RETHINKING GROWTH IN INFORMATION SYSTEMS RESEARCH

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Abstract

Growth is a concept which can be found in various research contexts. In economics, medicine, biology, geography, physics, mathematics and many more the concept of growth is used to describe development issues of whole complex systems. It is assumed than the concept of growth is well known and fully understood. But, there is a change in certain systems like e.g. Economics, where the concept of growth as increasement of countable resources tends to lose validity. This is an obvious one first example, where scientists try to understand, what the meaning of growth is beside the obvious point of increasement. In this research, the current concept of growth in information systems is discussed and reflected with the adjacent research areas economics, geography and mathematics. Based on this, a new conceptualization of growth is proposed, which might be more appropriate to future research and practical implications in information systems research.

Keywords: Growth, Information Systems Research, Economics, Geography, Mathematics, Conceptual Framework.

1 MOTIVATION

Looking at certain economic systems in the last few years, the concept of growing seems to move in a new era. One prominent example of this new situation is the subprime crises in the US (Kregel, 2008). These crises started in 2007 and was mainly based on a unrealistic growth in certain financial sectors, based on highly risky assumptions (Ackermann, 2008; Demyanyk & van Hemert, 2011). A second striking example is the financial crisis in the European Nations (Cline & Wolff, 2012). Several countries in the European Union have financed their economic growth on debts and are now not able to finance these debts any more. Both examples have two key issues in common. First: the situation has not been predicted neither by economic scholars nor by the industry sector itself (Allen & Faff, 2012). A well established foundation of economic theory over the last decades did not provide any models which might explain what have happened. Second, both examples worked with a similar concept of growth. For the US crisis, all participants of the ecosystem tried to gain more: more credit, more customers, more gross margin, more house. In the European example, all countries long for a substantial growth in terms of the gross national product. This means that growth in these economic systems is conceptualized with this metric and can be measured as target. The example of the European economic shows, that growth in this conceptualization is not reasonable to a global, distributed system like a European economic trading space.

Coming from these examples, the idea came up to take a closer look at the current conceptualization of growth in Information Systems. The two main issues – prediction risks of future states and complexity dynamics in large, distributed systems – are well-known in information systems and information systems research. In practice, current IT systems become larger and gain complexity in the context of a distributed system. CIO’s and IT managers claim, that some IT systems achieve a sense of complexity with excessive amounts of uncertainty within. Since most of these IT systems are critical for the success of the specific company, this is a critical issue. It is a challenge for IT responsible in companies to manage the change and growth process of their running IT systems. Will there be a similar development in Information System like in the economic examples?

This paper investigates the concept of growth in current information systems and information systems research. The key question is: how is the current conceptualization of growth in Information Systems and will this be sufficient for future challenges in the development of IT systems? To answer this question, the paper is structured as follows: in section 2, different conceptualization of growth in adjacent research areas are provided. These concepts are based on the current literature on the specific research area. In section 3, the current conceptualization of growth in information systems is provided. This was done by conducting a literature study on existing research results, combined with interviews of IT industry experts on this topic. In section 4, the conceptualization of growth in information systems is placed in the context of the other research areas and a new conceptual model for growth in information systems is provided. In section 5, this conceptual model is discussed in the context of the two key dimensions predictability and complexity. Section 6 closes with a summary and an outlook to future research.

2 FUNDAMENTAL GROWTH CONCEPTS

In the motivation, two examples of growing and critical economic systems were mentioned. To understand to growth and the problems resulting from growth in these examples, it is necessary to understand the underlying conceptualization of growth in the related research areas. A first brief literature study in the relevant publication outlets for information systems research shows that there is currently no thorough conceptualization of growth in this research area. This literature study was taken in the Basket-8 journals of information systems research (EJIS, ISJ, ISR, JAIS, JIT, JMIS, JSIS, MISQ)(Association for Information Systems, 2011). The study was conducted by using the keyword "growth" as a search phrase in the search engines of the journals' website without any further restrictions. The summary of the search results can be obtained from Table 1:

