Towards Systemic Evaluation of the Business Value of IT

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Abstract: Evaluating the IT business value is a challenging combination of managing the complexity of value phenomenon and the complexity of broad IT impacts. This study analyses the focal characteristics of IT business value evaluation and proposes a research agenda towards systemic evaluation approach. The systemic approach combines concepts of goal driven perspective for benefits, value as a combination of benefits and costs, and the lifecycle view of potential and realised value. These concepts are integrated through system dynamics modelling to understand the IT impact structures and dynamic value creating behaviour emerging from the structures. Finally, systemic approach should be supported by evaluation workflow practices that facilitate seamless data retrieval for the evaluation process, and the integration of evaluation outputs within the organisation.

1 INTRODUCTION

The evaluation of the IT business value is an existing challenge and, at the same time, the applications of information technology are becoming more ubiquitous and integrated in everyday business context. Fragmental interpretations of IT business value do not ease these evaluation efforts. IT business value can be interpreted as effectiveness or productivity, or it can refer to cost efficiency or added value.

In order to ensure the desired benefits from the investments, IT cannot be evaluated only as a black box and by relying only on economic measures such as return on investment or net present value (e.g. Martinsons et al. 1999). IT impacts should be studied from the diverse viewpoints of the organisation stakeholders while considering various indirect and complementary factors (Lee, 2001). As an investment, IT differs from the traditional tangible assets. It is not used in a 'vacuum' and, as an evaluation target, IT can be approached as a socio-technical phenomenon (Palvia et al. 2001). The evaluation of the IT business value is relevant during the various phases of the IT lifecycle, from the investment calculations to the benefit realisation management during the usage phase, until the decisions on upgrade or discontinuance.

Many authors promote for integrative and holistic approach for evaluating IT business value (e.g. Melville et al. 2004). However, finding the balance between a generic, widely applicable means of evaluation and sufficiently detailed frameworks for providing effective guidance on specific context remains a challenge (Stockdale and Standing, 2006). A considerable body of literature is also devoted to IT business value on industrial and economic level (e.g. Brynjolfsson & Hitt, 1998) but applicable solutions to evaluate individual IT systems are scarce.

The purpose of this paper is to analyse the IT business value evaluation by reviewing the challenges and existing approaches/solutions. We focus on company level and approaches that are applicable at an individual IT system level. The performed literature review is guided by the following research question "*How to characterise the evaluation of IT business value?*". Building on the evaluation characteristics we propose a schema

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of conceptual, methods and workflow basis for further research towards systemic IT business value evaluation.

The structure of this paper is as follows: Chapter 2 (*Research methods*) presents the literature review methods. Chapter 3 (*Evaluation of IT business value*) introduces the applicable concepts of value within business system, and continues with a synthesis of the main challenges of IT evaluation. The chapter is finalised by reviewing existing evaluation approaches. In Chapter 4 (*Towards systemic evaluation*), the main findings on IT business value evaluation are summarised, and the basis for systemic evaluation approach is discussed. Chapter 5 (*Conclusions*) concludes the contributions of this study.

2 RESEARCH METHODS

This study used a qualitative literature review to identify the challenges, principles and existing solutions to IT evaluation. The main body of IT/IS value evaluation literature was searched from seven widely used academic databases (including ProQuest, ScienceDirect, ACM and IEEE Explore). The searches were completed in November 2011 and scoped to journal article titles, with keyword combinations of 'IS', 'IT', 'information system', 'information technology', 'value', 'analysis', 'evaluation', 'measuring', 'measurement'. A total of 912 resulted articles were screened based on their titles and abstracts, after which 53 papers were selected for a deeper analysis. This analysis focused on the literature which elaborated the evaluation aspects at a company as well as at an individual IT system level. Finally 36 papers were included in the concluding analysis.

A parallel literature pool for systems thinking and system dynamics was studied. The core of this systemic literature covered the nominal text books from e.g. Sterman (2000) and Meadows (2008), as well as articles of Journal of System Dynamics Review.

The data analysis phase utilised the grounded theory (Corbin and Strauss, 2008). The coding of the evaluation literature identified for example problems, benefits and costs, methods and frameworks. The coded data was further analysed and higher level data groups were formed. These groups are elaborated in evaluation challenges and approaches sections 3.2 and 3.3.

