas for using conceptual models as interpretive instruments and for measuring variety based on these conceptual models. Furthermore, it was shown that the concept of variety and consequences of the law of requisite variety are far from trivial and both helped in diagnosing and restructuring the organizational design of real organizations.
Theory building (Chapter 5)	Constructs & models	This study showed how existing theories on social systems, organizations and information systems can be integrated into a more comprehensive theory (LAVAT). By combining prominent theoretical perspectives in one model and by providing central constructs and empirically falsifiable propositions, a first tentative step has been made towards a more comprehensive understanding of the complexity of organizational adaptation, organizational design and organizational quality with regard to communication and coordination. The general framework of systems theory and cybernetics was enhanced by ideas from social systems theory, philosophy of language, and information systems research, providing a conceptualization of organizations and information systems as variety-adapting language communities that may also be used in other related studies to develop a deeper understanding of how the behavior of individual agents influences organizations and information systems in a multitude of different settings. Consequently, the main contribution of this theory building is that it provides future research with an opportunity to test its implications in real world or laboratory settings.
Empirical testing (Chapter 6)	Methodology	This study presented an interview guideline as an operationalization of the premises of LAVAT into a qualitative measurement instrument. This instrument can be used to capture interviewees' perceptions about the operations of language communities and variety adaptation in an organization. Fellow researchers can follow the procedure, replicate the findings or test LAVAT in other settings.
	Results	This thesis is one of few examples of research in the relevant area of financial data warehouse projects. The conducted case studies as reported in this thesis followed guidelines on how to plan, design and conduct this type of empirical research design. The case studies provide an in-depth case narrative and provide empirical evidence for LAVAT's central propositions.

Table 7.1: Contributions of the Study

Phase of research	Limitation	Discussion
Research position & design in general (Chapter 2)	Philosophical assumptions	The research questions could have been examined from other philosophical positions such as positivism. Efforts have been made to explain and communicate the reasons for adopting this philosophical position.
	Research goal	Instead of focusing on developing and testing a theory for explaining and predicting, the thesis could also have adopted a more normative stance such as developing and testing a theory for design and action. Although this might have improved the overall relevance of the thesis, the actual findings of the study lead to explicit advice for organizational designers.
	Scope of inquiry	This thesis focused on investigating processes of language-based variety adaptation in organizations of all kinds. Although the exploratory field studies were conducted pertaining to different divisionally structured organizations, the testing focused explicitly on financial data warehouse projects in the finance industry as a special kind of organization. Of course, this is a limitation for the generalizability of the findings, which cannot be simply extrapolated without doubt to the domain of all organizations. This should be addressed in future research, for instance, by replicating the findings with a set of case studies in a different domain and with a different organizational setting, or by addressing specific propositions in laboratory experiments.
	Research methods	The research design already incorporated some different research methods compatible with the philosophical position such as action cases, action research and case studies. These methods were also selected due to their ability to engage into direct contact with the research subjects. However, although the research design tried to be multimethodologist, more suitable qualitative methods for theory generation (e. g., ethnography or grounded theory) and quantitative research methods for theory testing (e. g., surveys or experiments) could have been incorporated. This is definitely a point for further research and generalizability of the thesis' findings beyond this research setting.
Literature review (Chapter 3)	Selection of framework	Besides systems theory, cybernetics, organization theory and language critique – which provide the general framework for this research – there are alternative theories and models available. Different theoretical perspectives could have been applied to obtain the insights into the nature and characteristics of organizational quality with regard to communication and coordination. Although arguments and justifications for the selection of the underlying framework have been provided, other theoretical frameworks could have been used in this step (e. g., transaction cost theory). This could have led to different propositions and different insights into the characteristics of organizational quality. Further research could examine the same research questions using a different theoretical framework to see if similar conclusions can be derived and finally to shape better theory.
Exploratory field studies (Chapter 4)	Nature of inquiry	Qualitative field studies are often associated with a number of limitations. In this thesis, efforts have been made to conduct both rigorous and relevant research during the exploratory phases. The overall research design explicitly incorporated research methods (i. e., case studies) to overcome the limitations that stem from exploratory research alone and to fully address the framework for research (Chapter 2).
	Scope of inquiry	The scope of the exploratory field studies was restricted to the two organizations described in Chapter 4. More organizations, more sources of evidence, different geographical regions and different domains could have strengthened the insights. However, it was tried to overcome these limitations by conducting embedded multiple case studies that set out to corroborate the propositions of LAVAT, which partially have been based on the findings of the exploratory field studies.