Journal	Number of search results (articles)
European Journal of Information Systems (EJIS)	2
Information Systems Journal (ISJ)	163
Journal of Information Systems Research (ISR)	231
Journal of the AIS (JAIS)	107
Journal of Information Technology (JIT)	2
Journal of Management Information Systems (JMIS)	62
Journal of Strategic Information Systems (JSIS)	251
Management Information Systems Quarterly (MISQ)	33
Total:	851

Table 1. Search results of the keyword "growth" in Basket-8 journals.

At first sight, the total number of articles which have been found by the keyword search imply that growth a very central topic in information systems research. But, taking a look at the articles themselves, nearly all of them are not incorporating specific growth concepts beside the general concept of growth as an increasing factor. Since there is no fundamental current work on growth concepts in information systems, it is favourable to take a look at adjacent research areas, which contain a well-discussed concept of growth and are somehow related to the topics of information systems research. To decide, which research areas are relevant to consider, the starting point is the concept of information systems as a three element system: people, tasks, and technology (Hansen & Neumann, 2009; Lehner, Wildner, & Scholz, 2008). Following this common agreed system structure of information systems, the decision was draw to use economics, geography and mathematics as adjacent research areas for the investigation (see figure 1).

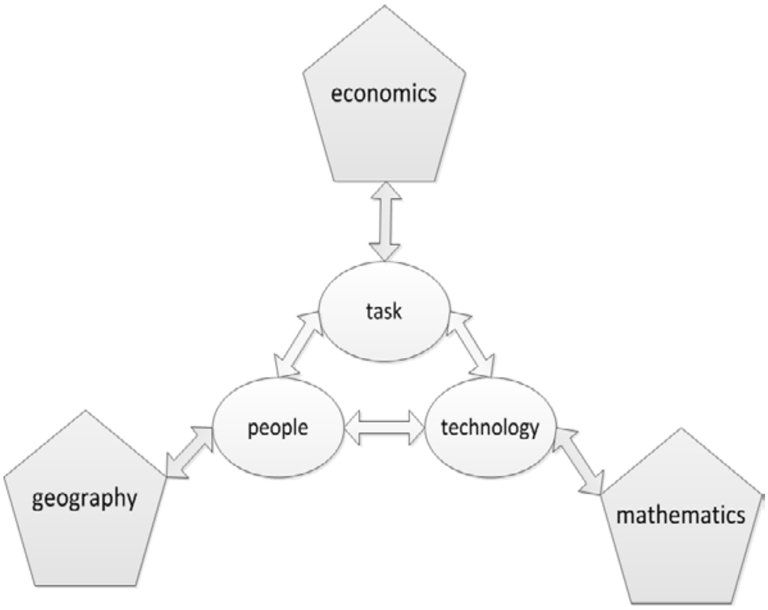

Figure 1. Research Areas Inter-Relationship

To reflect task aspects, economics has been chosen to investigate the inherent mechanism of business output. In this sense, economics is considered as the summary of tasks within an economic community which are supported by information systems. With this viewpoint, it would be possible to conclude from conceptual findings in economics to an application of these concepts in information systems research. Furthermore, economics provide the bridge from the discussed examples in the motivation section to the other research fields. Geography reflects the people aspect of the investigation. The research area of geography is widely distributed with topics ranking from the description of the lands and its features up to the study of the man-land relationship and human phenomena (Pattison, 1990). Therefore, geography is a means to understand the Earth and its human complexity (Bonnett, 2008). It is divided into the sub-disciplines human geography and physical geography (Pidwirny, 2006). For the identification of relevant concepts for transfer purposes to information systems research, the focus lies on different findings in human geography. The technology aspects are derived from a reflection on growth concepts in mathematics since this is mainly the foundation of further methods and concepts in information technology. Mathematics can be considered as the fundamental description language and technique for information systems and their effects. It can be used to study the quantity, structure and change of systems and system components (Kneebone, 2001; LaTorre, 2012; Schleicher & Lackmann, 2011). Therefore, the investigation of growth concepts in mathematics will provide a solid base for growth reflections in information systems research.