3 EVALUATION OF IT BUSINESS VALUE

3.1 Value Perspectives

Our unit of analysis is an individual IT system that is evaluated as part of a company's business system. At a general level, the IT business value is defined as the contribution of IT to the company performance (Tallon et al. 2000; Melville et al. 2004). Performance may mean effectiveness in meeting the business system purpose and goals with the economic worth as the ultimate judgment of success for the profit making companies. The economic worth is quantified by measures such as return on investment (ROI), internal rate of return (IRR) or paypack time (Martinsons et al. 1999). However, using only the traditional economic measures for valuing IT is easily insufficient due to the broad scope of IT impacts and the attributability challenges when linking the impacts with benefits and costs.

In this paper we define value as an outcome of comparison between benefits and costs. For this, both benefits and costs have to quantified, but not necessarily in monetary terms. The relevant units for the quantification depend on the commensurability needs of the chosen performance evaluation level. Obviously, monetary units are widely commensurable while the index - benefits per costs relation - can be useful for company internal purposes.

The IT impacts aggregate and disperse through various business processes (e.g. Mirani and Lederer, 1998; Melville et al. 2004). In order to understand the multidimensional impact chains of IT, we should be able to link value creating factors to each other at multiple levels:

- **Individual**: benefits and costs as realised by the employees utilising IT in their daily tasks.
- **Organisational**: benefits and costs as realised at process level, e.g. process efficiency as input/output ratio.
- **Business**: benefits and costs as realised at business outcome level, e.g. productivity, sales or profitability, economic worth.

The above mentioned three levels serve as an example of means-end structure where the lower level goals in the hierarchy act as the means to achieve the higher-level goals as ends. This means-end chain theory is widely applied in customer value research to understand the structures and factors

affecting the value formation (e.g. Gutman, 1982). Similar structuring is also exercised within IS research, for example Benefits Dependency Network to diagnose IT investment business cases (Peppard et al. 2007).

In order to better understand the temporal challenges of valuing IT impacts, next we investigate 'locus of value'. In customer value research, locus of value is used for separating the benefit realisation as a phenomenon from the locus of explicitly measuring the reflection of phenomenal value. Ng and Smith (2012) discuss phenomenal consciousness (P-C value) vs. access consciousness (A-C value). P-C value is "*creation of value in context that is phenomenal, the raw experience of creating value (goodness) in interactions around the experience*" while A-C value exists "*in the perception, introspection and memory (or imagination) of P-C value before (ex ante) and after (ex post)*".

From the value evaluation point of view, locus of value relates to: 1) the delay between P-C and A-C value, i.e. the delay between benefit realisation in the context and the benefit and/or value measurement or quantification, 2) how well we are able to link the root P-C value to the A-C value that is evaluated at different levels of the business system. In IS research, locus of value is discussed together with the levels of analysis. Within the IT impact chains, locus of value is considered together with the question of how well the measures distant (e.g. economic measures) from the value creation event can actually address the first order impacts at individual employee or business process levels (Barua et al. 1995; Davern and Wilkin, 2010). The distance between the first order impact and the measurement point can be both cause-and-effect structural distance or it can be a time distance as a delay between the event and its measurement.

Davern and Kauffman (2000) discuss locus of value within the scope of the IT lifecycle. Locus of potential value defines the baseline for the expected value before the IT investment while locus of realised value is relevant after the investment. Locus of potential or realised value is not a single spot in time and place but it occurs at multiple levels of analysis, being a summation of multiple loci of value from different levels of analysis, including for example individual, work group and process levels.

3.2 Challenges of IT Evaluation

In general, the evaluation of IT impacts is described as 'complex' and 'multidimensional' (e.g. Lee, 2001). In the next paragraphs we elaborate the main challenges and rationale behind these broad descriptions (see Table 1 for the summary).

Focus and Volume of IT impacts

We start with two background factors: the *focus of IT* and the *nature of business system*. Our evaluation is scoped to a single company with a specific IT system as an element of a socio-technical business system. The business system includes other elements such as organisational structures, tasks and process hierarchies, goal hierarchies and different interpretations of value. IT impacts traverse through the business system, either broadly with wide effects or with more focused and narrow contributions. The broadness depends on the interrelation of the IT usage and focus with company goals and functions: the closer the focus of IT with strategic and transformative goals, the broader the IT impacts are when more employees, their tasks and business processes are supported by IT. The focus of IT together with the nature of business system reinforce the *volume of IT impacts*. The volume reflects the high number of IT's direct and indirect touch points with its surrounding business system.

