

A DECISION-THEORETIC FOUNDATION OF IS BUSINESS VALUE RESEARCH

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Abstract

Enduring doubts about the value of IS investments reveal that IS researchers have not fully managed to identify and to explain the economic benefits of IS. Three research tasks are essential requisites on the path towards addressing this criticism: the synthesis of knowledge, the identification of lack of knowledge, and the proposition of paths for closing knowledge gaps. This paper considers each of these tasks by a) synthesizing key research findings based on a comprehensive literature review, b) identifying and unfolding key limitations of current research, and c) applying a decision-theoretic perspective, which opens new horizons to IS business value research and shows paths for overcoming the limitations. The adoption of this perspective results in a decision-theoretic foundation of IS business value research and includes the proposition of a consistent terminology and a research model that frames further research.

Keywords: Decision theory, IT value, IS assessment, IS evaluation

1 INTRODUCTION

Researchers have provided rather sobering arguments against the economic relevance of information systems (IS). For example, Hitt and Brynjolffson (1996) doubt the strategic power of IS, and argue that IS are commodities and that any IS-based advantages will soon be eroded. Carr (2003) sums up doubts by going as far as to entitle his paper “IT doesn’t matter”. Another discourse is rooted in some empirical studies that do not find evidence of IS positively affecting specific performance measures, such as productivity (Stiroh and Botsch 2007), stock market reactions (Im et al. 2001), or “Return on Assets” (Dehning and Stratopoulos 2002). Apparently, IS researchers have not fully managed to identify and to explain the economic relevance of IS, so that business executives and researchers continue to question the value of IS investments, as Kohli and Grover (2008) note in their recent review. However, finding an answer to this question is regarded as fundamental to the contribution of the IS discipline (Agarwal and Lucas 2005). Three research tasks are essential requisites on the path towards answering this question and towards strengthening the role of IS (business value) research: 1. Synthesis of knowledge (what do we know?) 2. Identification of lack of knowledge (what do we still need to know?) 3. Proposition of paths for closing the knowledge gap (how should we proceed?) While many research articles, including literature reviews, address task 1, only few works address task 2, and we rarely find contributions, such as the works of Kohli and Grover (2008) and Soh and Markus (1995), that are dedicated to task 3. This paper follows the ideas that all three research tasks should be embedded into one logical flow, and that research task 3 should be approached on the basis of a theory. Consequently, the contribution of this work is threefold: It provides a synthesis of key research findings, it identifies gaps in research, and it shows paths for overcoming the current research limitations by providing and applying a decision-theoretic model of IS business value research.

The remainder of this paper is structured as follows: The next section frames IS business value research, as it is understood in this work. Section 3 synthesizes key research findings, before Section 4 identifies research gaps. Section 5 identifies decision theory as an appropriate theory base. In Section 6, the terminology and the model of (normative) decision theory are introduced, which are used in Section 7 to propose a decision-theoretic model of IS business value research. This model is discussed in Section 8 with regard to its potential to frame future research and to overcome current research gaps, before Section 9 concludes.

2 DEFINING IS BUSINESS VALUE RESEARCH

The academic field of IS research is terminologically pervaded with syntactically similar notions, such as “information system (IS)” and “information technology (IT)”. However, these notions often lack any precise semantic definitions and they are also based on different understandings. Reviewing articles published in “Information Systems Research”, Orlikowski and Iacono (2001) find that the “IT artifact” has not been theorized, and is widely interpreted depending on the specific research context. Having reviewed more than 200 papers related to IS business value, we find that this problem still exists. The notional fuzziness and heterogeneous semantics in literature are not surprising, because the IS discipline does not yet provide a broadly accepted or even standardized terminology. In this review, we adopt the “holistic” view on IS, as described, for example, in the ATIS Telecom Glossary (option 3): “*The entire infrastructure, organization, personnel, and components for the collection, processing, storage, transmission, display, dissemination, and disposition of information.*” (ATIS 2007). Having addressed the notion “information systems”, we now define “IS business value research”.

