THE ICT MONSTER – HOW DO WE UNDERSTAND IT

Analysing the many perspectives, functions and roles of ICT artefacts.

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Abstract

When rereading a selection of NOKOBIT papers, I am surprised to see that quite a number of papers lack a description of what type of ICT artefact they are studying. This lack of preciseness in their analysis may result in that we fail to see actual connections or other interesting findings that may exist. The aim of this paper is to contribute to a better conceptualization of the ICT artefacts studied in IS research.

This work has an explorative research approach, aiming at identifying important dimensions that may help understanding the various aspects of ICT. The empirical base comprises two part. Firstly, it builds on a review of selected literature, which then has been used for building an analytic framework. This framework is applied in analysing a sample of NOKOBIT-papers.

The analysis shows that some of the papers builds on an incomplete or missing conceptualisation of the ICT artefact(s), and which may result in that interesting findings have been overlooked. Based on my preliminary analysis, I will conclude that IS research would benefit from being more precise on what (types of) phenomena that are studied. Moreover, the public debate about the role of and consequences of ICT (and its usage) would also be more informed by more evident understanding of the specific ICT solutions that are analysed.

Keywords: ICT artefact, ICT conceptualisation, tool, perspectives

1. Introduction

The 25th anniversary of NOKOBIT creates the opportunity to revisit some of the papers. In doing so, I am surprised to see that quite a number of papers studying an ICT artefact or its use, lacks a precise conceptualisation of what they are analysing. Computers have been around for more than 70 years, but still we may not understand all its functions and roles in organisations and society. The computer technology is a generic technology that should be analysed along many dimensions and perspectives, offering a vast variety of outcomes and impacts. The economist Solow claimed that "*computers are everywhere, except in the productivity data"* (Solow 1987). One likely reason may be that computers (and the broader concept of ICT[i]) have many functions and roles other than to increase productivity, and to emphasize the economic dimension only is to tell a partial history.

In their seminal paper "Desperately seeking the 'IT' in IT research", Orlikowski and Iacono (2000) called for å better (theoretical) understanding of I(C)T in research. More than 15 years later, their call is still highly relevant. I will argue that we need more precise conceptualization of ICT, both in research as well as in the broader discussions of its impact in or on society. This lack of preciseness in analysis will easily lead to that we fail to see actual connections between the specific technical artefact, its use and possible impact in organisations. E.g. when analysing what factors that influence choice of system development methods, it will be highly relevant to see what types of ICT artefacts that are being developed. The adaptation of a simple office automation tool may not require same method compared to when developing an advanced production system.

Thus, in our efforts to better understand the ICT "monster", we have to identify its various dimensions, functions and roles. The research objectives are:

1. To map the dominating conceptualizations of the ICT artifact in selected [IS] literature, and to suggest a conceptual framework for analyzing IS research in terms of perspectives, functions and roles
2. To identify the various understanding of the ICT artifact in selected NOKOBIT papers, and thereby explore whether the suggested framework seem to be fruitful.
3. A further, but more speculative question is to discuss to what extent more precise concepts would contribute to better analysis.

1.1 Research approach

This study is based on an inductive and explorative research approach, aiming at identifying important factors that may help understanding some ICT. The selection of literature are somewhat anecdotal and personal, reflecting my own interest and experience. Although biased, I do believe that this selected literature represent important contributions in our field. This review is the basis for an analytical framework that has been applied in analysing selected papers presented at NOKOBIT. The analysis have been done by identifying the specific problems that have been addressed, further the research question and method that have been stated, and to what extent the technology and relevant development methodology are described in the papers. I make a distinction between what is clearly expressed in the paper, different from what can be derived or interpreted from the text. The author alone has done all interpretations, which thus imply the risk for misinterpretations and other source of errors.

1.2 Structure of the paper

Chapter 2 reports from the literature review, while chapter 3 outlines the conceptual framework. Next, chapter 4 present the analyses of selected papers by applying this framework, then followed by some preliminary findings (and suggestion for further research).

2. Theoretical perspectives

Below, different theoretical perspectives and dimensions of ICT found in the literature are discussed. The presentation has a sort of historical approach, starting from the first stand-alone computers to the present all-embracing view on ICT, but not always follow an chronological order.

2.1 An Objectivistic Perspective on ICT

Being a student in a computer science department in Norway in the 60'thies, we were introduced to a computer as a *computational, algorithmic machine*, primarily for solving mathematical and logical problems in a systematic and stringent manner. The material basis was the standalone mainframe. Our teacher, professor O. J. Dahl pointed to that "digital computer systems, have certain fundamental properties: i) a processor is a strictly sequential device, which operates in a sequence of small, elementary steps, ii) information is stored in the main memory is accessible one small unit at the time, iii) access to a unit [of information] is through identification of a storage cell in which it resides seen as computational artefact" (Dahl 1972). Furthermore, he emphasized that [structured] programming is basically characterized by two fundamental concepts: i) *decomposition* and ii) *classification*, implying that the strategy for solving complex problems is to break them into manageable parts (subsystems) assuming that the whole (totality) can be described (modelled) by assembling all parts. However, we know today that this in many cases not possible or desirable, as the whole is more than the sum of all parts: e.g. a network is more than its individual nodes.