Table 7.2: Limitations of the Study (I)

Phase of research	Limitation	Discussion
Theory building (Chapter 5)	Selected theoretical foundation	The construction of LAVAT was characterized by the selected theoretical framework and the findings of the exploratory field studies. Of course, this implies that LAVAT incorporates all of the limitations ascribed to this underlying theoretical framework. However, since LAVAT explicitly incorporates and integrates a number of different theoretical perspectives, it was tried to overcome the limitations inherent to each theoretical perspective alone. Moreover, the empirical evidence gained from the exploratory field studies further enhanced this procedure.
	Propositions	As Mintzberg (2005), p. 362, states, "hypotheses close me down; questions open me up." In this perspective, the key to theory development as done in this thesis is to be pulled by an important and relevant concern, not to be pushed by some elegant construct. In building LAVAT on existing theories and empirical, explanatory research which sought to address relevant practical problems, this thesis tried to follow in this path. The propositions of LAVAT are verbally formulated and rely on the informed guesses of the author who interpreted the existing literature and exploratory field work to come up with an explanation. However, the constructs are by no means arbitrary, but subject to logical consistency and therefore empirical testable. Following logic, a theory's predictions are its conclusions. Thus, any error made by the researcher should subsequently show in testing. Of course, proposition building was carried out with having the research questions of this thesis in mind. Consequently, other important constructs and relationships could have been neglected.
Theory testing (Chapter 6)	Nature of inquiry	Case study research is often associated with a number of limitations. Therefore, it was tried to select a research design that directly addresses most of the limitations of case study research, for instance, by engaging into multiple case studies. Moreover, guidelines and checks to mitigate the risks associated with case study research have been applied and closely followed.
	Scope of inquiry	The scope was restricted to the six European organizations and projects described in Chapter 6. More organizations, more sources of evidence, direct observations, different geographical regions and different domains could have strengthened the insights. However, the cases were explicitly selected due to their characteristics and the possibility to employ natural controls. Also, since analytical generalization is different from statistical generalization, random sampling is not an issue.
	Data analysis	In contrast to statistical generalizability, analytical generalizability has no body of rules easily applicable for verifying the validity of deductions involving verbal propositions such as those of LAVAT. However, verbally expressed predictions such as those of LAVAT and verbally expressed deductions are identical to and no less valid than mathematical propositions and deductions. Moreover, this thesis tried to address the issue of ensuring analytical rigor by following guidelines and checks suggested in the literature.

Table 7.3: Limitations of the Study (II)

7.2 Implications

7.2.1 Implications for Research

Firstly, because no theory can ever be proved true, LAVAT can only be corroborated.[863] In scientific research, further tests are always in order.[864] Consequently, the propositions of

[863] Popper (1965); Lee (2004), p. 2.
[864] Lee (1989b), pp. 38 f.

LAVAT suggest an experimental and empirical setting that could spawn a hundred further studies and a diversity of related research streams. The existence and adaptation of a language community – semantic cohesiveness, or language overlap – should be observable in other settings, both qualitatively and quantitatively. For instance, this suggests an experimental setting where different semantics and pragmatics are generated for different groups: present each group with a different set of certain key terms, a kind of "word history", and observe what differences in communication arise due to this and if these are compatible with LAVAT. Furthermore, LAVAT provides a point of reference for a range of empirical studies that could be conducted in order to challenge LAVAT and to further test it, test new extensions of LAVAT, apply LAVAT to different domains, or use other research methods such as survey instruments or laboratory experiments. For instance, these empirical studies could be conducted for other forms of organizations from different domains that have been the subject of previous examination. Besides further testing LAVAT, these studies could provide important findings for differences in the observed patterns. One conclusion is that there is need for deeper research on individual and situational patterns and the way they impact and interact with language community creation and the operations of language communities. For instance, the study of differences between novices and experts, the role of project versus divisional structures, the role of culture and familiarity or the relevant characteristics of communication situations would provide further understanding of the process and patterns of language-based variety adaptation. LAVAT can provide a cornerstone for future empirical studies in a diversity of organizational contexts.

