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Discussion Paper

## IT as Curse and Blessing

by

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# IT as Curse and Blessing

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Pandora's box is opened – for years IT systems have been increasingly interpenetrating all areas of business and personal life. The negative implications of this are ubiquitous in the public debate, culminating in topics such as worldwide violations of data privacy protection or global economic crises. They are enabled by IT, which has created a more global, faster, and more interconnected world. Despite the irreversibility of these developments, they also bring hope – as once Pandora's box did. Numerous innovations are facilitated by modern IT systems providing great value in all parts of society. Therefore, IT is from a social perspective a curse and a blessing at the same time. It has great potential, provided that Business and Information Systems Engineering (BISE) contributes to find a balance between the two poles.

In 1965, the journal *Electronics* published the prediction of Gordon Moore (Moore 1965), one of the two founders of Intel Corporation, that the number of economically producible micro transistors per chip will double roughly every two years. The enormous performance boost observable today, which confirms Moore's Law (Intel Corporation 2005), together with a successively increasing interconnectedness between mobile and stationary terminals, has enabled the collection, processing, and analysis of huge data amounts.

In this context, the technological advances in information exchange and the automated acquisition and processing of data have caused economically highly relevant dynamics. These potentials can be seen in the impressive rise of multi-billion dollar technology companies such as Google and Facebook, whose business models were only made possible this way. But also well-established companies are forced to rethink their business models as the example of Apple shows: Only due to the combination of hardware products and digital services in a self-contained ecosystem, the company was able to secure its survival and to become the most expensive company in the world under Steve Jobs. But the example of Apple shows as well that the aforementioned dynamics of innovation forgive neither halt nor mistake. Therefore, it is highly questionable whether the successors of Steve Jobs can continue his successes.

The technological developments allow an unprecedented level of interpenetration and acceleration of all areas of business and personal life. This ever faster and more comprehensive data stream enables in turn an increasingly stronger interconnectedness of companies as well as individuals. It leads to a continuous and ever broader transformation of business models and value chains. However, these emerging opportunities and possibilities also impose great dangers that seem almost unpredictable due to the complexity of the interconnected world.

The increasing interpenetration of the world with sophisticated IT systems offers extensive possibilities of labor division. The resulting accelerated vertical disintegration involves a strong fragmentation of corporate value chains. Coordination and communication systems generate global dependencies in regional value networks, which are becoming increasingly intransparent for all participating companies.

In the area of financial economics, the threats of the increasing complexity came into notice for instance in the stock market flash crash on May 6, 2010. High frequency trading – see also Gomber and Haferkorn (2013) – acted as a catalyst (Kirilenko et al. 2011) for a singular defect, which thus spread worldwide and caused massive slumps in the market within minutes. Apart from these short-term frictions, the extent of long-term financial dependencies became apparent in the systemic relevance of some large market participants during the financial crisis. In the highly information focused financial sector such effects on transparency, security, and manageability are of great relevance. However, the growing opportunities in the field of information technology lead not only to a growing interconnectedness within the financial sector, but also with and within the real economy. Therefore, information technology has evolved along with the financial economy to be an important part of the circulatory system of the real economy.

The transformation of real economic value chains to complex value networks with intransparent dependency structures has become apparent in various recent events, as for example after the flood in Thailand in the year 2011. Altogether 45 % of the global

hard disk drive production came from the area around Bangkok so that its flooding led to global supply disruptions. The fact that companies can choose nowadays from a global range of suppliers via modern information technology entails many advantages in the design of value networks. However, the result of the general interconnectedness taken together with the vertical disintegration are very complex value networks. As in food webs of biological systems, the increasing complexity can lead to a destabilization and yield unpredictable risks (May 1972). Exogenous shock events such as a destructive flood may thus have unexpected and far-reaching consequences for the network as companies often only have knowledge of their immediate suppliers but not their suppliers' suppliers, sub-suppliers, etc.

Due to the high speed of information and cash flows, the financial system has become an important part of the circulatory system of the real economy. On the one hand, this leads to a close connection between the information flows of the financial markets and the real economy, whose flow of goods is far slower than the information flow.

On the other hand, this simultaneously facilitates the emergence of collective irresponsibility. The global linkages do not only cause unexpected interdependencies through which short-term oriented, individually rational actions of each party can in the long-term lead to an irresponsible outcome for society. It offers at the same time the possibility for market participants to neglect their own responsibility, which successively grows with the knowledge about the whole system. Instead, one can hide behind the system, a regulation deficit or behind other – even more irresponsible – market participants. Thus, it is possible for individual decision-makers to optimize their own short-term benefits without having to consider negative consequences for other parties and the overall system, respectively. The chance of being found out as the truly responsible person can seem too unlikely, if not impossible to them, so that there is not even the pressure that they may later have to justify their own actions.