We were also taught the novel object-oriented programming language Simula 67**,** that have all these element integrated into the language, including classes/subclass, inheritance, dynamic object creation, etc., which is found in all object-oriented languages today. Even though the language very much built on the Algol 60 syntactically, it extended the range of applications to include e.g. modelling and simulations, thus demonstrating its ability to simulate even human behaviour. This illustrates that the computer also can be regarded as a dynamic actor, all though the actual program code is still based on deterministic algorithms.

While the computational and algorithmic approach was dominating in the early years of computer science and in other scientific applications, the data (base) management dimension was more visible in other areas of application, as in administration and management, at that time denoted ADP (administrative data processing). This tradition was a continuation of the (Hollerith) punch card tabulators, utilizing computers with unprecedented capacity to collect, store and process very large amount of structured data, thus a mechanistic approach to using computers.

This still objective and instrumental understanding of ICT is clearly evident in an OECD report, distinguishing between these dimension: i) ICT as an integral part of a *product* or ii) of a *service*, versus iii) ICT *in production* or iv) *in administration*. As a link between these dimensions is to see ICT as an v) *infrastructure* (OECD 1980). Seen in retrospect, these categories are still relevant, but should be supplemented, e.g. by social media, Internet of things, big data, robots, machine learning and AI, blockchain/bitcoin etc.

2.2 A subjectivist perspective in the understanding of ICT

In the objective thinking, we make a distinction between the computer or data system and the people, where the computer (system) is regarded as a tool or machine outside the user. Kling (1987) describes the "tool" view of information technology as "A computing resource that is best conceptualized as a particular piece of equipment, application or technique which provides specifiable information processing capabilities". He argues that such a view conceives information technology independently of the social or organizational arrangements within which it is developed and used. The objectivist approach overstates the importance of technology's material characteristics and ignores the social interpretations and actions that may modify the impact of particular software systems or hardware configurations. By presuming that technical artefacts also are capable of having an impact on social systems, such research treats both technology and organization structures as objects.

However, as computer systems were increasingly used to solve or support task inside an organisation, this borderline between technical and non-technical elements became more diffuse. The introduction of interactive user interfaces made this distinction even more vague. By changing the focus to *information system*, including both the manual and automated part, this instrumental, objectivist perspective was challenged. Kling and Scacchi (1982), in opposing the traditional "tool-perspective", developed the concept of "web models" of computing in contrast to what they saw as the dominant "discrete-entity" model of computing. In addition to functional capabilities, computers are also social objects, which may be highly charged with meaning. They thus held that computer-based systems are a form of social organization, which is not at all neutral. From their perspective, information technology is more than just the tools deployed on the desktop or the factory floor. The subjectivist approach is typified by those assuming a "social action" perspective on technology; that the same technical solution may have various effects in different organisations (Orlikowski and Robey 1991). They held that ICTs have both material and social properties, being physical and socially constructed by subjective human actions. By adopting an interpretative paradigm, we can view ICT in its social setting, seeing the world as a social construct (Hirschheim 1986). Computer-based systems are in this view a form of social organization, which is not at all neutral (Kling 1987).

2.3 Link between organisational functions and use of Technology

Zuboff (1988) make an important distinction of the difference between automating and informating. The term informating was coined in her book "In the Age of the Smart Machine", where she points to that this is the process that translates descriptions and measurements of activities, events and objects into information. By doing so, these activities become visible to the organization. According to Zuboff, informating has both empowering and oppressing influence. On the one hand, as informating processes become more powerful, the access to information is pushed to ever lower levels of the organization. Conversely, informating processes can be used to monitor what Zuboff calls human agency. She thus illustrates how same technical solution may be understood in different ways, depending on e.g. where you are in an organization.

Orlikowski (2000) shows through her study of the use of a specific computer application in a large organisation, how the same technical solution was interpreted very differently by distinct groups of employees in the same organisation. By identifying four different technologies-in practices, she shows how we better can understand why and how people are likely to use the technologies. Furthermore, technology has also both intended and unintended consequences in different organizational and technological conditions. This clearly shows how the same or very similar technical solutions are being understood very differently across organisations and in society at large; underscoring that also interpretative approaches are necessary.

