Action Paths of Knowledge Management on Firms' Innovative Performance

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Preliminary Draft 01.06.2007
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1. Introduction

Knowledge Management (KM) is the term for a firm's activity to organize her knowledge assets. Beside a multitude of definitions of KM and a more or less intensive focus on Information and Communication Technologies as part of a KM, the intention of KM is to increase a firm's economic and innovative performance. There is however a lack of empirical evidence on the causalities between the complex relationship of a firms' organizing knowledge capabilities, its innovation activities and the firm's performance indicators. This may of course arise from a general difficulty to measure the success of management measures and due to the causal ambiguity, through which success cannot directly be subscribed to one management measure. (Davenport & Prusak, 1998; Lippman & Rumelt, 1984). Nevertheless, quantitative success indicators offer the opportunity to give an objective picture instead of subjective over- or under-reported qualitative success of management measures (Gold et. al, 2001, 206). The aim of this paper thus is to proceed in empirical research on KM and its relationship to the innovation performance of firms.

So far, most research concentrates on unidirectional causalities between measures of (knowledge or innovation) effort and innovation performance. There exist, however complex causalities between the firm's innovation assets, its ability to combine and apply them, and its commercialization success (Kogut & Zander, 1992; Mata et al., 1995; Swan et al., 1999). Thus, we take interdependencies of management strategies and related success indicators, as well as measurement difficulties, into account by applying structural equation modelling (SEM) (Jöreskog, 1970; usw.). By investigating the firms' overall innovative success and the detailed employees' innovative performance we attempt to overcome the measurement problem of management success. In using SEM, we generate latent concepts of Knowledge Management, innovation effort, innovation success, and economic success respectively, and anticipate measurement errors for each latent concept. The aim of this paper is at first to discuss a measurement model of KM, and which of the tools, we select as relevant, are the most important and constituting parts of KM of a firm. Furthermore we investigate, on which action paths KM contributes to a firms' innovative performance. We will have a look on the impact paths of KM on innovation activities of firms, at first on a firm- and later on the employees' level. The use of SEM and path diagram provides the ideal tool for our research aim.

The paper proceeds as follows. After introducing into the dimensions of knowledge, from which we derive the need for respective KM tools, we discuss the impact KM may have on both the innovation performance of the firm in general and on the individual employees in detail. In an intermediate step we introduce into the SEM approach, followed by data description. We then present the, with SEM solved and confirmed, path model of KM impacts. Concluding remarks finish the paper.

2. Theoretical background

Approaches as well as implementation strategies of KM concentrate a lot on IT related issues (Swan et al., 1999, 263; Nonaka et al., 2000, 6, Alavi & Leidner, 2001, 115). Innovation, however, is built on collective knowledge sharing activities of especially tacit knowledge (Howells, 1996; Nonaka & Takeuchi, 1995; Gibbons, 1994). Dialogue and frequent interaction between different individuals or groups often form the basis for the creation of innovation. Innovation goes often along with formal and informal employee interaction, which has an inherent potential of novelty creation. Due to this interaction, relationships and perspectives are shared between employees, which creates an organizational culture. This in turn leads to a collaboration atmosphere which is useful for the transfer of tacit knowledge (Gold et al., 2001, 189). These knowledge sharing activities cannot be enhanced in IT networks alone. KM is seen as a managerial tool which can promote the knowledge creating and sharing processes which is essential for innovation. KM is an organizational device, a problem-solving tool, which increases knowledge exploring as well as knowledge exploiting success of the firm (Swan et al., 1999, 264). The aim of this paper is to concentrate on KM activities which go beyond the IT oriented KM approach and emphasize organizational and managerial requirements derived from the specific characteristics of knowledge.

2.1 The dimensions of knowledge and respective KM tools

2.1.1 Tacit knowledge and KM

Tacit knowledge has certain key characteristics. One of its most important is the difficulty to express, verbalize or communicate it.Tacit knowledge is hardly to gain; often only experientially, by learning-by-doing or by observation. It is personal- or context-specific, may be uncertain or even considered unimportant to anyone else (Swan et al., 1999, 270). Tacit knowledge is influenced by subjective categories, intuition and hunch. It is deeply embedded in procedures and routines, in values and beliefs (Nonaka et al., 2000, 7). This is why it has to be extracted, or crystallised (Nonaka et al. 2000, 7) to become explicit. Spender views tacit knowledge as knowledge which has not yet been abstracted from practice (Spender, 1996, 67). It is not yet abstracted into information and data, thus made explicit. Since tacit knowledge is essential to innovation (Grant, 1996; Hall, 1993), it is also in focus of Knowledge Management measures.