This is particularly evident using the example of global commodity markets, since in this field both worlds collide with each other. Long-term oriented investors and short-term acting speculators are more than ever able to distort commodity prices and thus inflict direct damage to the real economy. Although none of the market participants has this intention, the systemic linkages and the opaque interdependencies lead to socially unacceptable results.

Another driver of the increasing complexity of our world is the growing importance of hybrid value creation. The output of companies in the real economy is changing more and more from goods-dominated to service-dominated systems (Lusch and Vargo 2006), so that the boundaries between the real economy and the financial economy become blurred. We operate in a continuum between these worlds where companies are offering individual combinations of goods and services focused on the specific customer needs. This way, they achieve increased competitive differentiation as well as a higher quality of their products and services for their customers and with it a higher margin potential. The fact that real economic companies sell downstream services to their customers in addition to their products is not new. Meanwhile, however, companies offer a highly customized bundle of products and services to their customers – an integrated view of products and services is therefore essential.

For example, Rolls Royce already started to sell engine power instead of aircraft engines more than a decade ago. Engine power including customized maintenance and replacement plans are provided for the customer for a fee per hour of usage – speaking literally, hot air is offered (for aircraft propulsion) instead of a mechanical product. However, the single components of a hybrid product can also be offered by a value network with partner companies. A relatively well-known example, which also excellently illustrates the strengthening ties between real and financial economy, is the zero-cost insurance of the optician Fielmann, which is offered in cooperation with the insurance company Hanse Merkur.

The supply of a complete product-service bundle represents a simplification for customers. However, this results in an increased dependency – the providers of hybrid products bear more and more responsibility due to their far-reaching integration into the value networks of their customers. Only the increasing possibilities of IT-based communication and coordination systems have facilitated the integration of service providers in the value networks of real economic companies respectively the increased coordination requirements between customers and the providers of hybrid products.

Among others, the clear focus on the customer in the area of hybrid value creation or in cloud computing, however, require the proper handling of the necessary customer-

specific data. The volume of management-related internal and external data is continuously growing and data is increasingly becoming a strategic “raw material” for companies, which is also reflected in the current Big Data hype.

Already in the editorial of issue 02/2013, we have discussed Big Data in detail and we will also dedicate the special focus issue 05/2014 to this hype topic. The challenges with respect to both the successful design and implementation of appropriate Big Data initiatives as well as regarding data privacy protection are still huge. If successfully implemented, Big Data, however, provides companies with great opportunities to achieve a significant improvement in their control concepts and a more extensive individualization of the services offered. The analysis of various data with the aim of deriving management-related information is basically not new for companies and has been common practice for years in the context of business intelligence strategies/data analytics. However, the possibilities of Big Data move far beyond: Not only does the volume of available and analyzable data increase but also data diversity. More and more new data are generated – both within the company (such as the data of intelligent embedded systems) and externally (such as data from online social networks). This often leads to a high heterogeneity of the data structures, which arises from the merging of data from different sources and from the use of partly unstructured data. In addition, Big Data offers companies among others a variety of new possibilities for the focused development of products and services which enable competitive advantages – especially in the area of hybrid value creation. Here the companies are facing the challenge of adjusting their data management and control systems to Big Data.

The previous considerations inevitably make clear: Modern IT systems are a blessing and a curse at the same time. The advancing technological developments bring along numerous business opportunities for companies to transform and enhance their business models and their value-creating processes to their benefit (and at the same time to the benefit of their customers). However, companies are thus also liable to an ongoing change process and the challenge to master the growing complexity and acceleration of these IT-driven transformation processes. BISE as a design-oriented and solution-oriented discipline can make an important contribution in addressing these challenges.

BISE can help to control systemic risks as in the context of value networks and to make the global and non-transparent interconnections of networks of real and financial economy with its partially unpredictable effects manageable. For this, innovative and practicable IT-based concepts have to be developed that help creating transparency, rating risks (semi-)automatically and making economically sound decisions about countermeasures. Since the beginning of the financial crisis, science has been addressing the occurrence of systemic risks primarily from a financial perspective, e.g., by means of improved stress tests for banks and more effective regulation – even if only *ex post*. Thus, recently it was proposed to tax companies based on their individual contribution to systemic risk (Chen et al. 2013). This allows regulators to work towards a decentralization of a network for its stabilization. However, the analysis of systemic risks in real economic networks or power grids and the development of practical approaches for the identification, valuation and controlling of risks are still largely missing, as the example of the energy networks in Germany shows.