Similarly, Orlikowski and Iacono (2001) argue that ICTs are not just tools, and they suggest a number of different conceptualisations. Based on their coding of a number of research articles, they identified 14 specific conceptualizations of information technology, grouped in 5 broad categories (nominal, computational, tool, proxy, ensemble). It may be disputed whether their specific categorisation, being extracted from how researchers have conceptualised ICT in research, really reflect how ICTs actually are used and understood in organisations. One weakness is that their categorisation mixes up perspectives (as tool, ensemble) with functions (e.g. computational). This analysis does, however, nicely illustrating that ICT can be interpreted in different ways, underscoring their insightful contribution to a better understanding of the IT artefact. This type of analysis is even more important when we are studying the increasingly use of social media, which often have different functions and fulfil distinct roles in various organisational or social settings.

Without subscribing to their specific conceptualizations, such analysis illustrate the many functions and roles that ICTs may have in organisations, not to say in the society at large.

Crowston and Malone (1988) are suggesting four different perspectives in organisations: rationalist, information processing, motivational and political, which can be used to interpret organisation structure. While the rationalist perspective assumes that organizations are composed of rational agents, operating towards some defined goals, e.g. efficiency. The information processing view shares many of these characteristics, but focuses instead on the organizational processes and communications patterns of the firm. The motivational perspective recognizes that workers may have different interests than the management of an organization, but typically assumes that these goals can be matched by properly designing the jobs of individual workers. The political view assumes that different groups within, the organization may have conflicting goals that cannot be reconciled. Power determines which group achieves its goals, and IT may be used as a mean to increase power.

These few examples on different interpretation of ICT usage outlined above illustrate that an objectivist and functional perspective only represent one dimension of ICT, while e.g. an informating or a technology-in-practise perspective show that one technology has potentials for many organisational functions and roles, some of them not necessarily clearly understood and predicted beforehand. Thus, different perspectives of ICT usage are closely related to the understanding of functions and structures in an organisation.

2.4 The Scandinavian school of system development

The object-oriented thinking, which was a basis for the Simula language, included also a need for an alternative thinking. The co-creator Kristen Nygaard extended the understanding of computer artefact to act as a subjective actor, which will be interpreted differently by different users. He developed language tools, (including a system description language), that could help workers (at the shop floor) to control computer based tool through the "Iron and Metal Workers Union" project (Nygaard and Bergo 1973; Nygaard 1977). In this way he extended the human interface to computer, yet in a traditional, language-oriented manner.

He became a pioneer of participatory design approach and the "Scandinavian school of systems development". Scandinavian research in systems development can be grouped into (at least) three major traditions, based on quite different ideologies and theories, as e.g. Bansler (1989) distinguish between the system theoretical, the socio-technical and the critical school. Bratteteig (2004) emphasizes these approaches: construction, organisational change and political action. The differences among these schools are related to the historical and social contexts in which they developed. External political, economic and cultural factors have strongly influenced research in this field (Nygaard and Sørgaard 1987, Nygaard 1999).

These perspectives are further explored by Dahlbom and Mathiassen (1992), claiming that there are at least three approached to understand ICT development and use in organisations: *hard, soft and dialectic system thinking*. "Hard" system thinking conceive a system as hierarchically organised set of element, usually developed through a functional analysis, emphasizing ordering, stability, consistency and completeness. At the contrary, "soft" system thinking emphasizes that systems and organisations are shaped by our experiences from using them. We see different things, have different perspectives and structure the world differently. Interpretations become important to understand how systems and organisations should be designed. Their third, "dialectic" thinking departs from the soft thinking in emphasizing that multiple view and perspectives do exist at the same time. However, it also emphasizes that different perspectives are expressions of irreconcilable conflicts and power struggles. The claim of this approach is that we need to think in terms of contradictions in order to explain and control change, implying that we have to identify interests, roles, structures, and processes in organisations. These perspectives are not mutual exclusive, but rather coexist in an organisation and may therefor imply varying, partly confliction conceptions of ICT functions and their governance.

2.5 The technological imperative debate– do we lack preciseness in our analysis?

The position that computerization causes either centralization or decentralization is an old, but still relevant position. It originated by Leavitt and Whistler (1958), in predicting that the introduction of computerized IS would lead to the centralization of organizational decision authorities. Similar studies supported

this claim. They were shortly opposed by others, e.g. Toffler (1980), Naisbitt (1982) arguing that ICT was more likely to lead to decentralization of resources and power.