Secondly, this study showed that the combination of existing theories from social systems theory, cybernetics, organization theory, philosophy of language, and information systems research provides a reasonable conceptualization of organizational adaptation on the individual human level. This certainly can provide a guidance for research which is concerned with organizational change and design, not only in information systems research but also in organizational research in general. Especially, this study showed that the combination of cybernetics and language critique is applicable and fruitful in the study of social systems such as organizations and related phenomena. Consequently, it counteracts some of the critique of cybernetics, for instance, that of missing empirical research and the operationalizability and applicability of concepts such as requisite variety.[865] Instead, this thesis shows that the exact opposite is the case: LAVAT is rooted in cybernetics and variety has a bearing on some very fundamental patterns. The case studies provided convincing empirical evidence that the combination of cybernetics and language critique can indeed explain and predict organizational behavior patterns and assist researchers and practitioners in arriving at an informed opinion about the complexity that relates to organizational change and adaptive behavior.

Thirdly, the exploration of the language-based variety adaptation process leads directly to challenging propositions that require further research. For instance, one of the propositions addresses the possibility to directly measure the semantic similarity or semantic coherence of work groups and project teams; however, this propositions could not be addressed in this study. This suggests that the theoretical foundation provided by this thesis should be leveraged by future research to further study language-based variety adaptation and

[865] E. g., Rivett (1977); Zouwen (1996).

alternative measurement methods for organizational goodness or quality with regard to communication and coordination.

Fourthly, another possibility would be to use LAVAT for designing a formal social dynamics model.[866] A simulation based on this formalization could model the theorized processes that are difficult to study using traditional research methods. To be usable for simulation, such a more formal model must specify an interaction protocol between agents, for instance by using naming games[867] where different playing strategies would lead to different outcomes. This could help in understanding whether and how, starting from each organizational member having a different understanding of concepts, agreement emerges or instead fragmentation occurs, and which characteristics of human agents favor or hinder the agreement. Realistic assumptions must be made about the cognitive capacities of the agents or the effects of natural or cultural selection. Human beings, as embodied autonomous agents, have strong limitations, for instance, they cannot perceive the world exactly from the viewpoint of another agent and so equal perception is excluded, direct meaning-transfer is not possible, no agent can have a global overview of the language in the total population, et cetera.[868] In the field of social network analysis[869], a more formal model of the organization as a complex adaptive system, based on LAVAT, could be represented as a graph or network, with agents placed on nodes and links representing their interactions. Metrics from social network analysis (e. g., centrality, lattice, or small-world property) could be used to analyze how network structure impacts the speed of language adaptation and level of coherence or the characteristics of the agents. Those questions are closely related to boundary spanning.[870] The insights obtainable from analytical models and computer simulations could help to design better collective communication systems and to better understand the role of communication for organizational success and viability.

Fifthly, many approaches in the information systems field build on theories from other disciplines. This includes behavioral theories from economics, sociology, management science and organization theory, or psychology such as transaction cost theory[871], enactment theory[872] or structuration theory[873]. For designing and engineering IT, existing information systems research has tried to transfer insights from those behavioral theories into engineering-driven approaches for developing and designing IT artifacts.[874] Therefore, it is often a matter of debate if information systems research really qualifies as a separate discipline[875] and how it relates to the so-called IT artifact.[876] In conjunction with the conceptualization of information systems as language communities developed by Holten, LAVAT proposes

[866] E. g., Anderson (1999).
[867] E. g., Steels (2005).
[868] Steels (2006b).
[869] E. g., Scott (2000).
[870] E. g., Kleinbaum & Tushman (2007); Pawlowski & Robey (2004).
[871] E. g., Williamson (1981). See also Mahaney & Lederer (2003) in the context of information system development projects.
[872] E. g., Weick (1979); Weick (1995).
[873] E. g., Giddens (1984).
[874] E. g., Loucopoulos & Karakostas (1995); Sommerville (2001).
[875] E. g., Avgerou (2000); Weber (2003).
[876] E. g., Benbasat & Zmud (2003).