From this we derive four central starting points for further research in the field of BISE. First, it is essential to reduce the existing deficit of information concerning the network structures. The information about the stakeholders of a value network and their interdependencies must be made accessible in a transparent way. The protection of important data in the context of the creation of the informational basis plays a crucial role from a business perspective. Experience shows that companies do not make their data available, if they see their competitive position at risk due to this. New concepts of information exchange, such as the promising trusted-third-party approach, are able to create relief. Second, the accumulated data should be analyzed with appropriate methods to draw conclusions about the state and the dynamic behavior of a network. Here network stability proves especially important. As the examples of the destructive flood or the financial crisis show, a local shock event can make a global network, which is apparently stable in normal condition, collapse quickly. Therefore, suitable methods for the IT-based modeling, identification and valuation of systemic risks in real economic value networks are required. Companies have to be enabled to obtain a better understanding of existing goods-based, financial and informational dependence structures through the management-oriented modeling of their value network. Among others,

both simple and robust risk assessments (e.g., structural analysis, key risk indicators) as well as sophisticated analysis methods (e.g., parameter estimation methods, causal chain analysis) are required. This is the foundation to, third, give companies the opportunity to design their supply networks and business processes so that local shocks within the value network do not become a threat for the own company. Thus, it is essential to carefully weigh the benefits of a higher level of detail when determining the risks against the associated costs for gathering and processing information. The classical methods of finance offer the possibility to make risk-/return-optimal decisions about investments in risk prevention, in order to mitigate systemic risk. Overall, every single company should be able to contribute to the stabilization of the overall system by eliminating any lack of transparency as well as deliberately handling dependencies in value networks. This is especially of great relevance when an appropriate regulation cannot be achieved due to complex and global dependency structures. Thus, the creation of improved regulatory capacities and methods simultaneously represents the fourth starting point for further research in the area of BISE. In addition to maximizing transparency, which is of interest for companies and regulators alike, it is necessary to provide regulatory authorities with an appropriate set of measures and methods based on advanced informational foundations and improved IT-based valuation methods.

The complexity of real economic value networks is additionally enhanced by the developments in the field of hybrid value creation. New concepts and methods for an improved management of systemic risks and the resulting improved control and coordination skills are in particular also highly relevant for the management of hybrid business models. Moreover, hybrid value creation poses the challenge to cope with the growing requirements of an individual, customer (group) specific generation of goods and services. Here, BISE is needed already in earlier stages of technology development to enable the concurrent development of relevant, user-centered services. This should include an economic valuation and management of opportunities and risks of new technology based offerings, including all associated challenges within processes and IT support – who might be better suited to do so than BISE with its interdisciplinary and techno-economic orientation?

A “strategic resource” for better methods and concepts as well as for the appropriate design of new customized offerings is always a company’s data. It is clear that a more extensive data collection alone does not automatically result in an improvement of the management and the design of new offerings. Successful Big Data initiatives require appropriate tools for quality assurance, analysis and interpretation of large data volumes. Here, particularly the development of tools is necessary which allow an appropriate handling of the especially pronounced data diversity in the context of Big Data. The successful integration of data thus requires clear rules to ensure high data quality and an intelligent data management, i.e., the quality assurance, selection and use of relevant data.

In addition, especially the aspect of data privacy protection plays a key role. Fueled by the current NSA discussion, this topic is also becoming increasingly important in public. Due to the growing data volumes and the rising interpenetration of companies with networked information, technology spying and obstruction pose a growing threat. It is important to be prepared for these current and future threats and prevent massive economical damage. For this purpose, relevant threats have to be identified, analyzed and their consequences must be evaluated with financial methods. On this basis, recommendations can be derived that help companies and public institutions to make economically sound decisions about possible countermeasures. The risk-reducing effects of measures have to be weighed against the costs, considering different limiting conditions as well as economic and social objectives.

Finally, it should be noted: The ever-advancing technological progress will continue to shape the world in general and in particular the increasingly complex business activities. Perhaps some people may desire to reverse part of these developments. However, Pandora’s box is already opened and the curse of modern IT systems is released to the world. We are therefore encouraged to use the increasingly advanced technological capabilities to curb the curse of the ever more complex and faster world. However, we also have to pave the way for the hope from Pandora’s box and unfold the beneficial impact of IT on new opportunities. In this field of tension between curse and blessing BISE has an important role: has an important role: Due to its inherent strengths such as interdisciplinarity, methodological pluralism, design-orientation, and engineering tradition, strength of innovation and practicality it continues to show great potential. We,

the BISE community, are especially responsible for the utilization of IT systems for our society.

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