Both of these positions may be seen as a variant of a more basic assumption: that computerization *causes changes* in organizational decision authority structures. This view, which has been called the *technological imperative,* "... views technology as an exogenous force which determines or strongly constrains the behaviour of individuals and organizations" (Whistler 1970 p. 585). George and King, 1991 held that causal statements like the technological imperative do imply a reliable pattern of cause and effect, so the unresolved question of which effect occurs plagues any articulation of the technological imperative. Thus, both logical arguments and empirical evidence that supported two contradictory positions made it easy to argue that there was no inherent causal relationship between computerization and decision authority structure: The "no-inherent-relationship" position was not the only way to account for the contradictory evidence. Instead of assuming that computerization caused particular decision authority structures to emerge, it made more sense to some researchers to assume that computerization activities would *reflect* the prevailing centralized or decentralized persuasions of the organizations in which they occurred. This view became formalized as the reinforcement politics argument, in which computing is viewed as a malleable technology controlled by the dominant coalition in an organization and used by that group to serve the interests of the status quo (George and King, op.cit). Such view has been called the *organizational imperative* which "assumes almost unlimited choice over technological options and almost unlimited control over consequences [..] information technology is the dependent variable in the organizational imperative, caused by the organization's information processing needs and manager's choices about how to satisfy them" (Markus and Robey, 1988 p. 587). These findings are in line with Kraemer et al. (1989), in their claims that managerial actions are the dominant factor affecting outcomes of ICT-usage.

I will, however argue that in much of this research, ICTs are primarily regarded as an simple artefact, more or less seen a black boxes. That may be one explanation for why there are so many apparently contradicting findings. We need to open this "black box" and identify the specific type of ICT artifact we are studying. E.g. Jansen (1999) showed that seemingly similar ICT system have different impact on work processes as knowledge and competence build-up.

2.6 Information infrastructures and information society

Yet another example of a rather one-dimensional view of the impact of the ICT-revolution is found in e.g. Toffler (1980), Naisbitt (1982), in their understanding of the "information society". Even though some of their forecasts have been true, much have by and large been misleading, e.g. the belief that ICT would lead to further decentralisation and distribution of resources and power. One reason is that much of the analysis was based on an inadequate understanding of the information society, as primarily seen from a technological point of view, neglecting the organisational and institutional forces influencing these developments.

A more fruitful approach was generated by the notion of information infrastructures, first coined by Al Gore in 1991[ii]. It departs from the concept of [ICT] infrastructures in the industrial age, but enrich the understanding to capture the informational and knowledge base that was made possible by World Wide Web (WWW). While ICT infrastructures primarily are understood as technical facilities, the diffusion of WWW, including all its applications, created a need for an extended, socio-technical and evolutionary understanding of such distributed, but interlinked information networks. Following Hanseth and Lyytinen (2004), we understand Information Infrastructure (II) as "*a shared, open and unbounded, heterogeneous and evolving socio-technical system consisting of a set of IT capabilities and their user, operations, and design communities*.". Because this dispersed and distributed ownership, the lack of centralized control is a fundamental attribute of an II (Hanseth and Lyytinen 2010). Consequently, different actors shape, maintain, and extend an II "*in modular increments, not all at once or globally"* (Star and Ruhleder, 1996). Thus, in our analysis of the growing information society, we must include organisational, economic and institutional structures that shapes and partly controls its further development. Very illustrating examples are the development of the so called Web 2.0 and its application as Twitter, Facebook, where we have experiences that systems that were initiated as idealistically activities, have been transformed to big and tough businesses. II theory thus offers a framework for analysing such phenomena

2.7 Stein Bråten: Computer Culture and model monopoly

A traditional way of thinking has been that access to more information will help us to make better decision and to close the gap between "information-poor and information-rich". A different viewpoint was taken by sociology professor Stein Bråten through his theory of model monopoly. This theory states that a "power-through-model" paradigm is required in order to utilize information available, and at the same time withstand influence from others (Bråten 1983). Offers of information to a person are useful only to the extent that the person has a model capacity for processing the information offered. If not, the model-weak actor will easily adapt the dominating model held by others. Thus, a transition to a more open communication structure (in the name of democratization) may rather increase this gap. To counteract such negative impact, a different, independent model among the less influential is required. This "model monopoly" theory, developed before WWW is even more relevant today, illustrating that access to information is not sufficient for increasing ones capacity to critically evaluate information and even take decisions.

Another important contribution to the understanding the impact of ICT's in organisations and society is his modelling of different types of integration, which may be depicted in this way.