Notions and scope: A wide range of articles on IS offer a variety of notions and semantics regarding the economic consequences of IS investments (Kohli and Grover 2008, Melville et al. 2004). This variety in terminology does not only mirror notional inconsistencies, it also reflects different understandings (semantics) of how to operationalize the economic impact of IS. For example, a large subset of empirical studies apply econometric approaches by analyzing the relationship between IS

investments and economic variables, such as productivity (Hitt and Brynjolfsson 1996), “Return on Sales” (Bharadwaj 2000), or Tobin’s q (Brynjolfsson and Yang 1999). Other studies stress that, beyond financial and non-financial measures, intangible assets can be affected, such as organizational capabilities (Kohli and Grover 2008). The discussion becomes even more complicated when researchers also distinguish between what the particular outcome of an IS investment is, and how this outcome is interpreted. For example, the interpretation of a particular outcome, such as a productivity gain, depends on the view of the particular evaluator (Sylla and Wen 2002), on what competitors have achieved (Dehning and Richardson 2002), and what is finally done to exploit it (Alshawi et al. 2003).

Level of examination: Literature suggests using different levels for the examination of the economic impact of IS. A widely used classification distinguishes individual level, firm level, industry level, and economy level (Bakos 1987, Devaraj and Kohli 2000). In addition, research can also focus on consumer surplus (Bakos 1987, Brynjolfsson and Yang 1996, Devaraj and Kohli 2000). The importance of taking the particular level of examination into account is stressed by Dehning and Richardson (2002, p.8) and by Brynjolfsson (1993), who states that the usage of different levels even contributes to the explanation of the “productivity paradox”. Consequently, we take the level of examination into account in the following synthesis of research findings.

Object of evaluation: Due to the holistic definition of IS, investigations of the economic impact of IS investments differ in their objects of evaluation. While some studies consider overall IS investments, others are more specialized and focus on particular IS assets, such as IT capital (Barua et al. 1995), or IS personnel and training (Chatterjee et al. 2001). Similar to the level of examination, differences in the object of evaluation are considered in our analysis of results.

Time of evaluation: As Kohli and Grover (2008) stress, research on IS value can be of “ex ante” and “ex post” nature. While “ex ante” research refers to decision making, “ex post” research is dedicated to the control of past expenses. This work focuses on “ex ante” evaluation situations.

To sum up, we define IS business value research as any conceptual, theoretical, or empirical study that examines economic impacts of IS on individuals, firms, industries, or economies or consumers.

3 SYNTHESIZING RESEARCH FINDINGS

In order to cover the abundance of literature on IS business value systematically, to synthesize key research findings, and to identify research problems, we followed the theoretical suggestions of Webster and Watson (2002, p. xvi). More specifically, we performed a title search in pertinent journal databases and we further scanned the table of contents of eleven leading IS and management journals, including *MIS Quarterly*, *Information Systems Research*, *Management Science* and *American Economic Review*. The final body of literature considered in this work consists of more than 200 articles. We also explored the following literature reviews on IS business value: (Bannister and Remenyi 2000, Brynjolfsson 1993, Brynjolfsson and Yang 1996, Chan 2000, Chau et al. 2007, Dedrick et al. 2003, Dehning and Richardson 2002, DeLone and McLean 1992, Devaraj and Kohli 2000, Irani and Love 2002, Kohli and Grover 2008, Melville et al. 2004, Pare et al. 2008, Piccoli and Ives 2005, Soh and Markus 1995, Sylla and Wen 2002, Wan et al. 2007). A detailed description of the process of identifying relevant literature and a complete list of references are provided on www-users.rwth-aachen.de/guido.schryen/publications/Annexes_IS_Business_Value_Research.pdf.

Reviewing the large body of literature on IS business value research reveals that this field is dominated by empirical studies (Chan 2000, Pare et al. 2008) and econometric approaches, an “ex post” perspective, the adoption of variance theories in contrast to process theories (Pare et al. 2008, Soh and Markus 1995), a firm-level perspective (Chau et al. 2007, Pare et al. 2008, Wan et al. 2007), the analysis of firm performance in terms of productivity, market performance, and financial performance, and the consideration of the complementary influence of contextual factors and lag effects. Table 1 draws a condensed picture of what literature has found in the aforementioned areas.