Knowledge occurs always with both dimensions, the explicit side of the knowledge co-occurs always with a tacit part. Both dimensions are supposed to require different Knowledge Management tools capable to leverage and vitalize them. Especially, a firm's routinized and uncodified working processes often contain tacit knowledge. In a way, tacit knowledge is becoming a habit, which no-one in a firm can explain. "This is the way things are done around here" is often mentioned in this context (Spender, 1996, 68).This, however, is a challenge for Knowledge Management measures (Dick & Wehner, 2002, 13)

The tacitness of knowledge is explicitely addressed if for example creativity techniques like brainstorming and mindmapping are institutionalized, or if meetings and work groups take place for exchange of ideas. Often, an exchange of personel inbetween departments can be seen as the exchange of emboddied (tacit) knowledge. For Nonaka et al. (2000, 10), the socialization of tacit knowledge occurs through shared experience and spending time together in the same environment. It occurs in apprenticeship, informal social meetings, thus in-between the firm, or via interaction with customers or suppliers outside the firm. Also, communities of practice, mentioned by Probst et al. (1999), can contribute to sharing of tacit knowledge across departments. Respective Knowledge Management tools can be summarized under the headline knowledge and experience sharing opportunities.

2.1.2 Explicit knowledge and KM

The IT-related Knowledge Management is mainly concerned with the explicit dimension of knowledge. The recognition of tacit knowledge as purpose of an innovative Knowledge Management comes slowly in literature (Swan et al., 1999, 270). Tacit knowledge is not easily leveraged and shared by using Information Technology (Swan et al., 1999; Johannessen et al, 2001). Most literature on KM relies on an IT-based approach, where the information and communication infrastructure of a firm is the central element of her KM. By applying an IT-tools-based approach, the aim is to identify and capture knowledge which is inside people's heads, with help of modern IT-devices and infrastructure. There arise three problematic assumptions related to this tool-based approach. The first misleading assumption is, that all the relevant knowledge in the firm can be extracted and codified and becomes available in the firm. That this is problematic becomes clear by looking at the tacit dimension of knowledge. An IT-based approach furthermore concentrates heavily on the process of exploitation of already existing knowledge. As indicated above however, especially innovation has to do with exploration of new knowledge. Finally an IT-based approach is supply-driven. The assumption is that once information is offered, it will be applied and used in the same amount to create novelty (Swan et al., 1999, 478). Whether this happens or not, is not directly regarded in the IT-based KM approach.

Often, the concentration of KM on IT-tools leads to the supposition, that the pure increase of IT investment increases also the business performance. Case examples do not confirm this supposed correlation (Swan et al., 1999, 265 – look at Malhotra 1998). Not seldom, the communication infrastructure is installed, and the social network links and interaction between knowledge sharing entities in the firm is left to chance and individual inclination. (Swan et al., 1999, 273)

An IT-oriented KM can come to grips with such problems, if it goes along with an advanced human resource management and organizational practices which support the building of social networks (Swan et al, 269). Dick and Wehner emphasize, that not the technical realization of KM is the problem but the organizational embedding of KM systems (2002, 11). This is why both emphasize the participative character of KM. Knowledge workers should participate in the process of change caused by the implementation of a KM (Dick and Wehner, 2002, 11). Opportunities to generate overlapping knowledge between workers instead of isolated islands of knowledge in a firm may furthermore increase knowledge exchange and shared understanding. In this way, knowledge workers develop responsibility for the whole system instead of group thinking.

IT-supported KM systems are never the less in most firms the beginning of a deliberate storing and organizing of her resource knowledge. IT-infrastructure has the advantage, that it reduces the risk of "knowledge walking out of the door"(Swan et. al, 1999, 265). Despite a fluctuation of knowledge workers with uncodified knowledge and capabilities, the simultaneous running out of the capabilities and core competences of the firm is prevented. It is however the case, that skilled workers contribute only that part of their knowledge, that is codifiable at all and that they are willing to contribute. If a worker makes his knowledge not available to the firm then the firm cannot use this knowledge. This knowledge is no vital part of the knowledge base of the firm, which leads to our third discussion point.

