

# The Duality of Technology: ICT as an enabler and inhibitor in Business Process improvement

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## Abstract

The improvement of business processes often depends on ICT, which can either facilitate or impede improvements. Yet it is not clear though to what extent ICT enables or inhibits business process improvement and what factors can explain this effect. Orlikowski's duality of technology underscores the socio-historical context of technology and the dual nature of technology, as objective reality and as socially constructed product. In this article the duality of technology is used as the theoretical lens to analyze the interaction between ICT and business improvement using two case studies. Factors show the duality of technology by having an enabling or inhibiting effect depending on the situation. Some factors were found that can have either an enabling or inhibiting effect and this effect was found to be dependent on the context. This stresses the need for situational-specific understanding and taking into account the context.

## Keywords

Duality of Technology, Enablers, Inhibitors, Business Process, Business Process Improvement

## Introduction

Organizations often want to increase their efficiency in order to reduce their costs. Business process improvement, such as the Lean Six Sigma methodology, is therefore increasing in popularity (Näslund 2008; Nave 2002). At the same time, a trend can be seen of increased use of information and communication technology (ICT) in companies (Bevilacqua et al. 2015), creating more sociotechnical environments; environments where people and technology interact. The increasing presence of ICT in an organization's business process can however influence process improvement. As most improvement methodologies were originally designed for the manufacturing industry before the ICT era started (Powell 2013). Yet it is unknown how the presence of ICT influences business process improvement (Zhang, Van Donk and Van der Vaart, 2011).

Though successful implementation of both ICT and business process improvement has proved to be possible (Bell and Orzen 2010; Powell et al. 2013), there are still questions concerning the relation between ICT and the applicability of change. Kuk and Janssen (2013) show that modifying an organization's technology is not that simple when implementing change. As the theory of *duality of technology* (Orlikowski 1992) states, technology cannot be seen as either a socially constructed product or

an objective force, but it is a combination of these both. She states that technology's design and development is influenced by human actors through the different meanings they attach to the technology and the various features they emphasize and use (Orlikowski 1992). The use of the same or similar technologies, in similar organizational contexts, can often result in radically different organizational impacts (e.g. Barley, 1986; Kuk & Janssen, 2013). However, once the technology is developed and in use, it tends to become an institutionalized object that is difficult to change for the human actors working with it. Technology in this form can then either enable or constrain change (Kuk and Janssen 2013).

ICT systems are widely used by service companies in their business processes for example for their customer data storage. The nature of this system can influence the applicability of business process improvement. For example, Maguire (2014) argues that a system should allow for flexibility in the way computer-based tasks are achieved. One can imagine that when you can perform your task on a computer in different ways, it allows you to find the most efficient way. The *allowance of variation* in task performance can therefore contribute positively to business process improvement. Next to the ICT system, there are more characteristics of ICT that can influence business process improvement. A culture-related example provided by Maguire (2014) is the *neglecting of politics* by developers, as the value of the human experience can be tended to be overlooked in the rush to automate processes and organizations, which can influence business process improvement. Nelson (2007) also names *gold-plating* and the *silver-bullet syndrome* as classical mistakes in business process improvement by ICT. *Gold-plating* is the phenomenon where both users and developers want to add extra, unnecessary functionalities, which slows down improvement and the *silver-bullet syndrome* means that people expect the new technology to solve their problems and are inevitably disappointed.

Technology and change are related, however, this is often researched on an organizational level and the processes level is given less attention. This is also a criticism on Orlikowski's theory (1992), as it is designed on an abstract level and her theory has not been researched on lower levels, although there are expectations like the shop floor (Bechky, 2003). Also, most research using the duality of technology lens focuses on organizational change and not on small incremental change as described by business process improvement methodologies. In conclusion, ICT could possibly act as an enabler or an inhibitor of business process improvement in sociotechnical environments. The influence of ICT on improvement has not been researched yet and it is assumed that the influence of ICT depends on different characteristics. It is not known which characteristics these are and to what extent they enable or inhibit business process improvement.