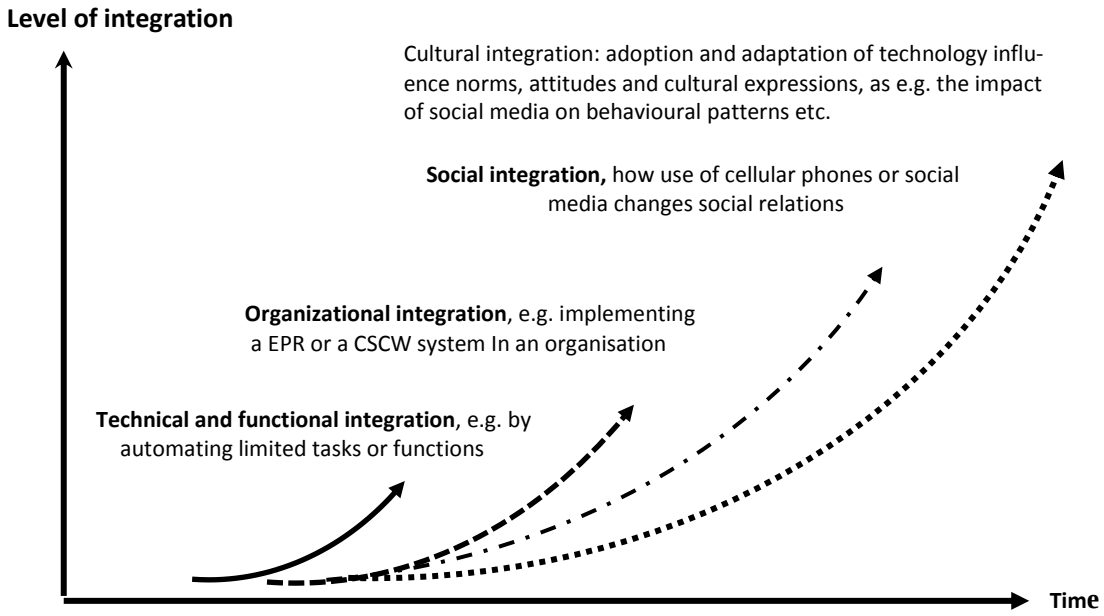

Figure 1: Technical, organizational, social and cultural integration (Bråten , 1983)

Bråtens levels of integration offers a challenging framework for analysing the role of social media, (as Facebook, Snapschat etc) in influencing our social behaviour and even our self-understanding.

2.8 The compulsive programmer

Still another viewpoint is introduced by Joseph Weizenbaum (1976) in his seminal book *Computer Power and Human Reasoning*. He departs from the view of seeing computer as an algorithmic, mechanistic tool and a data processing machine. However, when in including a subjective perspective, he points to how computers can be used to develop model views on the world, seeing the computer as an actor in broader perspective. Even more innovative thinking, he introduces the notion "the compulsive programmer", which metaphorical describes how a computer can be magnetic, even be experienced as an obsession. Weizenbaum (ibid, p 117) writes *"But because a compulsive can hardly be motivated to anything than to program, he will almost never document his program*" Thus, he illustrates how computers may have many faces, both objective, subjective and social. He concludes by "*We must also learn that the same danger [as e.g. with computer games] is inherent in other magical systems that are equally detached from authentic human experience and particularly in those sciences that insists they can capture the whole man in their skeletal framework"* (ibid, p 131). It is remarkable that he back in 1976 could predict the steady growing addiction to social media as Facebook. His notion of the compulsive programmer being "locked into" social and even cultural structures, can thus nicely be illustrated by Bråten (1983) different levels of integration, see figure 1. Also Weizenbaum's program ELIZA from 1966 that could "converse" in English by analysing the input

text and compose a response from a set of scripts, anticipated later AI debates. Even if the program did not include much intelligence, many user believed that they were interacting with a human.

3. A framework for the conceptualisation of ICT in research

In order to understand and conceptualise the multidimensional and versatile character of ICT, its diversity of applications, and not least the variety of consequences in organisations and in society, we need a rather comprehensive framework that comprises different dimension and perspectives. In order to delimit the complexity, these dimensions are discussed below:

- Perspective or viewpoint
- Approaches and methodologies
- Functions and roles

However, it can easily be argued that other dimensions could also be included, as e.g. to specify the level of analysis (macro, meso, micro) or levels of integration. However, such dimensions are primarily linked to the research focus and not the ICT artefact itself. It must be noted that this classification is not a goal on its own, but should contribute to more precise analysis.

Below, we will discuss what distinct categories that are relevant for these different dimensions.

Perspectives or viewpoints

Perspectives may be conceptualized in different ways; one is the more philosophical meaning (as weltanschauung), understood as a particular philosophy or view of life. Another, simpler meaning is s specific standpoint or position. Some examples are Kling and Scacchi (1982), which distinguishes between an *objective*, *mechanistic* perspective versus a *subjective*, *interpretative* understanding, and Dahlbom and Mathiassen (1992) add a *dialectic view*. Another categorisation is suggested by Crowston and Malone (1988), when distinguishing between *rationalist, information processing, motivational and political* perspectives.

Based on these and other scholars, I will distinguish between these perspectives: *Objective - mechanistic, subjective - interpretative, cultural- symbolic and political/power relation* as explained below.