2.1.3 Incentives and KM

As indicated in the section above, besides the storing and exchange of knowledge the willingness of employees to do both has to be encouraged. So far, KM tools rather concentrate on the dimensions of knowledge, based on the assumption that both dimensions need to be addressed in an integrated KM. Besides this we view incentive structures as essential feature of KM. The willingness to share and diffuse knowledge, to participate in knowledge creation and deployment processes in the firm depends considerably on the incentives employees have, thus the professional competence (Reinmann-Rothmeier & Mandl, 2000). Knowledge workers are the major carriers of knowledge which ensure the competitive advantage of firms (Probst et al., 1999, 40), they are the main object of KM (Grant, 1996). The installation of organisational and technical KM is a sign for infrastructural KM measures in a firm. It gives opportunities to share, create and use knowledge. Nevertheless, it is the knowledge worker who finally maintains these knowledge processes. And he in turn, is for example not willing or not able to contribute all knowledge to the firm, or he follows a not-invented-here strategy or run the risk of lock-in in routines and habits (Probst et al, 1999, 276). Aims of an incentive-based KM thus are the motivation of employees to use new knowledge, to question given solutions from time to time, to be willing to share knowledge. The aim is to develop a knowledge-intensive culture to encourage knowledge creation, sharing and offering (Alavai & Leidner, 2001). We admit major incentive measures like a bonus system, which motivates knowledge creation and sharing, the decentralization of decision power and increased responsibility of employees as knowledge-culture creating tools.

2.2 KM as influence factor on the innovation performance of firms

Our work contributes to an analysis of the various effects of KM on the (quantitative) innovation performance. Thus instead of analysing whether KM initiates innovation we rather look at how KM influences the innovation success. KM is able to increase the overall innovation success of a firm. The action paths of KM however, are still rather unclear. In analysing the innovation productivity per highly educated staff, we are able to discover the KM impact on the intangible asset human capital as one of the most important resources of firms.

2.2.1 KM and innovation success

The consideration that KM increases innovation success can be based on the resource-based view of the firm in the sense that KM is seen as resource, which increases the economic success of innovative activities. Based on Barney (1991) only several firm assets enable the firm to conceive of and implement strategies that improve her efficiency and effectiveness and thus can become a resource (see e.g. Rumelt, 1984). These firm attributes are becoming firm resources if they *"include all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by the firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness"*. Barney establishes four characteristics of firm resources to become strategically relevant: valuable, rare, imperfectly imitable, no strategically equivalent substitutes. Barney (1991) emphasizes in his definition also organizational processes as resource and discusses information processing systems as a resource of competitive advantage. Despite widely applicable, they enable firms to recognize and exploit its specific assets from which sustained competitive advantage can be generated. Installing personal computers per se is no strategic source of sustained competitive advantage. Efficient information flow, however, quick and widespread distribution and sharing of large amounts of information are a critical capability for the firm. Mata et al. (1995) emphasize the role of Information Technology (IT) which enables the firm to leverage her fundamental resource advantages. Especially managerial IT skills, namely to conceive of, develop and exploit IT applications, are a source of competitive advantage. An embedded IT management understands business needs, works with different partners, coordinates IT activities and anticipates future IT activities successfully. The idiosyncratic features of embedded IT makes it heterogeneously distributed across firms, path-dependent and thus hard to imitate by other firms.

Recent empirical work treats KM as resource in the sense of the resource-based view, which increases the firms' innovation success. Liao & Chuang (2006) suppose that KM makes firms more receptive to innovation opportunities. They proof, that the magnitude of innovation in terms of the total number of new product, processes and practices could be improved. Huergo (2006) showed, by using a production function model, the significant influence of technology management on the generation of both product and process innovation in her investigation of Spanish manufacturing firms. Gold et al. (2001, 196) concentrated on the organizational effectiveness of different KM tools, which could be proofed relevant. They used qualitative statements on improved organizational abilities, for example to innovate or to identify new business opportunities, to measure the firm success, instead of quantitative performance indicators. Due to an OECD initiative several countries conducted surveys on KM, amongst them Germany (Edler, 2003), France (Kremp & Maraisse, 2003) and Canada (Earl & Gault, 2003). These studies concentrate on industry and size specific aspects of KM (Earl, 2003) and analyse for example the innovation and patent activity due to KM (Earl & Gault, 2003). In France for example, KM is mainly adopted in large firms and knowledge intensive industries. Furthermore, KM has a strong impact on the propensity to innovate (measured as proportion of firms out of the sample which generated innovation in the last three years) and on the intensity to patent (which is the success share in turnover generated by patents). Similar results commit the results of France, although there exist country specifics concerning industry distribution. Nevertheless, critics on the measurement of a successful KM exist for both quantitative as well as qualitative measures (Davenport & Prusak, 1998, 289).