2.1 Growth in Economics

In economic research, the discussion about growth as a concept has a long tradition. There are broad insights about growth paradigms, leading to specific growth models and their related growth policies. In the classic economic literature, four paradigms of growth are discussed: the neoclassical model, the AK model, Romer’s product variety model and the Schumpeterian model (Aghion, Howitt, & Bursztyn, 2009).

The neoclassical model defines approaches to economics focusing on the determination of prices, outputs, and income distributions in markets through supply and demand. The difference between supply and demand is often mediated through a hypothesized maximization of utility by income-constrained individuals and of profits by cost-constrained firms employing available information and factors of production, in accordance with rational choice theory (King, Plosser, & Rebelo, 1988). Neoclassical economics dominates microeconomics, and together with Keynesian economics forms the neoclassical synthesis, which dominates mainstream economics today (Clark, 1998). There are three assumptions beneath the neoclassical model: People have rational preferences among outcomes that can be identified and associated with a value, individuals maximize utility and firms maximize profits, and people act independently on the basis of full and relevant information (Weintraub, 1993).

The AK model of economic growth is an endogenous growth model (Rebelo, 1991). Standard neoclassical endogenous growth models were theoretically unsatisfactory because they were not able to explore long run growth. The key property of AK endogenous-growth model is the absence of diminishing returns to capital (Barro & Sala-i-Martin, 2004). There are two meanings of the phrase endogenous growth. First, long-run growth is not driven by some exogenous process, like exogenous technological progress. Instead, the long-run growth rate depends on the economic decisions of economic agents. Seconds, public policy is capable of affecting the long-run growth rate. This paradigm leads to several implications. First, growth is endogenous in the sense that we did not revert to an exogenous engine of growth, like exogenous technological progress. Second, the growth rate of the economy depends positively on the investment rate. Third, the model implies divergence in international income. If two economies start out with different initial stocks of capital, then the resulting gap gets larger as time proceeds. The main assumption of the AK model is that output is linear related to capital.

Two of the best known endogenous growth models, those of Romer (Romer, 1987) and of Aghion and Howitt (Aghion & Howitt, 1992) differ as to the role played by creative destruction. In particular, in Romer’s model R&D activities create new types of capital goods, which accumulate in the economy thus contributing to economic growth and raising output variety. In Aghion and Howitt’s model R&D activities create capital goods of higher quality, which replace the incumbent, lower quality, capital goods. Thus, Romer focuses exclusively on the emergence of new products while Aghion and Howitt focus exclusively on product quality. As previously pointed out, the two models choose either growing product variety (Romer) or growing product quality (Aghion and Howitt) as the main factor contributing to economic growth.

Schumpeterian growth is a particular type of economic growth which is generated by the endogenous introduction of product and/or process innovations. The term “Schumpeterian growth” is used to honor Joseph Schumpeter who described the evolution of capitalism through a process of creative destruction. This process serves as the fundamental building block in Schumpeterian models of growth and captures the social benefits that result from the endogenous destruction of old products and processes by new ones (Schumpeter & Swedberg, 1994). Models of Schumpeterian growth in open economies constitute the backbone of dynamic trade theory and complement the traditional trade theory by focusing on the analysis of the economic forces that determine the generation and international transfer of technology. They provide valuable theoretical insights to understanding the patterns of growth and trade, global income distribution and poverty, and the effects of economic policies on the performance of the global economy. Schumpeterian models have also analyzed the determinants of growth in open economies. Earlier endogenous growth models identified three broad channels which transmit the effects of economic openness to long-run growth. First, trade, by increasing the size of the market, raises the profitability of R&D investment and increases the long-run rate of innovation and growth in all trading countries. Second, economic openness, by facilitating the exchange of information, increases the scope of knowledge spillovers, raises the productivity of researchers and accelerates the rates of innovation and growth in the global economy. Third, trade openness, by reallocating economic resources across sectors and between R&D investment and manufacturing activities, affects the long-run rates of innovation and growth (Segerstrom, Anant, & Dinopoulos, 1990).