Area	Key literature findings	Literature
Performance Measures	Many empirically investigated economic measures, including productivity, product quality, consumer welfare, various profit ratios and market-oriented measures	Brynjolfsson and Hitt 1996, Brynjolfsson and Hitt 2000, Barua et al. 1995, Thatcher and Oliver 2001, Thatcher and Pingry 2004, Barua et al. 1995, Bharadwaj et al. 1999
	Widely adopted classifications are (1) the model of DeLone and McLean and (2) the classification that distinguishes between process performance and firm performance	(1) DeLone and Mclean 1992, Seddon 1997, DeLone and McLean 2003, (2) Barua et al. 1995, Dehning and Richardson 2002, Melville et al. 2004
	Impact of IS investments on firm performance is intermediated by process performance	Barua et al. 1995, Dehning and Richardson 2002, Kim et al. 2006, Lee et al. 2004, Melville et al. 2004, Mooney et al. 1995, Shin 1997, Soh and Markus 1995
Impact on Productivity	Early studies did not find a positive correlation between IS and productivity at firm level, industry level or economy level	Brynjolfsson and Yang 1996, Baily 1986 Jorgenson and Stiroh 1995, Roach 1987, Berndt and Morrison 1995, Roach 1991, Loveman 1994
	Recent studies draw a more positive picture on the impact on productivity: productivity paradox has been resolved at firm level, major impact of IS investments on national productivity and economic growth	Aral et al. 2007, Brynjolfsson and Hitt 1996, Brynjolfsson and Hitt 2000, Kelley 1994, Lin and Shao 2006a, Neirotti and Paolucci 2007, Menon et al. 2000, Shin 1997, Stiroh 2002, and Swierczek and Shrestna 2003, Devaraj and Kohli 2000, Dedrick et al. 2003, Jorgensen 2001, Jorgenson and Stiroh 2000, Oliner and Sichel 2000
Impact on Market Performance	No positive correlation between IS investments and Total Shareholder Return	Tam 1998, Brynjolfsson and Hitt 1996
	Impact of IS investments on stock market reactions is largely determined by the particular type of IS	Dos Santos et al. 1993, Im et al. 2001, Richardson and Zmud 2002
	Positive correlation between IS investments and Tobin's q	Bharadwaj et al. 1999, Brynjolfsson and Yang 1999, Brynjolfsson et al. 2002
Impact on Financial Performance	IS investments positively affect (1) Return on Sales and (2) Operating income to employees	(1) Bharadwaj 2000, Dehning and Stratopoulos 2002, Kim et al. 2009, Santhanam and Hartono 2003, Zhang 2005; (2) Bharadwaj 2000, Santhanam and Hartono 2003
	Positive impact on (1) Return on Assets, (2) Return on Investment and (3) Return on Equity seems to depend largely on lag effects, contextual factors and the level of IS investments compared to total assets	(1) Bharadwaj 2000, Dehning and Stratopoulos 2002, Hitt and Brynjolfsson 1996, Kim et al. 2009, Peslak 2003, Rai et al. 1997, Santhanam and Hartono 2003, Stratopoulos and Dehning 2000, Tam 1998; (2) Hayes et al. 2001, Mahmood and Mann 2005, Peslak 2003, Stratopoulos and Dehning 2000; (3) Alpar and Kim 1990, Beccalli 2007, Peslak 2003, Rai et al. 1997, Shin 2006, Stratopoulos and Dehning 2000
Contextual Factors	Contextual factors can be divided into firm, industry, and economic factors	Barua et al. 1996, Bharadwaj 2000, Davern and Kauffman 2000, Dehning and Richardson 2002, Ko and Osei-Bryson 2004, Melville et al. 2004, Zhu et al. 2004
	Alignment of IS with a firm's core competencies and business planning and close ties between IS investments and upper management are crucial for enhanced firm performance	Chari et al. 2008, Dos Santos et al. 1996, Floyd and Wooldridge 1990, Li and Ye 1999, Ravichandran and Lertwongsatien 2005
	(1) Industry factors and (2) macro-economic factors are addressed only rarely	(1) Lin and Shao 2006a, Sircar et al. 2000, Lim et al. 2004, Melville et al. 2007, (2) Kim et al. 2009, Swierczek and Shrestha 2003 and Zhu et al. 2004
Lag Effects	Mismeasurement of IS investment impact may be rooted in the ignorance of effects delayed by years	Kauffman and Weill 1989, Stiroh 2002, Weill and Olson 1989, Brynjolfsson and Hitt 1998, Jain 2005, Mahmood and Mann 2005, Santhanam and Hartono 2003

Table 1. Key literature findings in selected areas of IS business value research

4 IDENTIFYING RESEARCH GAPS

Despite the large body of literature on IS business value, dissenting voices on IS value show that IS researchers have not fully managed to identify and to explain the economic relevance of IS (Kohli and Grover 2008). In this section, we identify important gaps in current IS business value research, which are roots for limitations and the low explanatory power of current IS business value research.