2.2.2 KM and human resource innovation productivity

If we want to know, which impact KM has in the firm, how it enhances innovation in detail, there is a need to look closer on the firm assets, which are especially addressed by KM and which are supposed to be improved by KM. We suppose to discover KM impact in the successful exploitation of a firms' human resource. In a sense, we suppose, that KM acts as "meta-resource" behind human capital. This view can be related to the discussion of dynamic capabilities of firms.

The resource-based view extended to dynamic markets has led to the dynamic capabilities concept (Eisenhardt & Martin, 2002, 1106). This concept was introduced by Teece et al. (1997). The authors define dynamic capabilities as *"the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments."* By calling the capabilities *dynamic* Teece et al. refer to the ability to renew competences in order to adapt to changing business developments. These facilities are labelled *capabilities* because "*the term emphasizes the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment.*" (Teece et al., 1997, 515)

The competitive advantage of a firm lies now in its managerial and organizational *processes* (the way things are done), which are shaped by firm-specific asset *positions* (the current specific asset endowment) and by the developmental *paths* (the possible alternative strategic ways given the firm-specific past) which restrict a firm's future strategic alternatives (Teece et al., 1997, 518). The pure accumulation of technology assets alone does not make the market successor, since there may still be a lack of useful capabilities. The key is to implement a

management that coordinates and deploys internal and external competencies effectively (Teece et al., 1997, 515).
The fact that it is the management which controls over scarce firm resources puts it in the centre of strategic issues. The management of knowledge and know-how is an essential element when reconsidering firm strategies. It encompasses skill acquisition, learning and accumulation of organizational and intangible assets. The valuable scarce resources of a firm thus require capabilities to care for them and to exploit them successfully. These capabilities may be imagined also as a meta-resource behind the actual firm resources, which becomes object to strategic considerations.

Ray et al. (2004) investigate the potential of IT and admit the managerial information technology knowledge as important source, which increases efficiency of customer service processes. Ray et al. (2004) claims that resources per se can only be source of competitive advantage if they are *applied*, if "something is done with them". The resources have to be exploited through business processes. Even Porter (1991) admits business processes as the source of competitive advantage, because only by them valuable firm resources are usable (1991, 108). Similar to Ray et al. (2004, 26), there is only a possibility, because not all assets can by exploitation become resources. Business processes which exploit *intangible* firm assets have the potential to be a source of competitive advantage, unlike processes which exploit *tangible* firm assets.

Based on this, KM can be discussed as firm process improving capability or even as meta-resource. The term meta-resource is chosen to consider the following shortcoming. Meta-resources can be defined as idiosyncratic organizational resources of a firm, which yield the inherent potential to increase the effectiveness of use of the existing resources in a firm. Out of discussing KM as part of a meta-structure behind all valuable, rare and hard-to-imitate resources is, we assume that KM affects the assets deployed in the innovation process itself. Given this assumption we analyse the impact of KM on innovation with a sharp focus on the firms' employees. We assume KM to have a leveraging effect on the intangible human resource asset. Recent research of KM does not pay enough attention to the detailed impact of KM on innovation activities. There is a need to refer to the increased importance of skilled employees in the process of knowledge sharing and creation.

2.2.3 Innovation Success and Economic Performance

In assuming that innovative success enhances the economic performance, we suppose in a Schumpeterian perspective (1911) that the creation of novelty goes along with a temporal monopolistic market position and superior economic performance. The knowledge-based view of the firm provides additional arguments in the sense, that knowledge is seen as the central source of competitive advantage of firms (Grant, 1996, DeCarolis & Deeds, 1999). Innovation is a way to enhance a firms' superior competitive performance. Thus, we expect to find this positive impact of innovation success on economic performance.