2.2 Growth in Geography

In geography, concepts for growth arise in a natural way. Even the intersection between economics and geography is well discussed (John Luke Gallup, Jeffrey D. Sachs, & Andrew D. Mellinger, 1998).

A central concept as a basis for growth is the concept of the resource. Resources include commodities derived from nature. Characteristic of commodities is that they are removed from their natural environment and where there has been no further processing. They are classified in agricultural raw materials, air and water and mineral resources. Further divisions take place on the purpose, by their origin of animated or inanimate nature, as well as renewable, non-exhaustible or non-renewable, exhaustible resources (Haas & Schlesinger, 2007).

For the understanding of the concept of resources in economics, this seems to be a contradiction. From an economics perspective, resources are of labor, capital and land, all of which are needed to produce almost any good. The term "land" includes all natural resources, including minerals (Woll, 2011).

In general, it has to be distinguished between resources, reserves and marginal reserves. From an economic and geographic approach to resources as natural resources, the use of human to satisfy his needs could be referred. For this purpose, they include all stocks of raw materials and split on the degree of exhaustion in renewable and non renewable resources. Non-renewable resources represent a concentration of value elements in the crust, which occur in certain geographical areas and is therefore strictly localized. Their available quantity can be calculated in the best case, but usually only estimated. Not only geological availability, but also the economic and technical mining options have to be considered. Reserves surround the portion of resources allocated for that is that the reduction generated by a technically viable use income as the demand for raw materials enable this industry. All reserves, although mineable proven and whose funding from the economic point of view but are not worthwhile to be called the marginal reserves (Haas & Schlesinger, 2007) or reserve base (Wäger & Lang, 2010). An example of a long-lasting commodity price increase has been recorded, the promotion of cost-effective through improved technology and new deposits are discovered, this could prove to be profitable reserve a border (BMWI, III, 2006).

2.3 Growth in Mathematics

In mathematics, the concept of growth is directly related to mathematical methods, which are able to model certain concepts of growth. Therefore, mathematics may be regarded as appropriate language to describe growth concepts in other research areas.

Looking closer at the mathematical methods, a segmentation into three different classes of modeling approaches can be draw. First, there is a deterministic way of modeling growth concepts by using continuous and non-continuous functions, relations and functional solution spaces (Apostol, 1974). In this approach, growth concept may be expressed directly as a specific function or as solution function of a certain expression system. Examples for this are linear functions, exponential of logarithmic functions (as central function for growth descriptions) or as solutions to differential equations of certain orders. Second, growth concepts may be modeled by using a probability approach (Grinstead & Snell, 1998; Hays, 1973). By using statistic and probability calculations, the development of certain systems may be formulated, and future states of the systems may be expressed as the probability of reaching a certain state. Examples for this are evolutionary algorithm to predict the development of social systems. Third, a non-deterministic or chaotic approach may be used (Alligood, Sauer, & Yorke, 1997; Katok & Hasselblatt, 2009). Physical systems as well as social systems may be modeled as chaotic systems, which describe to development of a system from a certain starting point. Fundamental to this model approach is a highly dependency of starting factors. An example for this is the modeling of fluid systems.

3 GROWTH IN INFORMATION SYSTEMS

In information systems as well as in information systems research, the concept of growth is addressed in two different ways.