that communication lies at the heart of information systems research.[877] Of course, as has been shown in Chapter 3, this perspective has a tradition in the information systems field. Others have tried to build on communication as the core of theory as well.[878] So while this tradition and even a direct relation to the systemic and cybernetic framework of this research is acknowledged[879], this thesis builds on another strand of philosophy of language – language critique – and combines this with cybernetics and social systems theory in order to explain how domain-specific languages – terminologies – evolve in organizations and information systems as self-organizing systems and generate communication structures. The findings of this thesis justify to advocate more and deeper research into communication as an important part of information systems research. A common denominator needs to be found that allows researchers to examine the interplay between the social sub-system and the technological sub-system of an information system; a denominator that allows to shift the focus from examining only one of the two sub-systems to the phenomena that appear when both sub-systems interact.[880] This denominator cannot be the IT artifact alone, since it clearly belongs to the technological sub-system. It cannot be a purely social theory either, since these theories are concerned with the social sub-system. Consequently, following the conceptualization of information systems as language communities and according to LAVAT and the findings of this study, this common denominator could be *communication*:

- language-based communication is fundamental for the human species and a characteristic of social systems;
- improvement of communication is the reason for and utility of IT usage.

It follows that using LAVAT, IT-enabled communication structures within organizations can be explained without assumptions characterizing pure social or computer science theories. Therefore, this approach is advantageous compared to only relying on these theories since it omits obsolete assumptions and thus allows for more nomological and rigorous explanations of communication structures within organizations. LAVAT can be classified as a type of theory intended to explain and predict reality: if the nature of communication structures and self-organization is understood as the core of information systems research, one can go downstream and analyze a given technology concerning its social implications such as usability or economic value.

7.2.2 Implications for Practice

The thesis provides some important implications for practitioners and the community of organizational designers including, amongst others, business analysts, managers, and project leaders.

Firstly, LAVAT supports organizational designers and decision-makers in answering a fundamental question – how good is an organization with regard to communication and

[877] See also Holten & Rosenkranz (2008) in the following.

[878] E. g., Land (1985) argues that language is one of the most important factors in information systems research. Of course, the language/action perspective developed by Winograd & Flores (1986) stands in this tradition as well, see Chapter 3.7.2.

[879] Flores even worked together with cybernetic pioneers such as Stafford Beer. See Medina (2006).

[880] E. g., Lee (2001).

coordination? This study informs organizational designers what patterns influence the behavior of individual agents and how this behavior relates to the total organization. This may help in determining how "good" a specific organization is with regard to communication and coordination. The research conducted in this study highlights the importance of a number of factors for organizational goodness. The extent to which different language communities and terminologies exist, are created in case of external disturbances and rising external variety, and are subsequently standardized again to a coherent, shared language community – or not – has a significant impact on an organization's ability and speed to react to changes in the environment. From a decision-maker's perspective, LAVAT can also guide the design of effective interventions for introducing new IT artifacts into organizations – IT usage cannot be commanded, the self-organizing social system can only ever be steered and encouraged to adopt an IT artifact. Consequently, based on this study's findings, organizational designers can make more informed decisions and prepare for the introduction, as well as the continued use, of a terminology. The analysis suggests that high-quality organizations would not only attempt to strike a balance respectively between variety-seeking exploration (i. e., the creation of new terms and codings to deal with new situations and rising external variety) and variety-reducing exploitation (i. e., the consolidation of existing terms and the creation of a shared language community), but it would also establish and monitor which of the different strategies it was operating in at any given moment so as to match the strategy required to the resources available.

Secondly, LAVAT theoretically explains human agents' characteristics in organizations such as IT projects with regard to self-organization capacity and language. The findings suggest that most of the complexity encountered in organizations arises due to the dynamic processes described by LAVAT. The idea of autopoiesis, or of "self-producing", to describe processes by which a social system achieves autonomy and maintains itself explains in combination with LAVAT organizational changes in response to disturbances in the environment. Organizational members, project teams, or whole companies *have* variety, that is, they have a set of skills and experience which they may bring to a task and which is embodied in their terminology which can be observed. To be successful, organizational members must exhibit a level of shared understanding of the organizational domain and environment. For instance, incompatible viewpoints among members and failure to negotiate different perspectives and specialties in forming a language community may result in a breakdown of shared understanding, ineffective communication, and hampered collaboration.