Terminology: The discussion of notions and scope in IS business value research already revealed the diversity of notions and their inconsistent use. Orlikowski and Iacono (2001) even find that the IT artifact itself tends to disappear from view. However, for each academic discipline, a consistent terminology is undoubtedly essential to name relevant constructs, to define its semantics and to resolve potential ambiguities. Having reviewed also more recent literature, we do not find any evidence that research has finally started to address this issue. In order to overcome this issue in IS business value research, it is appealing to draw on an established academic field that already provides widely accepted vocabulary and semantics and that also allows a “natural” mapping of IS terminology onto its own terminology. We explain in this paper why decision theory shows these qualities.

Intangibles: As the previous section shows, the impact of IS investments is mostly viewed from the financial, the market or the productivity-oriented perspective. However, these perspectives are limited in identifying intangible benefits, which are deemed important as well (Devaraj and Kohli 2000). For example, capabilities and knowledge at organizational level, such as redesigned business processes and improved coordination flexibility (Kohli and Grover 2008, Soh and Markus 1995) may have an intermediate, delayed, or hidden impact on economic performance. Bhatt and Grover (2005) even argue that the quality of IS business expertise can form capabilities that have a significant effect on competitive advantage. However, only few researchers address intangible benefits in their empirical studies. The particular economic importance of intangibles has also been considered in the “Balanced Scorecard” (BSC) concept proposed by Kaplan and Norton (1996). They suggest applying key performance indicators that are related to the four dimensions of finance, customer, internal process, and learning and growth, in order to measure whether the operational activities of a company are aligned with its objectives in terms of vision and strategy. IS researchers have started using the BSC; for example, and Lee et al. (2008) propose evaluating the performance of whole IT departments by applying the BSC.

Diversity of IS Assets: It has been widely argued in the literature that better insights in the way IS investments induce superior business performance require a breakdown of IS investments into single IS assets (Melville et al. 2004, Sircar et al. 2000). Most studies that address particular IS assets are related to investments in IT capital (Barua et al. 1995, Sircar et al. 2000), or in IS personnel and training (Chatterjee et al. 2001, Sircar et al. 2000). The studies differ enormously in methodologies, data, time period, and measures used. Overall, the resulting picture is mixed and provides some sobering results. However, the failure of many studies to prove a positive impact of IS on business performance is not rooted in the breakdown into single assets. It is probably mainly based on the facts that (1) important linkages between IS assets are ignored (e.g., purchasing an email system is rather useless unless employees are trained how to use the system effectively), and (2) contextual factors, such as the extent to which business processes are based on using email communication.

Risk: As in the case of many other investments, IS investments bear economic risks due to the uncertainty of future and states (Mata et al. 1995) and are regarded even substantially riskier than non-IS investments (Dewan et al. 2007). However, risk in the context of IS investments has received little attention in the literature, even though the risks are widely recognized (Dewan et al. 2007, p. 1829).

Diversity of Performance: Although in IS business value research various performance measures are applied, only few authors recognize the existence and importance of linkages between different types of performance. For example, Thatcher and Pingry (2004) show in their theoretical work that it can be economically rational to accept increasing production costs and lowering productivity for the sake of profits by using IS investments to design a better-quality product and charge a higher price. Potential

contradictions between performance indicators are also revealed by Hitt and Brynjolfsson (1996), who find the application of IS being accompanied by increased productivity, but not by supranormal business profitability. The complexity of the economic evaluation of IS goes beyond the question of which specific performance measure to use. The co-existence of multiple measures rather calls for their contemporaneous consideration. Some initial work has been done by to provide practitioners with frameworks and techniques (Dehning et al. 2005, Lee et al. 2008, Sylla and Wen 2002).

Stakeholders and Subjective Preferences: The economic impact of IS investments is widely assessed in terms of contributions that can be measured by means of performance indicators. However, the ultimate meaning of performance (gains or losses) can differ in manifold ways, when the benefit that is derived from the economic performance is determined (Alshawi et al. 2003, p. 419), when the assessment of outcomes depend on what competitors have achieved (Dehning and Richardson 2002), or when the value depends upon the subjective preferences of the persons who perform the evaluation (Sylla and Wen 2002, p. 242). These arguments indicate the necessity to distinguish between performance, which is measured by means of economic indicators, and its (different) values in terms of the subjective interpretation of (different) stakeholders. While the former perspective is referred to as “outcome approach”, the latter corresponds to what is referred to as “perceived benefit”. The usefulness to distinguish performance and its value is further stressed when competitive advantage is distinguished from “hard” performance indicators and is regarded as value. Competitive advantage is one of the most controversially discussed impact of IS investments (Bhatt and Grover 2005, Carr 2003, Hitt and Brynjolfsson 1996, Piccoli and Ives 2005).