Complementarity

Complementary factors are non-IT issues that affect how well the desired benefits and costs are realised (e.g. Dedrick et al. 2003). The examples of complementary factors include management practices, user skills and process maturity. Due to the complementary factors, the same IT in different organisational contexts produces different outcomes (Davern and Kauffman, 2000). We argue that complementarity is largely a practical embodiment of a business system being a socio-technical phenomenon. Further, the broader the focus of IT within the business system the more significant is the role of the complementary factors.

Traceability for causes and effects

The volume of impacts together with complementarity complicate the traceability of IT impacts within the business system. The indirectness of relations between IT's first order impacts to business performance grow when the hierarchies and the length of cause-and-effect structures grow (Melville et al. 2004). The indirectness is related to the attributability and accountability issues (e.g. Marthandan and Tang, 2010) when trying to isolate IT's contributions for the higher level business measures.

Table 1: Challenges in IT business value evaluation.

Challenges	Concepts and keywords	References
Focus of IT	- Strategic, transformational, informational or transactional - Focus types e.g. operations or market focus - Savings vs. added value	Mirani & Lederer (1998), Giaglis et al. (1999), Dedrick et al. (2003), Gregor et al. (2006), Tallon et al. (2007)
Nature of business system	- Socio-technical system - Organisational structures and layers - Tasks & Processes, Business processes - Multilevel perspectives	Hamilton & Chervany (1981), Barua et al. (1995), Wegen & Hoog (1996), Palvia et al. (2001), Marthandan & Tang (2010)
Volume of IT impacts	- Broad impacts - Multiple benefits & costs	Simmons (1996), Mirani & Lederer (1998), Kanungo et al. (1999), Irani et al. (2006)
Complementarity	- Contextual interaction - Conversion contingencies, complementary assets - Complementary organisational resources & capital	Davern & Kauffman (2000), Lee (2001), Dedrick et al. (2003), Melville et al. (2004)
Traceability for causes and effects	- Indirectness - Attributability, accountability - Locus of value vs. locus of analysis	Giaglis et al. (1999), Delone & McLean (2003), Melville et al. (2004), Petter et al. (2008), Davern & Wilkin (2010), Marthandan & Tang (2010)
Time & dynamics	- Payback delays - Evolving effects, dynamic objectives - Locus of impact vs. measuring delays - Potential vs. realised benefits	Hamilton & Chervany (1981), Giaglis et al. (1999), Chan (2000), Peppard et al. (2007), Davern & Wilkin (2010)
Observability & measurability	- Intangibility, soft benefits - Non-monetary, non-quantifiable - Asset type, IT capital - Hidden benefits & costs - Perceived vs. independently observable	Giaglis et al. (1999), Ryan & Harrison (2000), Irani et al. (2006), Gunasekaran et al. (2006), Bajaj et al. (2008), Davern & Wilkin (2010)
Accountability for business impacts	- Economic, financial or accounting measures - Black box	Simmons (1996), Martinsons et al. (1999), Bajaj et al. (2008), Davern & Wilkin (2010), Marthandan & Tang (2010)
Maturity of methods & theories	- Generic applicability vs. effective guidance - Need for integrative or holistic approach - Insufficient theoretical frameworks	Giaglis et al. (1999), Gunasekaran et al. (2006), Stockdale & Standing (2006)
Maturity of practices	- Benefits overstated - Ambiguous goals & measures - Focus on easy measures - Unavailability of data for ex ante – ex post comparison	Hamilton & Chervany (1981), Ragowsky et al. (1996), Wegen & Hoog (1996), Peppard et al. (2007)

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Time & dynamics

In many cases, IT benefit realisation is delayed from the cost realisation (Peppard et al. 2007). Locus of value is dispersed into multiple levels of the organisation and there are delays between the value realisation and the evaluation of realised value. Additionally, IT impacts are not static: IT itself is upgraded and improved while the complementary factors and the context around the IT evolve (Chan, 2000). The goals for IT also evolve (Hamilton and Chervany, 1981). Time delays together with dynamic changes bring dynamic complexity into the business system.

Observability & measurability

The above mentioned socio-technical system characteristics, complementarity, and delay issues bring concrete challenges to the quantification and measuring of IT impacts.

Part of the benefits and costs are easily omitted from the explicit evaluation because those are structurally or temporally too far from the first order IT impacts. Additionally, some of the IT impacts are so intangible or 'soft' that they are not easily quantified into a measurable form.

Accountability for business impacts

The previously mentioned evaluation challenges explain why single economic measures are easily too narrow for covering the value of IT. Attributability and measurability issues affect the reliability of the financial measures for giving holistic credit for IT's contributions.