The discussion up to now indicates the different approaches of KM as an organizational tool to leverage the existing knowledge in the firm. The analysis of the detailed effects of KM on the innovation ability of a firm depends on the assumed action paths. KM can be a method to increase the general innovation success of the firm (Huergo, 2006; Liao & Chuang, 2006).
Gold et al. (2001) state that KM increases the organizational effectiveness of a firm. Similarly, Swann et al. (1999) emphasize the enhancement of knowledge exploitation caused by KM. The innovative labor productivity can be seen as measure of organizational effectiveness. We take into account, that KM explicitly addresses the knowledge workers in enterprises as carrier, user and recombinators of the knowledge, which exists in firms. And, as

Gold et al. and Swann et al. emphasize, the enhancement of knowledge exploitation. Thus, going into detail on where KM has effects requires looking on relative or firm-specific innovation performance. This is why we investigate the per highly educated
We measure the exploitation capabilities of a firm by the input-output relationship of innovation success relative to deployed human capital input. measured as the relationship of monetary success of the commercialized innovation to the number of R&D staff of a firm. Thus, KM as meta-resource increases the exploitation of the deployed resource human capital. The application of KM makes the human capital becoming an integrated and idiosyncratic firm asset, a collectively built resource. In this way, organizational knowledge is developed. Thus human capital becomes a resource in the sense of the resource-based view of the firm.

Out of our discussion we derive three major questions we want to answer:

1. *Which different Knowledge Management tools do build the latent concept of Knowledge Management?*
2. *On which paths and to which extent does Knowledge Management influence the overall innovation success of firms?*
3. *On which paths and to which extent does Knowledge Management influence the exploitation of human capital as an important intangible resource asset?*

In our conceptual model, we take into account, that Knowledge Management has impact on the innovation performance and the innovation effort of firms. In addition we anticipate the idea of increased competitive advantage due to innovation success and check for the impact on economic performance. Thus, the following action paths are investigated further.

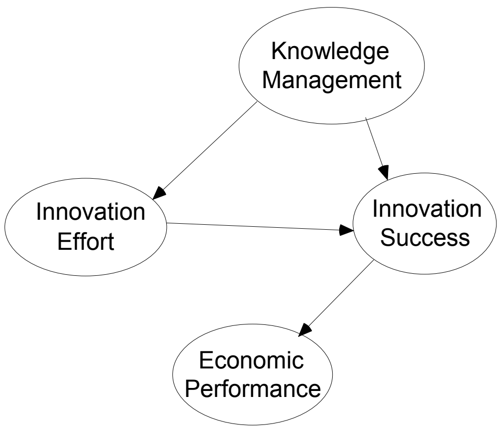

Figure 1: Mechanism of action of KM

3. Data

Originally, we dispose of firm data of 481 firms from the Thuringian region Jena and Saaleholz-Landkreis and the Hessian region Kassel and Northern Hesse. We conducted a cross-sectional (mainly manufacturing and knowledge intensive services) and one-time-period survey, in which we refer to innovation activities of the years 2002-2005, which result in measurable innovation success in the year 2005. For our analysis we had to restrict the database to firms which fit several requirements. We restrict our analysis to firms with more than 4 employees, which are actively innovating, which give information on their Knowledge Management activities and on the other questionnaire items necessary for our investigation. Due to list wise deletion of datasets with missing values (Garson, 2007) we are now able to present complete covariance and correlation matrices, which are necessary for reliable SEM. The underlying dataset of our analysis are 182 firms, whereby 138 are firms from Northern

Hesse and 44 firms are from Jena and surrounding. Our latent concepts are *Knowledge Management*, *Innovation Effort*, *Innovation Success* and *Economic Performance*. In the following we will give a short overview on the observed variables building the latent concepts[1]. All latent variables, built of the observed variables, constitute measurement models in the structural equation model.

Knowledge Management. In our survey we concentrate on eight KM tools, namely Information and Communication Technology (***ict***) and codified knowledge transfer (***ckt***) which are admitted as KM tools addressing codified knowledge. Creativity techniques (***creativity***), tacit knowledge transfer (***tkt***) and collaboration in workgroups (***workgr***) are assumed to focus on the face-to-face sharing and creation of knowledge. The third group of incentive structures for knowledge use and creation are represented by the tools decentralised decisonmaking (***decent***), increased responsibility (***resp***) and bonus for creativity and knowledge sharing (***bonus***). We asked the firms, which of the listed KM tools they apply and in which intensity (on a five-likert-scale) this tool contributes to the overall success of the firm. Due to limited responding behaviour concerning the second part of the question we have to restrict our KM analysis on the pure information of whether firms used the KM tool or not. Thus, the KM constituting observed variables are dichotomous variables with value 1 if used and 0 otherwise. The affiliation to tacit, explicit and incentive KM is considered by correlating the respective error terms of the observed variables.