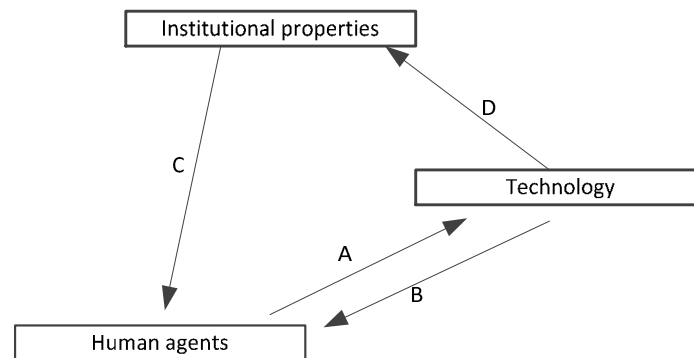
The goal of this paper is to investigate to what extent ICT enables or inhibits business process improvement and what factors can explain this. This paper is structured as follows. First a short brief background is given to the duality of technology and the applicability to the influence of ICT on improvement. Then the research methods explained and the findings of the research are discussed. It ends with a conclusion describing the dual nature of ICT.

## Background

Organizations co-evolve with changes in technology and the ways in which these factors interrelate influence how a network is shaped (Loukis et al, 2016). Orlikowski (1992) describes the interaction between technology and an organization as the so-called *duality of technology*. This states that technology cannot be seen as either a socially constructed product or an objective force, but it is a combination of these both. She describes the *duality of technology* as one of the premises of her Structural Model of Technology (Orlikowski 1992). This model underscores the socio-historical context of technology and the dual nature of technology, as an objective reality and as a socially constructed product. She defines two concepts for this model, scope and role. The scope of technology is restricted to material artifacts in order to theoretically distinguish between the material nature of technology and the human activities that design and use the artifacts. Orlikowski frames the role of technology in terms of a mutual interaction between human agents and technology, and hence as both structural and socially constructed (Orlikowski 1992). Luna-Reyes et al. (2005) identified four accumulations to be relevant in the process of changes; organizational design, knowledge about practice, system requirements, and system functionality.

Orlikowski uses two premises in her model; the *interpretive flexibility* and the *duality of technology*. The *interpretive flexible* nature of technology comprises the interaction of technology and organizations as a function of different actors and as dependent of the socio-historical context of technology's development and use. Here, technology stops being an artifact, and becomes a malleable “technology-in-practice”, whereby users constitute (or reconstitute) emergent technology structures through their actions (Volkoff et al. 2007). *Duality of technology* means that technology is created and changed by human action, yet it is also used by humans to accomplish some action.

With the premises of *interpretive flexibility* and *duality of technology*, Orlikowski shapes her Structural Model of Technology. Figure 1 shows the schematic representation of this model. As one can see in the figure, the Structural Model of Technology comprises three components. Firstly, human agents can be technology designers, users and decision-makers. Secondly, technology is as material artifacts mediating task execution in the workplace and thirdly, institutional properties of organizations include organizational dimensions, such as business strategies and culture, but also environmental pressures, such as government regulation and state of knowledge of technology (Orlikowski 1992).



**Figure 1 Structural Model of Technology by Orlikowski (taken from Orlikowski (1992), figure 5 and page 17)**

The figure above shows four arrows connecting the three components. Arrow (a) shows that technology is a product of human action. The interpretive flexibility is shown here in two modes of interaction: the design mode and the use mode. Arrow (b) shows technology as a medium of human action, as it facilitates and constrains human action through the provision of interpretive schemes, facilities and norms. Arrow (c) represents the institutional conditions of interaction with the technology. This describes the way that human action is shaped by the organizational contexts. Arrow (d) describes the institutional consequences of interaction with technology. The use of technology by the human actors often reinforces the institutional properties of an organization, but can also transform them (Orlikowski 1992).

Leonardi (2011) shows that the ways technology and material and human agency interlock in a certain path can result in different forms of change. More recently sociomateriality has gained attention in which material and social part are intrinsically linked (Orlikowski 2007). For the purpose of this paper we opted for conceptualizing the entities separately and understanding the interplay. Hence we used Orlikowski's Duality of Technology theory and the relationship among the elements depicted in figure 1 as a theoretical base to describe the interaction between ICT and business process improvement in our case studies.

## Research Method

The dual nature of ICT and its influence on business process improvement is investigated by conducting two case studies. This paper investigates to what extent ICT enables or inhibits business process improvement and what factors are responsible for this effect. The cases are selected for their similarities and to investigate whether different factors play a role when using ICT or the business process as a starting point when improving business processes. Cases within a single organization are selected to

ensure that the conditions are similar as possible, but the research is conducted with different employees within the same organization.