5 SELECTING THE THEORY BASE

This section contributes to the search for a theoretical foundation upon which to propose a theoretical model of IS business value. Such a model would then itself provide a theoretical basis for addressing the previously identified research gaps (terminology (G1), intangibles (G2), diversity of IS assets (G3), risk (G4), diversity of performance (G5), stakeholders and subjective preferences (G6)).

Researchers have employed many theoretical paradigms when analyzing the value that IS creates for organizations (Melville et al. 2004, Pare et al. 2008). Among the most widely used theories are production theory, resource-based view, and process theory (see references in Table 2). In the search for a theoretical paradigm upon which researchers could draw in order to address the identified research gaps, a straightforward approach would be to employ and possibly extend the aforementioned theories. The advantage of drawing on these theories lies in the experience that researchers have already gained from applying these theories in the context of IS business value. However, there is also a strong motivation to look for other theoretical paradigms, since opponents to the application of the aforementioned theories might argue that the wide application of these theories has actually led to the identified research gaps. We additionally select decision theory as a further candidate for the theory base. This selection is rooted in three rationales: (1) Core elements of decision theory are strongly related to risk (G4), multiple criteria (G5), and subjective preferences (G6). (2) Decision theory has already been considered a valuable theoretical basis in IS research. For example, Lee et al. (2008) and Sylla and Wen (2002) have applied decision theory, and the scope of the “International Journal of Information Technology & Decision Making” even includes the effects of decision-making tools in the information technology era. (3) Decision theory suggests “individual level”, “ex ante” models, which provide a perspective on IS business value research that is complementary to the more traditional and widely applied “firm level”, “ex post” perspective. Therefore, decision theory appears promising for gaining new insights into the IS business value domain.

A summary of the fit of theoretical paradigms to research gaps (G2)-(G6) is shown in Table 2, which also provides references to research papers on which our analysis is based on. As each of the considered theories provides a well established terminology upon which IS business value research can draw, we do not use (G1) as a criterion for finally selecting a particular theory base. We want to note that in our analysis we do not require a theoretical paradigm to provide constructs for each of the

research gaps, as theoretical paradigms can be extended to address further research gaps, including “stakeholders and subjective preferences”. However, as decision theory already provides model constructs for all the identified research gaps, we consider decision theory a highly promising candidate for a theory base in IS business value research.

Theoretical paradigm	Perspective	Focal unit	Research gaps				Stakeholders and subjective preferences
			Intangibles	Diversity of IS assets	Risk	Diversity of performance	
Resource-based view	heterogeneous firm resource endowments as a basis for competitive advantage	firm	intangible resources	resources	technological uncertainty and market uncertainty	business process performance and organizational performance	--
	Bharadwaj 2000, Caldeira and Ward 2003, Clemons and Row 1991, Jarvenpaa and Leidner 1998, Mata et al. 1995, Melville et al. 2004, Powell and Dent-Micallef 1997, Ray et al. 2004, Ray et al. 2005, Santhanam and Hartono 2003, Wade and Hulland 2004						
Production theory	inputs a firm uses can be related to output via a production function	firm, industry, economy	--	input variables	control variables	production functions with different output variable	--
	Brynjolfsson 1993, Brynjolfsson and Hitt 1995, Brynjolfsson and Yang 1996, Dedrick et al. 2003, Dewan and Min 1997, Lichtenberg 1995, Brynjolfsson and Hitt 1996 Dewan et al. 2007						
Process theory	Transformation of	business unit, firm, process	IT assets	IT assets	--	organizational performance	--
	<ul style="list-style-type: none"> • IT expenditures into IT assets (IT conversion process) • IT assets into IT impacts (IT use process) • IT impacts in organizational performance (competitive process) 						
Soh and Markus 1995							
Decision theory	optimal or good decisions in complex problems	individual	criteria (different scale levels)	alternatives	risk of states	multiple criteria (decision making)	utility
	Lee et al. 2008, Sylla and Wen 2002						