Innovation Effort. To capture a firms' activity to create innovation, we asked in our survey for the two most often used indicators in empirical innovation research, namely the employed staff directly devoted to innovation activity (***RDstaff***) and the amount of R&D expenditure investigated (***logRDin***). R&D staff was counted as number of those employees, whereby the R&D input is measured as the logarithmized real input invested in innovation activities in EURO.

Innovation Success. We wanted to analyse the quantitative innovative success of firms which commercialize their innovation. Thus, we asked firms to indicate, how much of their turnover in the last year was generated by product, process and in cooperation generated innovations, in percent. Due to responsibility behaviour we could only use both product innovation share and cooperatively generated innovation share. Out of this, we used the logarithmized real amount of EURO created out of both innovations to built the latent variable innovation success, named as ***LogProdout*** and ***LogCoopout***. Furthermore we used the overall innovation outcome to calculate the logarithmized per staff amount, named as ***LogProdstaff*** and ***LogCoopstaff***, to display human resource innovation efficiency.

Economic Performance. The firms' economic performance is captured by to five-likert scale variables indicating the growth of profit in the last three years and the firms' expected growth for the coming three years with a scale domain ranging from *"strong decrease (> minus 5 %)"* to *"strong increase (< 5 %)"*. Both, the past and the future economic performance (named ***ProfitPast*** and ***ProfitFuture***) are expected to indicate the overall economic performance of firms with the advantage of not being dependent on firm size.

4. Method: Causality analysis with structural equation modelling and latent concepts

In our paper we want to investigate multiple relationships between actually unobserved concepts like Knowledge Management, Innovation Success and Innovation Effort. Structural equation modelling (SEM) is an elaborated approach to investigate hypothesis about relationships among observed and latent variables (Hoyle, 1995). In applying SEM, backed up by measurement models, one is able to build latent constructs (like e.g. Knowledge Management), which are not perfectly measurable since they are scientific concepts, whichs operationalization is less complex than in reality. With SEM we investigate the existence of such concepts out of the supposed observed variables (like e.g. the KM tools deployed in a

[1] The descriptive statistics on all used variables are illustrated in the Appendix A.

firm). This technique is made prominently by Jöreskog und Sörebom and their LISREL (***Li***near ***S***tructural ***Rel***ationship-) approach in 1982. The idea is to investigate relationships between latent variables, based on the covariances between the observed indicator variables building these latent variables. Structural equation models thus consist of measurement models of the latent constructs and of the structural model between the latent variables (Zinnbauer & Eberl, 2005). Thus, SEM combines both confirmatory factor analysis and linear regression equations which are solved simultaneously.

The overall aim of SEM is to realize multiple regression analysis, in which interdependencies amongst the explaining variables can be taken into account additionally. In using SEM we anticipate the fact that we only can pretend to measure latent variables to a certain degree, and that measurement errors may occur. A covariation of error terms is anticipated which is often the case if other impact factors on the endogenous variables could not be included in the model. This is often the case in economic and social empirical research (Emrich, 2004, 48). We are furthermore able to investigate complex and multiple relationships between latent variables under consideration instead of single directional dependencies between directly measured dependent and independent variables as in classical regression analysis (Emerich, 2004, 2). For our analysis we apply the software package AMOS 6.0, which is, after LISREL and EQS one of the most applied software packages for SEM in empirical studies (Shook et al, 2004, 402).

5. Exploratory factor analysis of Knowledge Management

In assessing the different KM tools and their relevance for the latent construct Knowledge Management we establish a reflective measurement model of KM which is similar to exploratory factor analysis[2]. Reflective measurement models are based on the assumption that the observed variables are directly influenced by the existence of the latent variable (Eberl, 2004). In reflective measurement models the observed indicator variables should be highly correlated. It is assumed, that the existence of a KM strategy leads to the application of the observed KM variables. Due to a change in the constructed variable, the observed variables are changed in the same direction and extent. The reflective KM measurement model is presented in figure 2.