The case study is executed at a Back Office in a large energy supply company in the Netherlands. At this Back Office all work is done using computers, thus the workplace can be seen as a sociotechnical environment. Also a high need for process improvement is present, due to inefficient business processes. The case study is based on initial research using reports, observations and interviews to get a general idea of the ICT characteristics. The interviews are conducted with in total eight interviewees from the Back Office and the IT department and consist of questions about ICT, improvement and the influence of ICT on business process improvement. The case studies were conducted in 2015 and extended descriptions and the details of the case study can be found in Bras (2016).

The case studies are selected for their similarity, however, the role of ICT varies. The case studies consists of two cases in which an improvement is executed and during the improvement the influence of ICT is investigated, together with what characteristics have an influence and the nature of their influence. The first case includes process improvement without changing ICT and by only applying process improvement by Lean Six Sigma. The second case describes a changed ICT interface in a process and the consequent influence on the process. Lean Six Sigma was embraced by the company as a method to improve business processes. By having 2 case studies conducted in the same setting we were able to compare the differences based on the use of ICT.

## Case studies

For both cases the meter reading validation process is used. Customers of energy suppliers need to periodically submit their meter readings in order to calculate their usage of energy and send a bill. The meter readings need to be validated before a bill is sent to a customer. Generally the validation of meter readings is an automated process, but in some cases the submitted meter reading is rejected by the system and it is sent to the Back Office. At the Back Office these rejected meter readings are processed, so a bill can be sent to the customer after all. Both cases were focused on improving this process, but they had a different scope.

### Case 1: Lean Six Sigma

Case 1 scopes the process from the moment that the customer submits his meter readings until the validated meter readings are sent to the billing department. During this case Lean Six Sigma is applied as business process improvement methodology. Lean Six Sigma prescribes the so-called DMAIC implementation cycle, which stands for Define, Measure, Analyze, Improve and Control. Lean Six Sigma also prescribes certain tools, specified for the five phases of DMAIC, such as a Value Stream Map, a SIPOC diagram and a Pareto diagram. During the case study these tools are used and there is a constant reflection whether there are any features of ICT influencing the execution of Lean Six Sigma.

During Lean Six Sigma especially the root causes of problems are investigated and for these problems improvements are found. This includes suggestions for extension of the automatic validation rules and suggestions to reduce the incorrectly filled in meter readings by the customer due to incomprehension by making the submitting process more clear.

The most important influence of ICT can be found in three areas. Firstly, the ease of *data acquiring* (due to the use of ICT) is found to enable business process improvement, especially in the first phases where the process is defined and measured, as it is easy to generate data and measure performance of the process due to the use of ICT. Secondly, due to ICT it is difficult to get a *process overview*, as the processes cannot be physically seen, but are executed in computers. This shows the inhibiting side of ICT on business process improvement. Finally, the ICT system and its design also have an influence on business process improvement. Allowing users to perform their tasks in different ways, showing *Key Performance Indicators (KPIs)* during working or allowing users to *change settings* themselves are features of an ICT system that can enable improvement. For example, one of the found improvement points is the extension of the automatic validation rules. Fortunately these can be changed by the users themselves and this results in the enablement of business process improvement.

## Case 2: ICT

In case 2 the scope is shifted to the specific process at the Back Office. The process is scoped from selecting a customer from the rejected meter readings list by an employee until saving the processed meter reading in the customer database software. Processing rejected meter readings was previously done in the customer database software, but this is not designed for Back Office processes. The IT department developed a new interface, that focuses on the tasks of meter reading validation, showing only necessary information and in a structured and organized manner. During this case the improvement by the IT department is observed during the implementation phase of the new ICT interface.

In the previous case the dual nature of ICT was already shown and more features of the nature of ICT are found during the second case. The *detention* of ICT changes is an enabling effect. As it is difficult to reverse a change in ICT, it has a tendency to be maintained, which enables improvement. Inhibiting effects are the over-expectancy of ICT (such as the *silver-bullet syndrome* and *gold-plating*) and the low predictability of ICT changes (it is both difficult to test and difficult to predict the ease of the change).