Table 2. Mapping research gaps onto constructs of theoretical paradigms

6 CHOSEN THEORY BASE: DECISION THEORY

In normative decision theory, a decision maker has a set of alternatives (a_i) (options) available, which can be finite or even infinite, and from which s/he intends to choose the best or at least an appropriate one. For example, in the context of IS business value, each alternative corresponds to a specific IS asset, such as a piece of software, IT infrastructure, or administration staff. The result of this selection process, i.e. the alternative or set of alternatives chosen, is referred to as a “decision”. The effect of a decision, the outcome o_i , may depend only on the choice of the alternative(s), but it seems more realistic that the effect also relies on unknown exogenous factors, which are summarized into a number of cases denoted as “states of nature”. For example, these states can be economic conditions, such as the number and strengths of competitors, or country-specific infrastructure conditions. In the presence of states, the possible outcome o_{ij} of a decision is defined as the combined effect of a chosen alternative i and the state of nature j that obtains. It should be noted that the outcome can vary according to its scale level. For example, at nominal level, a possible outcome is the pure description of a result, such as “orders can be sent electronically to the suppliers”. Outcomes at ordinal level are comparable with each other (e.g., “increased customer loyalty”), while outcomes at cardinal level, such as an amount of money, even afford us to perform calculations. The standard structure for the evaluation-choice routine in (individual) decision theory is that of a decision matrix, in which the alternatives are tabulated against the possible states of nature (see Figure 1). For the purpose of supporting or analyzing a decision, we additionally need (1) information about how the outcomes are valued, (2) information pertaining to which of the states of nature will be realized, and (3) information about if and how outcomes need to be disaggregated in order to perform evaluation as to different criteria.

Value of the outcome: A key concept in decision theory is the differentiation between outcome o_i and its utility u_i : while the outcome refers to a phenomenon that can be observed (e.g. productivity gain), its utility is determined by means of a preference function that accounts for the subjective preference of the decision maker. Accordingly, decision theory also draws on utility theory.

State of nature: If the outcome depends on future states, the subfield is referred to as “decision making under non-certainty” (Goodwin and Wright 1991, p. 40f). Knowing the deterministic outcome of each alternative often seems unrealistic. For example, the impact of an electronic procurement system on a firm’s bargaining power towards its suppliers depends on the future number and power of suppliers in that particular industry. Many procedures and theories for processing non-certainty information have been proposed, including several probability theories and fuzzy set theory.

Multiple criteria: Usually, the outcome of a decision is complex, and the decision underlies different, probably conflicting objectives. For each alternative a_i , the total outcome is then divided into partial outcomes o_{ij} , with j being the corresponding attribute or criterion (costs, user acceptance etc.). As in the case of a single outcome, each partial outcome needs to be valued by applying a utility function g_j , which takes into account criterion j . With this procedure, we get as many values as criteria exist. Similar to a decision under non-certainty, the values often need to be aggregated (function h is applied) in order to obtain a “final” value for each alternative. This final value can then serve for comparisons of alternatives (see Figure 1). Accordingly, this subfield of decision theory is termed “multiple criteria decision making” (MCDM). As MCDM provides flexibility in terms of the numerical scale level of criteria, intangibles can be modelled as non-cardinal criteria.

7 DECISION-THEORETIC MODEL OF IS BUSINESS VALUE RESEARCH

The established terminology in decision theory can be used to suggest a concise terminology for IS business value research. Table 3 shows the suggested terminology, its semantics, and examples. Application of the decision-theoretic perspective does not only allow a drawing on established terminology, it also provides the opportunity to apply the decision-theoretic model to IS business value research. A straightforward approach is to use derived IS business value terminology and to exploit the analogy of IS business value and decision theory, as presented above. Figure 1 presents the resulting decision-theoretic model for IS business value research; it also provides examples.

IS business value	Decision theory	Semantics
IS asset	Alternative	<ul style="list-style-type: none"> • Due to a limited budget, various IS assets are candidates for investments • Examples are hardware servers, ERP system, Intranet infrastructure, CIO position, and staff training
IS investment decision	Decision	<ul style="list-style-type: none"> • Selection of one or several IS assets for investment
Type of performance	Criterion	<ul style="list-style-type: none"> • Economic value of IS can be based on different performance types (e.g. productivity, “Return on Assets”)
Performance	Outcome	<ul style="list-style-type: none"> • Economic performance is determined by both the particular IS asset(s) and environmental factors • Performance refers to observable results (e.g. increase of productivity by 5%)
Business value	Utility	<ul style="list-style-type: none"> • Business value is a perceived or derived benefit (e.g. business value of an increase in productivity by 5% depends on who evaluates)
Economic conditions (instantiations of environmental factors (firm, industry, or economy factors))	States	<ul style="list-style-type: none"> • Economic conditions are instantiations of environmental factors • Environmental factors determine the impact of IS investments • Economic conditions/Particular instances of environmental factors (e.g., well trained employees, adoption of XML-based RosettaNet standard at industry level) are regarded as states
Non-certainty of economic conditions	Risk of state	<ul style="list-style-type: none"> • Economic conditions are often non-certain and linked to risk