In the first, particularly prominent area, growth is discussed in specific aspects of information systems. From a systems theory viewpoint, growth discussions are drawn on multiple subcomponents of information systems like business processes, application complexity, interoperability complexity and data management, just to name a few. Most of these examinations have in common that the focus of the considerations is on growth aspects of the unique subsystem, without taken into account broader, intersystem considerations. Therefore, solutions and findings of these examinations are focused on their specific subsystems issues like growth of information, growth of application complexity or growth of databases.

Secondly, several work has been done on the application and transformation of growth theory in information systems. Galliers and Sutherland provide an article on the application and refinement of the stages-of-growth model in information systems (Galliers & Sutherland, 1991). They showed in a case study that the original stages-of-growth model is not fully suitable to the needs of information systems. They provide an extended model, which is incorporating strategic, organizational, human resource and management considerations. Serva et. al provided a latent growth model (LGMs), which can be considered as an extension of the structural equation model (Serva, Kher, & Laurenceau, 2011). Aim of thís new model is getting a deeper understanding for longitudinal effects in information systems. Going back to 1983, Drury provides an article about investigating different stages of growth in information systems (Drury, 1983). These articles show that there is a discussion about growth theory in information systems, but this discussion is remarkably narrow and concentrated on single aspects. In the current literature, no global concepts for growth in information systems, which includes fundamental growth theory combined with specific aspects of information systems and information systems research can be found. This observation strengthens the need to work towards global growth concepts, which are fully applicable to the research area of information systems.

4 CONCEPTUAL MODEL

Based on the findings of the literature study, a conceptual model is developed. A conceptual model may be used to refer to models which are represented by concepts or related concepts which are formed after a conceptualization process in the mind (Embley & Thalheim, 2011). Conceptualization from observation of physical existence and conceptual modeling is the necessary means human employ to think and solve problems (Davies, Green, Rosemann, Indulska, & Gallo, 2006). The conceptual model is depicted in figure 2.

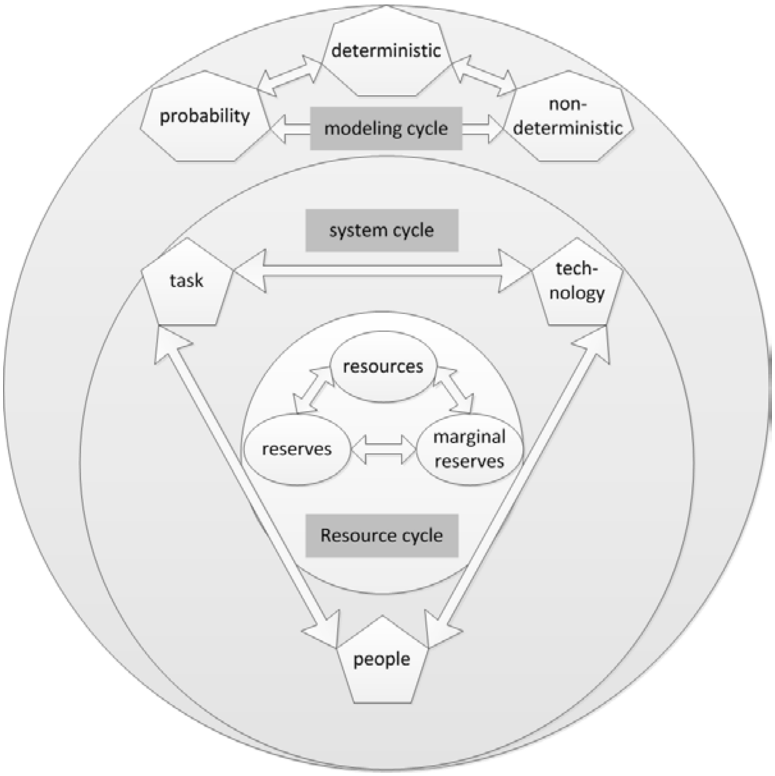

Figure 2. Growth Allocation Model

The conceptual model is structured in three cycles. The inner cycle represents the resource cycle. The resource cycle is drawn from the consideration of the geographic growth concept. While existing models in information systems only consider resources as a basic unit, the proposed model makes use of the concept of reserves and marginal reserves. This emphasizes a more sophisticated viewpoint on resources, taking the availability and the economical aspect of a resource in account. Based on the resources concept in geography, resources can become reserves and reserves can become marginal reserves and vice versa. Therefore, the resource aspect of the proposed model is conceptualized as circle.