Maturity of theories, methods & practices

Many authors recognise that the underlying theoretical basis for IT value evaluation is scattered. Holistic and integrative evaluation approach is requested in order to tackle the complexity and multidimensional issues (e.g. Giaglis et al. 1999; Gunasekaran et al. 2006). However, one of the challenges is to find the proper balance of wide applicability and practical usefulness with specific situations (Stockdale and Standing, 2006). This balancing challenge motivates our study by setting scalability requirements for the investigated systemic approach.

Many of the evaluation challenges are rooted in maturity issues of organisational practices and evaluation culture. Examples include practices for collecting evaluation baseline data, defining explicit goals for IT or managing the evolution of measures and evaluation frameworks (e.g. Ragowsky et al. 1996; Wegen and Hoog, 1996).

3.3 Approaches for IT Evaluation

In the next paragraphs we present an overview of the categorised evaluation approaches, starting from general principles and advancing towards practical solutions.

Principles for measuring & evaluation

Due to the multidimensionality of IT impacts, benefits and costs, many studies advice for using multiple units of analysis. Measurements should integrate the results from several organisational levels, and they should utilise both qualitative and quantitative measures, or perceived and independently observable measures (e.g. Davern and Wilkin, 2010). Evaluation should be seen as an incremental and evolving practice (Giaglis et al. 1999; Chan, 2000), and it should be executed both before and after the investment decisions (Davern and Kauffman, 2000).

Benefits & costs classifications

The studies in this category identify and group common benefit and cost factors of IT. Simmons (1996) classifies benefits into five types: increased efficiency, increased effectiveness, added value, marketable product and development of corporate IT infrastructure. Gregor et al. (2006) classifies benefit types into transactional, informational, strategic and transformational benefits. Irani et al. (2006) introduce extensive cost taxonomy while Ryan and Harrison (2000) focus on social subsystem benefits and costs. These studies can be used as a reference or checklists when identifying relevant elements for business system modelling and further evaluation.

Constructs for success or effectiveness

Success or effectiveness constructs propose a structure for the factors impacting or leading towards desired goals. Information System Success Model by DeLone and McLean (2003) is a widely studied cause-and-effect structure that links IS quality, usage and satisfied users with organisational net benefits. Technology Acceptance Model (TAM, TAM2) elaborate IT impacts and usage at the individual user's level of analysis (Davis, 1989; Venkatesh and Davis, 2000). Other examples of IT effectiveness or impact constructs are provided by Grover et al. (1996), Kanungo et al. (1999) and Gable et al. (2008).

Instead of providing specific checklists for IT benefits or costs, the constructs in this category aim to understand the overall role and connections of IT within the socio-technical business system. As generic reference models, they give guidance for modelling systemic structures and interdependencies. Studies in this category can also identify complementary factors to be included in system models (e.g. Larsen, 2003).

Constructs for evaluation process

The studies in this category view the evaluation process or the framework as a unit of analysis. Hamilton & Chervany (1991) recognises two types of evaluation perspectives: 1) *goal-driven view* focuses on whether actions produced proper outcomes and the emphasis is on the results, and 2) *system-resource view* focuses on whether things were executed properly and the emphasis is on the process and the means. From the systemic evaluation point of view, both the above mentioned perspectives should be used when applying means-end thinking to identify the cause-and-effect structures.

Stockdale & Standing (2006) introduce Context, Content, Process (CCP) evaluation framework that takes a holistic view by asking *what* is evaluated

(Content), *why* evaluation is conducted and *who* affects the evaluation (Context) and *when* and *how* the evaluation is to be performed (Process).

Benefits Dependency Network (BDN) by Peppard et al. (2007) links the organisational change and business goals by using the means-ways-ends approach. Means cover the IT enablers and enabling changes which facilitate the ways level for improving, chancing or giving up something. Ways-level – the changes – target for business level benefits in order to satisfy the IT investment goals – the ends level. BDN is an example of a goal-driven approach that helps in understanding the business system through cause-and-effect structures. BDN is presented as a one-way hierarchy from means towards higher level ends, thus omitting explicit feedback mechanisms from the higher level issues back to the lower levels.

Specific evaluation frameworks/methods

Balanced Score Card based approaches are proposed for integrative and holistic performance and evaluation tools for IT/IS (e.g. Martinsons et al. 1999; Bajaj et al. 2008). BSC frameworks provide a familiar measuring concept for business managers but by default their hierarchical format do not support feedback structures from the higher level elements back to the lower level elements.