Table 3. Mapping IS business value terminology onto decision theory terminology

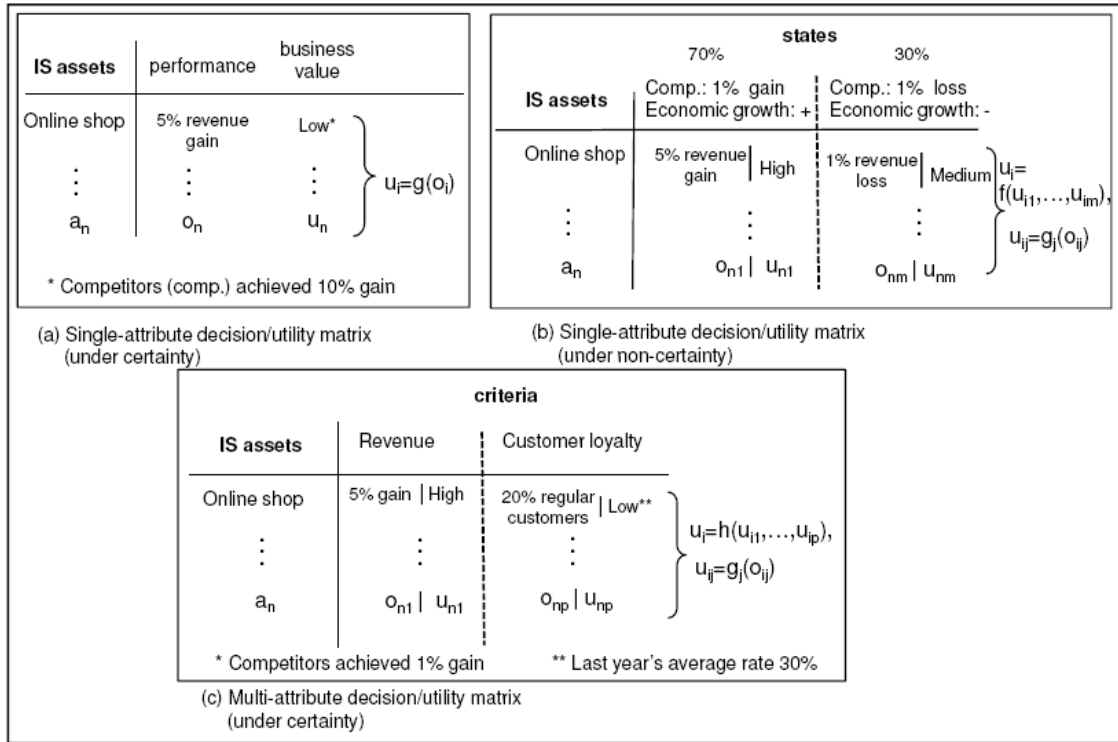


Figure 1. Decision-theoretic model in “IS business value” context

8 IMPLICATIONS FOR RESEARCH

This section discusses how the proposed decision-theoretic perspective frames further research in order to overcome the identified limitations in current IS business value research. We condense our recommendations into raising research questions and suggesting related research paths.

Intangibles: As the discussion of benefits reveals, the focus of past research lay on tangible benefits, which can be addressed with quantitative econometric approaches. Intangibles usually elude quantitative approaches, and have for that reason been less attractive for researchers. Adopting the decision-theoretic perspective, we might remove this bias for two reasons: 1) The consequence of IS investments, the performance or outcome, purely mirrors results, which can be given at cardinal scale level (in terms of hard figures), at ordinal level (in terms of comparisons), or even at nominal level (in terms of descriptions). The availability of these scale levels enables the covering of intangibles, such as “much quicker decision processes” or better understanding of business processes“. 2) Any performance still needs to be valued by means of a utility function. As the utility function is often no mathematical transformation, but is mainly dependent on the subjective preferences and attitudes of the stakeholders, the advantage of having figures available is much reduced. We conclude with **research thrust 1: Which intangibles should be considered by IS investment decision makers and how can they be operationalized in terms of measures?** To study this question, it will be necessary to empirically identify intangible benefits, to develop taxonomies, and to suggest measures that can be applied in practice to account for intangibles. For example, the concept of the Balanced Scorecard provides a good starting point, as it accounts for non-financial performance.