Thirdly, this suggests that based on LAVAT, the observation of terminology adaptation can be applied as a tool for diagnosis and analysis of organizations. This does not necessarily imply the analysis of subjective narratives or stories. For instance, as noted in Chapter 5.7, one possibility to access individuals' "mental models" other than through personal interviews is through their language-based documentation. Reports, memos, correspondence, electronic communication, and personal journals are all part of the discourse level. This documentation, authored individually or collectively, is a written expression of the language community (marks). The joint construction of these documents should express the status of the language community and should capture the shared "mental model" of an organization as a language community. LAVAT suggests that coherent documentation should be linked to successful organizational outcomes. A document analysis method should then be able to help in characterizing organizational goodness with regard to communication and coordination.

For instance, a suggestion is that a diagnosis of the rate of semantic similarity or coherence between organizational members' documents could exemplary be done by using latent semantic analysis[881] for comparing output documents as representations of organizational discourse, and evaluate variation in semantic choice and semantic coherence between team members as measures for knowledge convergence. This should allow to measure and monitor a kind of communicative "pulse rate" of the organization.

Fourthly, the impact of social and cognitive capacities on communication and construction of a shared language has also been observed by other researchers in human discourse. For instance, a recent experiment on emergent communication relied on an ingenious videogame in which players can only succeed when they communicate with each other.[882] Players in this game are forced to invent a new communication system from the scratch, without natural language or any other established set of signs to start from. This experiment makes it clear that both success in the game and the emergent communication system are tightly embedded in the coordination of the behavioral processes between the game players. Interestingly, the ability to build a communication system seems to require a cooperative attitude: some players fail to realize that their communication is ambiguous, and a task that some teams manage in some minutes takes others hours before they finally give up. Consequently, if a person lacks the basic skills to agree on a shared terminology, this must give all sorts of problems in real life as well. A variation of this game could be used by organizational designers to detect such problems in organizations beforehand. It has even been suggested that the game could take on a therapeutic value, helping those who lack the social intelligence for communication to develop it.[883] LAVAT could help in building such instruments for decision-making (e. g., IT project management).

7.3 Outlook

The imperative of this thesis was to explore and develop a rigorous and relevant theory for explaining and predicting the complex patterns underlying organizational adaptation and organizational quality with regard to communication and coordination. It sought to integrate existing streams of research and theories into a more comprehensive and useful approach. In order to reach that goal, a lot of empirical data has been gathered during both exploratory and explanatory studies, which this thesis could only present a small, synthesized and summarized portion of.

Another goal was to stimulate other researchers and practitioners to follow the road of this thesis and to explore some of the less traveled roads of organizational and information systems research and some of the forgotten avenues of systems theory and cybernetics. Clearly, this will help to extend the body of knowledge provided by previous research. To summarize, once a more sophisticated model of LAVAT has been built, there are many more valid areas of inquiry open for further analysis. Some possible venues for research include, but are not limited to:

- conduct a similar study in a different organizational setting;

[881] E. g., Landauer et al. (2007).
[882] Galantucci (2005).
[883] Steels (2006a).

- examine in more detail the propositions regarding conceptual models, for instance, with laboratory experiments;
- develop a more formal model of LAVAT which can be used for simulation studies;
- develop a variance model out of LAVAT's process model;
- conduct a quantitative survey study.

In developing LAVAT, this thesis showed how social systems theory, cybernetics, organization theory and philosophy of language can be combined in order to provide an effective explanatory model for organizational behavior. By applying language critique as a means to understand the behavior of individual human agents, this research was able to explain self-organization as an adaptation of variety by means of language. The novelty lies not in the components of LAVAT themselves, but rather in how they are integrated in a more encompassing model and how they are used to tackle aspects of how an organization arrives at a shared meaning and repertoire of concepts in order to establish requisite variety.