The figures close to the arrows leading from the latent concept Knowledge Management to the observed variables indicate the standardized estimates for the regression coefficients of the paths. This is the amount of variance in the latent concept explained by the observed variable. For example the KM-tool *ckt* explains 0.41 of the variance of KM. As a local fit index it is required to be above 0.5 for a good fit (Eberl & Zinnbauer, 2005). This is the case for *ict (0.52)*, *workgr (0.69)*, *bonus (0.50)*, *resp (0.50)* and *decent (0.54)*. These are the items which highly contribute on a significance level of 0.05 to the variance of our latent construct Knowledge Management. Thus, KM in the firms under investigation is based to a large extent on these 5 tools. Our measurement model is similar to an exploratory factor analysis, in which after measurement model assessment indicators with low explanatory power for the latent concept are eliminated. We aim at analysing all tools, despite borderline regression weights for 8 KM tools, so we do not reduce our model. An assessment of *Cronbach's Alpha,* which is an indicator for internal consistency of the items building up the measurement model, supports our measurement model[3]. It indicates, whether correlation between the items is

[2] Formative measurement models assume that the latent variable is built of the observed variables, thus no correlation is explicitly required. Instead it's the researchers' task to legitimize and specify theoretically the determining indicators (Eberl, 2004; Zinnbauer & Eberl, 2005).

[3] We used the standardized Cronbach Alpha, which is calculated as $\alpha = \frac{N \cdot \bar{r}}{\left(1+\left(N-1\right)\cdot \bar{r}\right)}$, whereby N is the number of indicators and $\bar{r}$ is the average correlation coefficient.

satisfyingly high to compose the latent construct. The *Cronbach Alpha* of our KM measurement model is 0.746, which fits the quality requirement of being close to 1 and above 0.7. We furthermore have satisfying goodness-of-fit measures.[4] Especially the insignificant and low chi-square test statistics indicate that the hypothesized measurement model is not significantly different from the covariance matrix found in the underlying data.

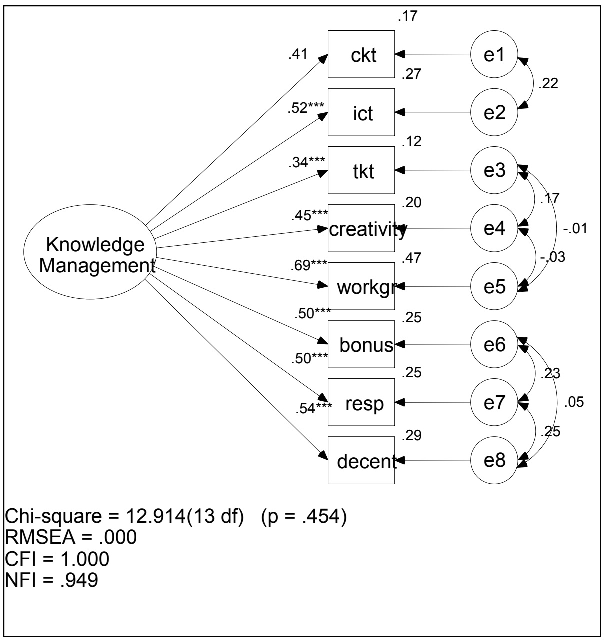

Figure 2: Reflective measurement model of KM;
standardized estimates; p-value: < 0.01 *** ; < 0.05 ** ; < 0.1 *

6. Assessment of Structural Equation Models

6.1. Structural Equation Model A on Innovation Success

The path diagram represents the model based on the hypothesis to be tested. By figuring out the path diagram, a set of linear structural equations is visualized and simultaneously solved in a multiple regression (Emrich, 2004). To this end, an implied covariance matrix is established. This supposed covariance matrix represents the way in which the observed variables should covariate. This implied covariance is compared with the observed empirical covariance matrix in a Maximum-Likelihood test statistics. The chi-square test statistics opposes the null hypothesis, that the implied covariance matrix corresponds to the empirical covariance matrix, with the alternative hypothesis that the empirical covariance matrix corresponds with any positive-definite matrix (Zinnbauer & Eberl, 2005, 569), thus with the independence model. The null hypothesis of Model A is that the implied model covariances are the best estimates of the population variances and covariances (Arbuckle, 2006). A significant chi-square model fit, however, implies that the observed covariances are significantly different from the observed covariance matrix of the underlying data. In a sense this is a chi-square badness of fit-measure (Garson, 2007).

H_0: The implied covariance matrix of Model A differs significantly from the observed covariance matrix.

[4] For an overview of global goodness-of-fit measures, see Table 1 in section 6 of this paper.