Next to characteristics that are in the nature of ICT, also characteristics related to the ICT system and the culture were found. In this case the ICT system does not allow users to change settings themselves, such as the interface of the system. Employees are dependent on the IT department for improving this, inhibiting business process improvement by employees themselves. The organizational culture influences improvement during this case by *communication* and *neglected politics*.

## Findings

The case studies show the dual nature of ICT, as ICT can be both an enabling or an inhibiting influence. Some factors can become an enabler or inhibitor dependent on the situation. Table 1 shows the factors found in the two cases based on the interviews, observations and document analysis. We categorized them in three categories, nature of ICT, ICT system and culture. These are explained in more detail with their corresponding effect below.

**Table 1 ICT factors that influence business process improvement**

| <b>Nature of ICT</b>    | <b>ICT system</b>      | <b>Culture</b>                 |
|-------------------------|------------------------|--------------------------------|
| Hard to predict success | Allowance of variation | Neglected politics             |
| Silver-bullet syndrome  | Changeable settings    | Inter-department communication |
| Gold-plating            | KPI presentation       | Intra-department communication |
| Testing difficulty      |                        | Different values               |
| Detention               |                        |                                |
| Data acquiring          |                        |                                |
| Process overview        |                        |                                |

## Enabling factors

The characteristics that can be appointed to the nature of ICT, can work either enabling or inhibiting. The fact that ICT causes *detention* is a feature of ICT that always works enabling for improvement, even if it is present in a small amount. Also the ease of data acquiring due to the use of ICT works enabling for business process improvement. It was very easy to export data about the rejected meter readings to for example Microsoft Excel, facilitating the measure and analyze phase. ICT was found to be a key component for improving business processes. Without ICT the second case would not be possible.

## ***Inhibiting factors***

The over-expectancy of ICT is expressed in the *silver-bullet syndrome* and *gold-plating*. The *silver-bullet syndrome* is found during the case study using ICT. The employees had expected the new interface to have all the functionalities they wanted and were disappointed when this was not the case. *Gold-plating* is mentioned during the interviews, but is also found in the ICT case study. A product owner indicated that users came with a small request, but during testing, they wanted many extra things, therefore they now ask their users to choose and select the really important things. He also described that IT developers are apt to adding extra functionalities, because they can easily see things that are also not correct yet and it seems easy to do these things then as well. During the case study it was noticed that employees initially said they could not start working with the new interface before all the promised functionalities were added, but when discussing the reason for this, they came to the conclusion that these functionalities were not that necessary at the start after all. Both the *silver-bullet syndrome* and *gold-plating* have an inhibiting effect on business process improvement.

Also, the low predictability of ICT changes has an inhibiting effect. First of all, ICT changes are *difficult to test*. Interviews indicated that testing a new ICT functionality is difficult, because it is not possible to test it 100%. Therefore, there could always remain a small thing that is affected by the new functionality, but you would not see that when developing or testing. This makes it difficult to predict the success of the new ICT implementation. Even with testing, things can go wrong, you cannot take everything into account. Software testing is a well-known issue in ICT environments (Myers et al. 2011). Next to *difficult testing*, it is *difficult to predict the outcome* of ICT changes. Doherty (2014) describes how many outcomes from ICT changes are unplanned and unintentional. Changes in ICT systems are harder to visualize than for example a change in more tangible equipment. Therefore it is hard for IT to predict how long it will take before an issue is delivered, how difficult this is and whether this will work. One cannot see this in advance, but notices it during the process. The interviewed product owners indicated that it happens often that changes turn out a lot bigger than they initially seemed, but also the other way around. Also an employee. An employee indicated:

“Most of the times they [IT department] are in the correct direction, but it is never, almost never, in one time right.”

An example is the Back Office Taken Lijst (BTL). This is a task list system that would divide the workload automatically instead of by one person every morning. On paper it seemed like a good project, but when implemented there turned out to be more struggles than expected.