Diversity of IS Assets: The application of the decision-theoretic perspective involves the usage of a decision matrix, which can be used for structuring the various literature results on the impact of different IS assets on different performance measures. The matrix concept guides the discussion about which IS assets are reasonable candidates for investment: The identification of different IS assets is particularly useful if the assets represent alternatives that are comparable to each other (e.g., different email systems) and that have an appropriate “composition level”: neither a single PC nor the bundle of

all application systems can be reasonably assessed in terms of the economic outcome they generate. We conclude with **research thrust 2: How can overall IS investments be broken down into (bundles of) IS assets, which provide economically reasonable units of IS investments?** To approach this research thrust, it is necessary to move from a technological perspective towards an economic perspective that focuses on performance gains induced by the usage of IS assets. Empirical research can improve our understanding of what practitioners regard to be reasonable units.

Risk: The need to consider risk in the context of IS investments is well addressed in the decision-theoretic model by the provision of states, which mirror economic conditions at firm, industry, and/or economy level, and the attached description of non-certainty. For example, Figure 1 (b) lists two simple states (positive/negative economic growth) with their attached levels of non-certainty (in terms of probabilities), and shows that both the economic performance and the perceived value are affected by the particular state. However, we are still at an early stage of risk-related research. We conclude with **research thrust 3: Which future economic conditions are relevant for the assessment of IS assets, how can they be modeled as states, and how can risk that is related to economic conditions be explicitly considered in the assessment of IS assets?** To study these questions, researchers can draw upon the diversity of firm level, industry level and macro-economic level factors proposed in the literature. Regarding the modelling of risk, Mata et al. (1995) suggest distinguishing between two major sources of non-certainty risk in IS investments: technological non-certainty and market non-certainty. Researchers can draw upon these factors and also upon decision theory that allows flexible handling of non-certainty. This flexibility allows decision makers to assign probabilities to states, or to express the likelihood of states in terms of linguistic variables (e.g., “very likely”). Further research should elaborate which of the established theories and methodologies for handling non-certainty are appropriate for IS investment appraisal.

Multi-Criteria Evaluation: The importance of having different IS evaluation criteria available is recognized in the literature (Hitt and Brynjolfsson 1996, Kohli and Grover 2008, Thatcher and Pingry 2004), but has not been addressed systematically. The decision-theoretic perspective does not only meet this requirement “naturally” by providing for various performance types/criteria, but also addresses the question of how to handle the co-existence of (often) conflicting performance types by having a well understood research field available: multi-criteria decision making. We conclude with **research thrust 4: How can multi-criteria decision making be employed to support IS investment decision makers in aggregating multiple contingencies into a single value?** To study this research thrust, researchers can draw upon a rich set of MCDM methodologies, which have already been applied in the context of IS investment appraisal. For example, Sylla and Wen (2002) propose a goal programming model and Lee et al. (2008) apply a Fuzzy AHP approach.

Stakeholders and Subjective Preferences: The necessity to distinguish between economic performance and its perceived or derived value can be well addressed by the concepts of “outcome” and “value”. Figure 1 illustrates how these concepts can be applied to IS investment evaluation. We conclude with **research thrust 5: What are the perceived value and the derived value of the economic performance of IS investment for various stakeholders?** To address this research question, researchers can draw on utility theory and on prospect theory to develop utility and value functions, respectively.

9 CONCLUDING REMARKS

This work synthesized key research findings of IS business value research, based on a comprehensive literature review that includes more than 200 research papers and 17 literature reviews. Thus, it is capable of mirroring the key research streams and findings of IS business value research. It also identified research gaps that are central to the field of IS business value research. A key contribution of this work is the adoption of the decision-theoretic perspective in IS business value research. This adoption resulted in the proposition of a concise terminology and a decision-theoretic model of IS business value, thereby strengthening the theoretical foundation of IS business value research. Finally,

this work showed how the proposed decision-theoretic model can be used to overcome key knowledge gaps and to frame further research. While we believe that the adoption of the decision-theoretic perspective allows addressing the identified research gaps, we admit that this perspective is not appropriate to derive specific causal relationships between IS investments, economic performance and environmental states. Thus, our decision-theoretic perspective should be used complementarily to other perspectives and theories. In contrast to many other theories applied in IS business value research, the application of decision theory is intrinsically tied to the ex ante, individual level perspective on IS business value so that the decision-theoretic model of IS business value is not adequate to combine research at different levels.

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