Perspective	**Objective-mechanistic**	**Subjective- Interpretative**	**Cultural-symbolic**	**Politics/power relation**
Characteristics/focus	Algorithmic, rational bureaucracy. Functional analysis. Formalization of data	Human perception and experiencing, understanding (informal) Information processing	To see computers in terms of cultural , symbolic and aesthetic values	Understand power structures: Struggle between interests and influence

Table1: Different approaches in IS planning, development

Approaches – research methodologies

There are many different approaches and methodologies discussed in the literature. Bansler (1989), when analysing the *Scandinavian school* of system development, distinguish between these three "schools: *system-theoretical development*, *socio-technical evolution* and *critical Intervention* (as in action research), which to a large extend is in Dahlbom and Mathiassen distinguish between these three approaches: *hard - construction, soft – evolution* and *dialectic – critical*. I suggest these rude categories of approaches :

Approach/ methodology	(System- theoretica) **analysis/construction**	(Socio-technical) **evolution**	(Critical) **analysis/intervention**
Typical elements	Analytic, top-down decomposition and classification. Conflicts are ignored	Evolution, (also) bottom-up, experimental – prototyping Aims at solving conflicts	Dialectic, ontradictions , inconsistencies Action research Accept and handle conflicts of interest

Table2: Different approaches in IS planning, development and implementation, including organisational adaption

Functions and roles

Contrary to the high level view taken when discussing perspectives and approaches, *functions and roles* describes low level, detailed tasks and activities where ICT may be used. The distinction between a function

and a role is not always clear; e.g. a payroll system supports certain functions, while also fulfil a role in the organisation.

Jansen and Tranvik (2012) have, in reviewing a selection of documents on eGovernment, identified a number of ICT functions and roles in public organisations, and grouped them into the following categories[1]: i) *tool, ii) control and management, iii) ICT –based services, iv)information and knowledge management, v) interaction and collaboration, and iv) information infrastructures*. Below we describe these categories in more detail

The *tool* function, as e.g. the traditional office automation and case handling functions. ICTs are here usually regarded as value-neutral artefacts, expected to do what its designers intended them to do, corresponding to Orlikowski and Iacono (2001). A tool, therefore, has no value beyond its capability to support production or administrative processes. In this perspective, the technology is primarily understood as a technical matter, separated from but controlled by human actors (Kling 1987). Tools are usually neither complex nor very flexible, and require limited or moderate organizational integration.

Somewhat related to this category is the *control and management function*, where ICTs are used for reporting, supervision, monitoring and controlling purposes, i.e. in collection of data on performance of the individual public agencies. Such uses of ICTs are normally characterized by moderate complexity, implying limited need for flexibility and organizational integration. Both functions represent primarily a rational and functional perspective on technology, and hard system thinking. They can often, but not always be linked to an organisational imperative, in that they need not lead to substantial organisational changes.

Our next category is the *ICT-based products and services*, where ICTs are integrated in the core of a product or a service. ICT-based products is more than tools, they operate more or less on their own, and may include self-adapting algorithms. On the other hand, an essential characteristic is that service provision involves ICT-based communication with actors outside the organisation, and includes both technical and organizational elements. Such services will imply a significant level of complexity and flexibility, and organizational reorganisation is crucial (Ritchie and Brindley 2005).

Further, we find that ICT is being used extensively in *information and knowledge management*, which comprises a range of strategies and practices used in an organization to identify, collect, manage, distribute data and enable adoption of insights and experiences by facilitating the sharing of knowledge. This perspective differs from the tool function in even if it include data handling processes that can be automated, it involves intellectual activities based on insights and experiences either embodied in individuals or embedded in organizations as processes or practices. The research field *Big Data is* part of this category.

Our next category include systems that support *interaction and collaboration.* ICTs are increasingly being used for communication, interaction and cooperation. Typical examples are groupware systems and computer supported cooperative work (CSCW), but also Web 2.0 and social media, which implies changes in division of tasks and organisation of work. This use of ICTs is less structured and it requires significant organizational flexibility (Bratteteig 2004). Even though these types of use have similarities with CSCW applications, they differ in that such systems are open and its use is not controlled by any organisation.

Lastly, *information infrastructure (II),* which comprise the basic technical and organization capabilities necessary for supporting application systems and solutions across organisations and society at large. In particular, infrastructures are "sunk into" the organisation (Star and Ruhleder 1996) and shall be used by a large variety users and fulfil many different, partly conflicting functions and roles. Furthermore, IIs are fundamentally a relational concept that occurs in relation to organized practise. Thus, infrastructure implies a high degree of complexity and need for organizational adaptation. To day, we see that it can be extended to include (at least parts of) Internet of things (IoT).

Other categories are obvious relevant, as e.g. computer games/virtual reality, machine learning and AI products etc. Other examples are Facebook and similar social media platforms based on user generated content, which from the outset could be classified as service, but do also include characteristics related to communication and interaction as well as network and infrastructures. Similarly, Castells notion of the network (society) captures more than information infrastructures. It should also be noted at the categories are theoretical concepts, primarily to be used in research. A specific ICT artefact may have more distinct function and fill more roles.

[1] These categories is slightly modified, as Jansen Tranvik (2012) studied typical function and roles in public sector.

A summary of these functions and roles and a short description is listed in table 3 below.