## ***Factors that can become an enabler or inhibitor***

The previous factors worked either enabling or inhibiting, but the culture- and ICT system related characteristics can influence improvement in both ways, depending on their degree. For example, little or bad *communication* can impede improvement, but *communication* can work as an enabler when it is good. This is also found in the case studies. In case 1 the automatic validation rules could be changed by employees themselves, leading to improvement enablement. In case 2 however it became clear that larger changes had to be performed by the IT department, leading to inhibition of improvement. Therefore *changeable settings* can work both enabling and inhibiting. Here, also the second premise, *interpretive flexibility*, can be found. It depends on how the technology is interpreted, on how it is used and whether it can enable or inhibit improvement. This is true for all culture- and ICT system related characteristics. Culture-related characteristics are *communication*, *different values* and *neglected politics*. The *communication* at the Back Office and between the Back Office and the IT department is not good and this inhibits improvement. A Back Office employee said:

“That’s not communicated, and if it is communicated, it surely does not reach this department.”

Bortolotti and Romano (2012) also mention *communication* can create problems during improvement, as this results in optimization of sub-parts of the process, instead of looking at the whole. Also Harrington and Guimaraes (2005) describe the importance of *communication* when implementing ICT change. The difference in values between the Back Office and the IT department can explain the bad communication. The Back Office employees have *different values* in mind when regarding issues. Product owners indicate

that also (safety) rules, privacy, compliance and information security are values that need to be considered when implementing changes and the Back Office employees generally do not know about these values:

“Something that a team never takes into consideration is information security: ‘O, but then we just take that from the internet?’, ‘No, we are not allowed to just take that from the internet!’ Such things seem so easy, but are not.”

*Communication* also affects *neglected politics*. It is important to communicate with the users of an ICT system, when building or changing one and a common mistake is to *neglect the politics* when implementing ICT change. Interviewed product owners indicated that IT is apt to forget to include the users, but that this is also due to the fact that they are still in a learning phase of scrum and agile. One product owner said:

“We are not at all accustomed to asking [users] ‘überhaupt’, so we just continue in the direction of which we think ourselves is the right one and after two months we hear ‘That was not at all necessary’.”

This results in developers building extra functionalities that the users does not find necessary and influences the inter-department communication.

Factors that are related to the ICT system are the *allowance of variation*, *KPI presentation* and *changeable settings*. The presence of these characteristics can enable improvement, whereas their absence can inhibit improvement. *Allowing variation* in the way users navigate through the process can influence improvement. It was observed during a day start that an employee said that they found a new way of solving a reject, leading to a faster process. As mentioned before, the ICT system is not designed for Back Office processes, but as a database, therefore there are many possibilities to work in the database. This also relates to Orlikowski’s interpretive flexibility. It gives employees the possibility to define the technology by the way they use it.

Presentation of KPIs, either manually or automated, could possibly influence improvement (Radnor 2010). A management member of the Back Office stated that by not showing what improvements have been done including their results, people are not starting to believe in the efficiency gains by improvements. If one could show this in measurable KPIs, this could be improved.

## Conclusion

This paper investigates to what extent ICT enables or inhibits business process improvement and what factors are responsible for this effect by using 2 case studies. Orlikowski’s duality of technology is used as a theoretical lens to investigate the influence of ICT on business process improvement. Duality of technology has been used primarily at the organizational level and in this work the dual nature of technology is confirmed at the process level. It is found that for many characteristics of ICT it is dependent on the situation whether their effect is enabling or inhibiting. This is especially true for the culture- or ICT system- related characteristics. The reason for this difference is that these factors can be changed, whereas the factors that are in the nature of ICT cannot. One can change the organizational culture or the ICT system, but not the nature of ICT.

The ICT system has an enabling or inhibiting effect depending on its design. An ICT system with *low allowance of variation*, *no changeable settings*, little *KPI presentation* and *no process overview* inhibits improvement, while the opposite is true when these characteristics are highly present. Also, an organizational culture with little *communication* and a high degree of *neglected politics*, does not favor improvement, whereas the opposite values of these characteristics allows for the enablement of improvement.

Factors related to the nature of ICT do not follow this trend however; they work either enabling or inhibiting. Enabling effects are due to *easy data acquiring* and *detention* of ICT, whereas the inhibiting effects are caused by the over-expectancy of ICT and the low predictability. However, the fact that the nature of ICT includes both effects again shows the dual nature of ICT. To conclude, this paper shows that ICT has a dual effect on business process improvement; it can both enable and inhibit improvement depending on the context of its features. Some factors were found that can have either an enabling or inhibiting effect and this effect was found to be dependent on the context. Our results confirm the duality

of technology for business process improvements efforts and stresses the need for situational-specific understanding.

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