The middle circle represents the system cycle. The system cycle takes over the general concept of information systems, where an information systems in divided into the three components people, tasks and technology. Based on this well-known segmentation, the assumptions of the different economic growth models are mapped to the corresponding system component. In the task component, the assumption of the existence of rational preferences among outcomes, the independent acting of people based on full and relevant information, the direct relationship between output and capital and focus on the product quality are mapped. In the people component, the assumptions of users maximizing their utility and companies maximizing their profit, the market size, the economic openness and the trade openness are mapped. In the technology component, the emerge of new products is mapped.

The outer circle represents the modeling cycle. In the modeling cycle, different modeling approaches are used to represent the growth description. Based on the three different modeling approaches with deterministic, non-deterministic and probability descriptions, a selection and change of the description approach can be done.

On the global level of the conceptual model, transition possibilities in every circle level can be observed. On the resource level, resource types can be transformed. On the system level, the assumption mapped to a specific component influence the corresponding components. On the modeling level, modeling approaches may be transformed to describe different phenomena. In summary, the transition possibilities on every level lead to the concept of reallocation. Reallocation is the central concept to describe growth in information systems and information systems research in contrast to a growth description of single subsystems of information systems like in current discussions of growth aspects.

5 DISCUSSION

The conceptual model as depicted in figure 2 covers growth concept of different research areas. This should help to understand and explain the growth concept in information systems for future considerations in academic as well as in practice. The core element of the proposed model is the reallocation concept. This means, that the growth of information systems will not be achieved by increasing single elements of an information system like more users, more processes, and more data. Growing information systems, which will achieve sustainability and a manageable complexity, have to strength their effort in reallocation. This leads to several implications for large, sustainable information systems in the future.

First, information systems will be established as federated, loosely coupled systems of components, combined to distributes, intra-organizational IT systems. The single components of this IT system may be transformed, exchanged and removed without loosing stability and manageability. Second, a broader market infrastructure for system components will be developed. This market structure will support the exchange of subsystems and the transformation of component provisioning without loosing governance and stability of the holistic system. This market structure will provide innovative, complex products and services, which will lead to market growth and sustainability. Third, in practice, companies will be more likely to establish complex information systems as commodity by coupling and decoupling specific business components, achieved from a broad market infrastructure. This will lead to a higher integration ratio of different companies, in strengthen the inter-company integration and to growing information systems.

6 SUMMARY AND OUTLOOK

Aim of this paper was the investigation of the growth concept in information systems as a foundation for further research and practical implications. This was done by analyzing growth concepts in three different research areas: economics, geography and mathematics. This analysis showed, that there are different conceptualization of growth depending on the culture, maturity and research approach of the research area. Based on this, the current growth concept in information systems was investigated. In this current stage, the discussion on growth is mainly aligned with specific, isolated goals. These findings have led to the proposition of a conceptual model for growth in information systems. This conceptual model combines established concepts from ancient research areas aligned with the aim for achieving predictability and maintaining the future management of rising complexity in IT systems. The discussion of the conceptual model showed, that new challenges in information systems and information systems research arise. This should motivate scholars as well as practitioners to gain a deeper understanding of growing information systems aligned with the management challenge.

This opens in a natural way new topics for further research. First, for the scientific advancement, there is a need for investigation accepted methods and models, which are related to the growth of information systems, whether they are aligned with the proposed model or not. This would lead to a more broad discussion on how to build large information systems in a sustainable way with loosing control over the system. Second, for practical implication, there is a need for practitioner's guidance to transfer these results into industrial practice.

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