	Function and roles					
	Tool	**Management & control**	**ICT-based goods or service**	**Information& knowledge management**	**Communication and Interaction**	**Network and Infrastructure**
Description/ examples	Spec. function, Office Automation etc. ,	Supervision , Auditing, Inspection, follow-up	ICT s integrated in products and services	E.g. data collection and analysis	Human-to-hum activity, CSCW, Social Media..	Heterogeneous, shared facilities management

Table 3: Different categories of ICT functions and roles and associated perspectives on technology

4. Analysis and discussion

Below is offered some statistics based on a review of 82 NOKOBIT papers (1997, 2000, 2006, 2013, 2017), applying the framework described above.

Firstly, it is interesting to see what themes or type of phenomena that have been studies. Based on a rather rude classification of themes, I have identified these categories, as shown in table 4:

Year	**Themes /phenomena**									
	System development	**Diffusion/ Adoption**	**Choice of technology**	**Usability/ user experience**	**IT in Teaching**	**Strategy /Planning/ architecture**	**Data/infor & knowledge management**	**IT & org. change/Innovation**	**IT in society**	Sum
1997	3	3	2	1	0	2	2	1	3	18
2000	6	1	1	0	2	1	0	2	3	16
2006	3	0	0	0	6	1	0	3	0	13
2013	7	0	0	2	3	0	2	2	2	17
2017	3	1	0	1	4	2	2	5	0	18
SUM	**22**	**5**	**3**	**4**	**15**	**6**	**6**	**13**	**8**	**82**

Table 4: Mapping categories of phenomena and themes studied in selected NOKOBIT papers

The table shows system development, along with IT in teaching and IT and organisation change /innovation (understood broadly) have been the most "popular" themes. More surprisingly, we find few papers on e.g. usability/user experiences and data /information management. Furthermore, the distribution of themes have not changed much during the 20 years of this study. However, the selection of paper represents only 5 years, and that my categorization may sometimes be imprecise or even misleading.

Table 5 show what are the dominating perspective in the papers.

Year	**Dominating perspectives**					
	Objective - mechanistic	**Subjective- Interpretative**	**Cultural-symbolic**	**Political /power**	**More perspectives**	**Sum**
1997	8	8	0	2	2	20
2000	8	8	0	0	0	16
2006	7	5	0	1	1	14
2013	6	11	0	0	0	17
2017	5	13	0	0	0	18
Total	**34**	**45**	**0**	**3**	**3**	**85**

Table 5: Identified perspectives in NOKOBIT papers

We see that that a large majority of the papers are taking either an objective–mechanistic or subjective – interpretative perspective, which is not surprising. Nevertheless, I miss more political oriented analysis as

well as discussions of cultural perspectives on ICT development and use. However, such perspectives may have been overlooking when reviewing the papers. Including more paper may also change this picture.

Similarly, table 6 maps the distinct approached that have been identified:

	Approaches - methodologies					
Yesr	System- Theoretical analysis	Socio-technical understanding/evolution	Critical Intervention	More Approaches	Not relevant	SUM
1997	8	7	1	1	2	20
2000	8	8	0	0	1	16
2006	6	4	1	2	1	14
2013	6	11	0	0	0	17
2018	5	13	0	0	0	18
SUM	**33**	**43**	**2**	**3**	**4**	**85**

Table 6: Different Approaches in selected NOKOBIT papers

While we find a balanced share between system-theoretical and social-technical, there are only 2 papers presenting critical approach. However, these numbers are based on my interpretation alone, as the approaches are not always specified.

	Functions and roles [x]							
Year	Tool	Control and Management	Product and service	Info. and knowledge management	Interaction and collaboration	Inform. infrastructure	Not specified/ not relevant	Sum
1997	3	0	0	2	5	1	7	18
2000	5	0	0	0	5	1	5	16
2006	3	1	1	1	1	1	5	13
2013	4	0	3	0	2	2	6	17
2017	6	0	3	2	0	7	0	18
Total	**21**	**1**	**7**	**5**	**13**	**12**	**23**	**82**

Table 7: Distinct function and roles in selected NOKOBIT papers

[x] If more functions and roles may be identified, the most dominating is chosen

This table shows that the papers focusing at ICT as tools, as information infrastructures or used in interaction and collaboration are dominating. It is surprising that very few papers discusses ICT artefacts in other functions or roles, e.g. in services or in knowledge management. It should be noted that the tool function is rarely explicit stated by the authors, accordingly this assignment is based on my assessment.

Table 8 shows if there are relation between perspective taken and the approach used? Table 8 below illustrates the covariation between them:

	Perspectives				
Approaches	Objective - rational	Subjective - interpretative	Cultural/ symbolic	Politics/ power	Sum
System-theoretical analysis/construction	28	8	0	0	**36**
Socio-technical understanding	6	37	0	1	**44**
Critical	0		0	2	**2**
SUM	**34**	**45**	**0**	**3**	**82**

Table 8: The covariation between perspectives and approaches in selected NOKOBIT papers

We see that there is a strong relation between an objective/rational perspective and a system-theoretical approach, and correspondingly strong relationship between a subjective/interpretative perspective and a

socio-technical approach. This is not surprising, but it should be emphasized that there is no one-to-one correlation, and our sample is rather small.