If "sound" management and design of organizations is among the desired goals, researchers and practitioners may benefit from those insights on how to conceptualize the relationship between individual human agents and organizations. This thesis should be seen as a preliminary effort, because this is a large agenda and this research has taken only a few tentative exploratory and explanatory steps. This research has developed and outlined the ideas of LAVAT. A much longer thesis might have developed the ideas more completely, such as by presenting a complete list of concepts and linking those concepts to specific propositions, or by developing a more formal mathematical model. However, this research is just beginning to increase our understanding of how organizations perform by studying their communication, language, and discourse.

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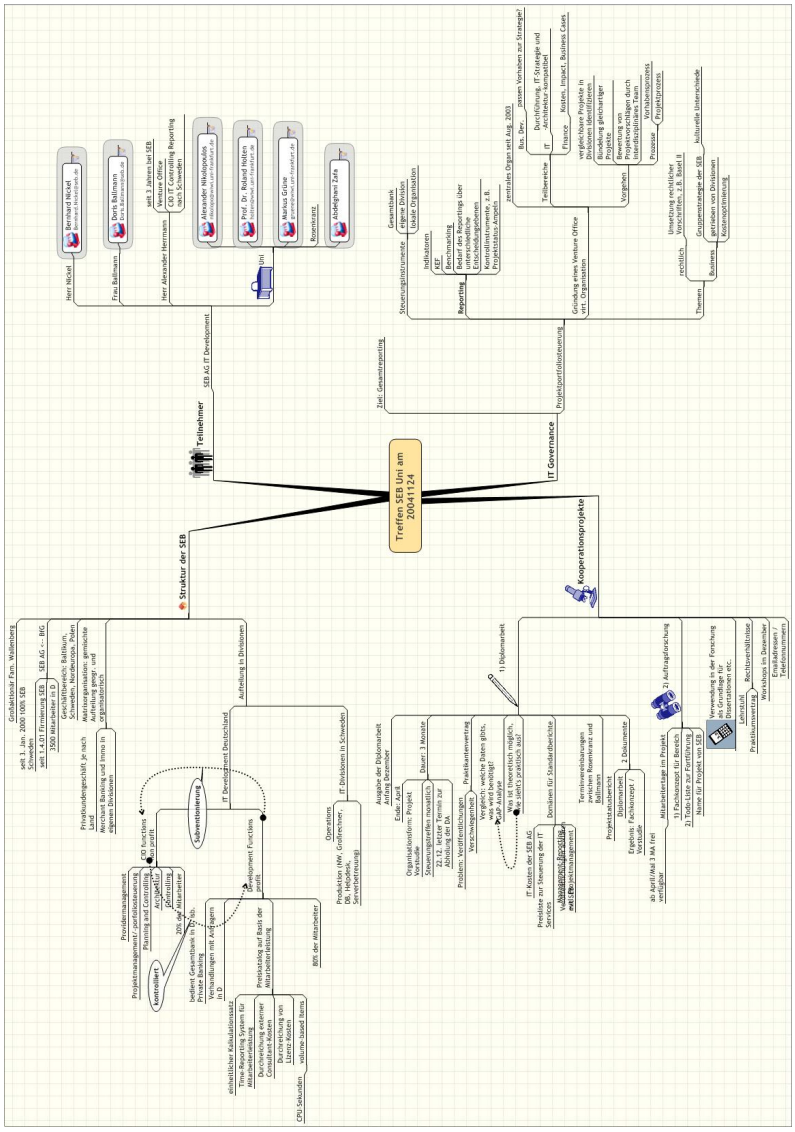
Appendix

A Example of Field Notes



B Interview Guideline (FSB Germany)

Date/Time & Location:
Interviewee:

Cost allocation model for IT chargeback and invoicing

1. Were the items of FSB Group presented or explained to the business units in general?
2. How was the item catalogue explained to you in person?
3. What are the most important advantages and disadvantages of the cost allocation model and item catalogue?
4. Is the level of presentation of the items meaningful or useful to you?
5. Do you understand the meaning of the items?
6. In your department, who is using the invoices, reports and / or item catalogue, and for what purpose (e. g., decision, controlling, budgeting, et cetera)?
7. Are the IT costs an instrument for regulating your business?