Tiernan and Peppard (2004) emphasize a lifecycle view to the IT benefits management - from vision to value realisation - and introduce a mathematical formulation for the vision-to-value vector.

System dynamics (SD) is used by several authors to evaluate IT/IS, for example Santos et al. (2008) combine SD with Multicriteria Decision Analysis (MCDA) within continuous performance management process, and Mutschler and Reichert (2008) introduce SD modelling based EcoPOST cost analysis framework for process-aware information systems. Pfahl & Lebsanft (1999) introduce a SD based integrated measurement, modelling and simulation (IMMoS) approach in a software development domain. One of the learnings from IMMoS trial project is the importance of a goal-driven top-down approach for scoping and maintaining the focus for system modelling and measuring efforts.

4 TOWARDS SYSTEMIC EVALUATION

The answer for our research question "*How to conceptualise the evaluation of IT business value?*" covered evaluation challenges and solutions from the IT/IS evaluation literature. The IT business value evaluation appeared to be a combination of complexity regarding the multidimensional value concept itself and the evaluation challenges with the multilevel IT impacts in the business environment. Several sources suggest an integrative and holistic evaluation approach that would cover multiple units of analysis, would combine tangible and intangible factors, recognise complementary factors, would be goal oriented and span the lifecycle of IT business case.

The above mentioned characteristics set the ground for a systemic evaluation approach. We propose a scheme of three tightly coupled building blocks for structuring further research on systemic evaluation: conceptual basis, methods basis and workflow basis.

4.1 Conceptual Basis

The conceptual basis covers the focal concepts of IT business value evaluation within a business system. At first, the concepts of *goal*, *benefit*, *cost* (or sacrifice), *IT impact* and *value* has to be semantically linked together. *A business model* and *an earning logic* are practical concepts that can be used to set the goals and valuing perspectives for IT impacts. *A (business) process* and *a service* are examples of concepts used to understand the execution logic and interconnections of a business system. In order to support the lifecycle view of IT, a *potential value* and a *realised value* should be linked with expected and realised benefits and costs.

The further research of the conceptual basis could produce a metamodel for guiding the population of case specific system models. While populating generic metamodels and identifying case specific system elements and their relationships, existing IT/IS literature provides rich examples as summarised in 'Benefits & Costs classification' and 'Constructs for success or effectiveness' sections.

4.2 Methods Basis

The methods basis gathers means for visualizing and modeling the linkage of IT impacts with benefits, costs and even with commensurable value units. Our

further research relies on systems thinking and system dynamics. Systems thinking provides principles for defining system boundaries, understanding emergent properties and synergism of the business system elements. System dynamics (SD) is a set of methods for modelling the system structures and the dynamic behavior of the system over time (e.g. Sterman, 2000). SD is scalable from the *qualitative analysis* with causal loop diagrams to *quantitative analysis* with stock-and-flow diagrams and mathematical equations.

Qualitative SD provides potential means for the traceability and feedback analysis of IT impacts by applying cause-and-effect linking with balancing and reinforcing feedback loops. Qualitative modelling reveals the mechanisms behind the system delays and non-linear behaviour. Quantitative analysis gives further insights into the system beviour over time. Simulations can be used to test various system configurations, to find leverage points in the system structure, or to perform sensitivity analysis for the system variables (Sterman, 2000).

System dynamics methods are used as a 'glue' for integrating and modelling the conceptual basis elements and their interdependencies within the business system. The actual challenges of for example defining quantitative measures for intangible benefits and costs still remain. However, the recognition of the elements and relations affecting the value creation is the first step in ensuring that those factors are not left on their own but actively monitored and managed during the lifecycle of IT.

4.3 Workflow Basis

The workflow basis focuses on practical means of applying systemic evaluation methods and concepts in a real organisational context. The workflow practices should facilitate a seamless integration of the evaluation process and the business system organisation. How to obtain the required data from the stakeholders, how to scope and iterate the modelling, how to extract measures from the models are all example questions for further empirical studies.

5 CONCLUSIONS

This paper highlights the focal characteristics of the IT business value evaluation and proposes systems thinking and system dynamics as the core of a systemic evaluation approach. The systemic approach facilitates integrative perspective into the IT role within the business system: IT investments and the usage are seen as a continuous business case.

The further research on systemic evaluation approach is structured into conceptual, methods and workflow views. These views are currently utilised as the authors continue data collection and analysis of the lessons learned from the six industrial cases experimenting with systemic evaluation approach.

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