Table 9 presents the provides the possible covariance between perspectives taken and the role or function of ICT that are studied. relevant figures.

Function or role	Perspectives				
	Objective/ rational	Subjective/ interpretative	Cultural/ symbolic	Politics/ power	Sum
Tool	8	2	0	1	17
Control and Management	1	0	0	0	2
ICT product or service	5	1	0	0	9
Info. & Knowledge management	1	1	0	0	3
Interaction and communication	6	10	0	1	18
Information Infrastructures	0	5	0	0	12
SUM	**21**	**20**	**0**	**2**	**60**
Not relevant	13	9	0	0	22

Table 9: The connection between perspectives and function & roles in selected NOKOBIT papers

It seem to be a tendency that research that are studying ICTs as tools most frequently take an objective – rational perspective, while II-studies as well as interaction & communication studies prefer to take a subjective interpretative perspective. The sample is however too small to postulate any evident connections.

Lastly, table 10 maps the covariation between approaches chosen and the type of ICT phenomena studied.

Function or role	Approach –methodology			
	System-theoretical analysis	Socio-technical understanding/	Critical Intervention	Sum
Tool	8	9	0	**12**
Control and Management	1	1	0	**1**
ICT product or service	1	7	1	**6**
Info. & Knowledge management	3	1	0	**2**
Interaction and communication	5	11	0	**16**
Information Infrastructures	2	9	1	**5**
SUM	**20**	**38**	**2**	**41**
Not relevant	13	9	0	23

Table 9: The connection between approaches and function & roles in selected NOKOBIT papers

We see, correspondingly that papers reporting from studies of ICT as information infrastructures, in information and communication and in service provision tend to apply a socio-technical approach, which may not be surprising. More interesting may be that in studies of ICT artefacts understood as tools, both system-theoretical and social-technical approaches have been used.

5. Preliminary conclusions and further work

This review of selected NOKOBIT papers indicates that most papers are in the kernel of IS-research, both regarding themes, perspectives and approached. But few papers are having a political or similarly critical perspective. Furthermore, tools and interaction and collaboration systems along with information infrastructures seem to be the most "popular" types of ICT phenomena that have been studied.

However, categorization and tables is not a goal on its own. More interesting is to ask whether this analytical framework and the statistics provide us with more insight?. There are some interesting patterns. The figures above show a rather skewed distribution: Few papers includes cultural or political perspectives, and a critical (methodological) approach have rarely been used in the paper studied. In addition, the categories

control and management, information and knowledge management and even *product and services seem to* have had limited focus. However, this apparently bias may result from the method used: The categorizations have not been done by the authors, only by me as an reader, and many papers do not state clearly neither perspectives nor approaches or type ICT artefact.

To what extent are the analytical framework fruitful? Both yes and no. As stated above, the tables show both expected and unexpected distribution of the different categories. Expected distribution will be in favour of a fruitful framework, while unexpected finding may (but not necessarily) weaken its value. Notwithstanding of my findings in this study, the framework need to be tested on a larger and more representative sample of papers. One obvious challenge is connected to the understanding and analysing use of social media (e.g. Facebook), which evidently falls into more categories, illustrated by Bråten (1983) "levels of integration" or Weizebaum (1976) "compulsive programmer". This illustrates that the use of the framework cannot be based on understanding the ICT artefact itself, but how it is used and in which context.

The last and "tricky" question is whether more specific conceptualisations of ICT can contribute to better research. Based on my reading of (so far) 82 paper, I will claim that about 15% (between 10 and 15 papers) would benefit from specifying more precisely what [types of] artefact or phenomena that have been studied. Two cases can substantiate my arguments. Firstly, when we study what SU–approaches or methods software houses are applying, it is highly relevant to identify the type of software they are developing. Developing a precisely defined software tool need simpler methods than required when building a more complex system. Similarly, when we are studying the connection between type of a process modelling framework applied and the specific outcome of the modelling effort, the specific role of ICT artefact is highly relevant. This is clearly in line with Orlikowski and Iacono (2001) proposing "that IS researches begin to theorize specifically about IT artefacts, and then corporate these theories explicitly in their studies". However, in what way this theorization should be done need to be studies further.

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[i] I will use the terms computer (technologies), IT and ICT interchangeable to mean information and communication technologies, understood as the selection of primarily digital methods, techniques and tools designed to collect, organize, store, process, communicate and present information. See e.g. Ritchie and Brindley 2005).

[ii] The **National Information Infrastructure** (**NII**) was the product of the High Performance Computing Act of 1991. It was a policy buzzword, which was popularized during the Clinton Administration under the leadership of Vice-President Al Gore[I]