Budgeting process

1. How long do the discussions take for negotiating budgets? How much of this time is due to explanations of items?
2. What are the most important advantages and disadvantages of the budgeting process?
3. Is the budgeting process an instrument for regulating your business?

IT organizational structure

1. Do you have a single point of contact for questions regarding IT services and / or items?
2. What are the most important advantages and disadvantages of the IT organization structure?

C Interview Guideline (Case Studies)

Date/Time & Location:
Interviewee:
Project:

Information System as Language Community

1. Can a common language be identified for the information system / the organization / the project, which incorporates specific technical terms and concepts and which is specific for the members of the project, that is, which is not easily understandable outside the project?

2. What are examples for such terms, which are not part of colloquial, natural language, but (1) either are specific for the domain or (2) specific for the project?

3. Could terminological discourse be observed within the project? That is, did problems of understanding and interpretation exist for people who were not part of the project?

4. Did problems exist due to syntactical (term is unknown) or semantical (correct meaning of term is unknown) misunderstandings? What are examples for this?

5. Were important terms and concepts defined and explained? Did new terms arrive during the course of the project?

6. How did project members learn these terms and concepts? For instance, were concrete examples and working situations used (empractical learning)?

7. How did one notice that the meaning of terms and concepts had been understood correctly?

Modeling and Specification

1. Did the joint modeling or specification respectively and the accompanying discussion of unclear circumstances, using those models or specification, speed up the creation of a joint problem understanding and clarification of misunderstandings respectively?

2. If no joint discussion of models / specification took place, did this have (negative) impacts on the creation of a shared problem understanding, or did misunderstandings appear (more frequently)?

3. Is it important to use a certain modeling language for developing a shared understanding faster?

4. Do the models and specifications have a use after their creation – aside from documentation – or is there a difference between ad-hoc sketches and detailed specifications?

Language, Ambiguity and Uncertainty

1. Did clarity exist concerning the meaning of terms after the clarification of important terms, and did this reduce (1) ambiguity (concerning understandings and interpretations) and (2) uncertainty (concerning decisions and actions) within the project?
2. Were decisions taken faster or better after the clarification of terms?
3. Did project or project phases that were perceived as "good" achieve a mutual understanding of terms faster or better?
4. Did this lead to a faster or better reduction of ambiguity and/or uncertainty?

Achievement of Objectives and Costs

1. Which basic activities and processes (with regard to matching of ETL requirements) can be differentiated (communication, modeling/specification/documentation, travels, others)?
2. If the project time line is divided in several periods, how much time/work/budget was spent for those activities in which periods (part of communication per month)?
3. How high was the project progress in those periods?
4. Was the project goal reached (project progress 100%)?

D Structured Self-Estimation Survey Template

The self-estimation survey template was sent by e-mail without a detailed description or manual to each interviewee before the interview. The interviewee was only asked to have the template ready at hand during the interview. After each interview, the researchers explained the purpose of the self-estimation survey to each interviewee in detail: (1) to measure *the perceived percentage of effort spent* by the interviewee for specific activities in each project phase (activity time in percent of total work time during a phase), and (2) to estimate *the perceived performance of a project phase* (perceived percentage that the goal of a project phase was reached as planned). Each interviewee understood the purpose of this template and was asked to check if the described activities fit with her or his experiences, or if some activity category was missing. This occurred in no case. Afterwards, each interviewee was asked to modify the template so that the project phases fit with the number of project phases that she or he experienced, and to subsequently fill out the template and return it within one week by e-mail. The following table gives an example with fictitious data entries.

Date/Time: 01.01.2007
Interviewee: Mr. XYZ
Project: Bank XYZ

Activity / Project Phase	**Project Phase 1**	**Project Phase 2**	**Project Phase n**
Support & communication (e-mail, phone)	10%	20%	...
Coordination with business units	20%	30%	...
Documentation & specification	20%	10%	...
Test preparation	5%	5%	...
Preparation & follow-up for on-site visits	15%	5%	...
On-site visits	30%	30%	...
...of that, travel time	5%	5%	...
Perceived performance of project phase	50%	80%	...