The path diagram containing estimates of our model with respective regression weights and path coefficients can is presented in figure 3.[5] The data close to the rectangles (the observed variables) indicate the standardized regression weights, figures close to the ellipses indicate the squared multiple correlations (R^2), also called the coefficients of determination, of the latent concepts. It indicates how much of the variance of the latent concept is explained by the predictors. A high coefficient of determination can be achieved for Innovation Success (0.91) and for Innovation Effort (0.30). Economic performance is with $R^2 = 0.07$ least best measured by the respective indicators, which indicates that the concept is captured rather weakly by the respective observed variables. Since KM is an exogenous latent concept, it is not predicted and thus is not labelled with a coefficient of determination.

Path coefficients. Figures close to the arrows indicate the standardized regression weights (for example if *ckt* goes up by one unit standard deviation then KM goes up by 0.41 standard deviation). A closer view on the effects of KM reveals, that KM has direct effect on innovation effort (0.59), at the 0.05-significance level. In case of innovation success we do not find a similar significant relationship to KM. Instead the innovation effort has significant impact on the overall innovation success of firms. Furthermore the hypothesized causality between innovation success and the latent economic performance concept is estimated significant at least on the 0.1 significance level with a path coefficient of 0.26.

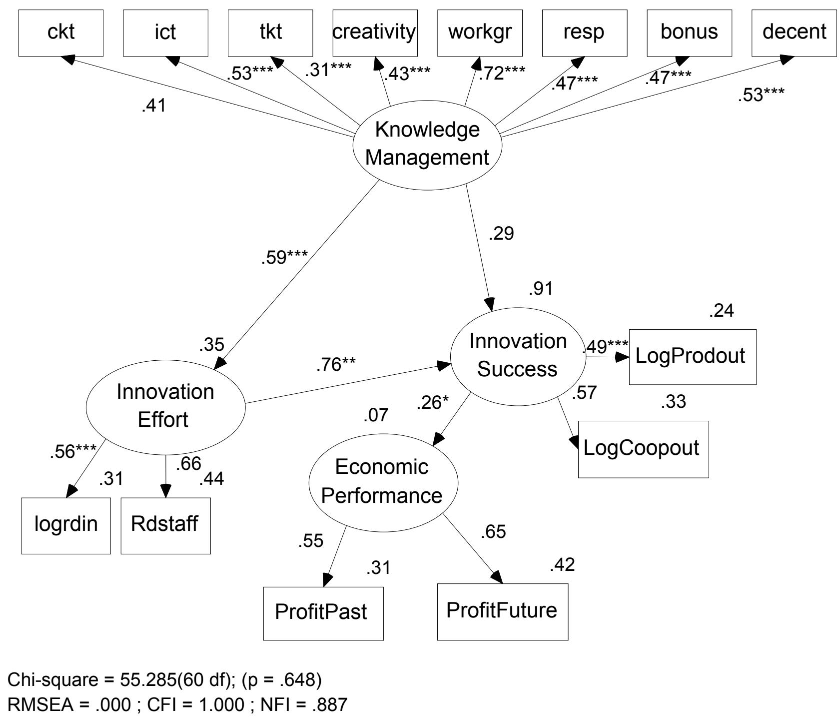

Figure 3: Structural Equation Model of KM impact on innovation success; standardized direct effect estimates; p-value: < 0.01 *** ; < 0.05 ** ; < 0.1 *[6]

Global Fit. We have a chi-square of 55.285 which is not significant at the p-value of 0.648. That means, that there is no significant departure of our data to the Model A. Due to

[5] The complete path diagram is presented in Appendix B, a complete overview of estimation results and of the correlation matrix of Model A can be found in appendix C.

[6] For each latent concept, the parameter of one indicator variable has to be restricted to 1 to ensure scale measure.

weaknesses of chi-square as indicator of model quality other measures of global fit are verified additionally. The RMSEA (Root Mean Square Error of Approximation) with a domain between 0 and 1 should be smaller then 0.08 to indicate a good model fit (Zinnbauer & Eberl, 2005). This is the case for our model. Another global fit index is the CFI (Comparative Fit Index), which should be above 0.9, which is the case (CFI = 1). The NFI (Normed Fit Index) which is also required to be above 0.9, is slightly under this quality threshold (NFI = 0.887). In sum, our hypothesized model provides a reasonable fit for the observed covariances, at least with regard to the global fit measures. The supposed impact of KM, however, on the general firm innovation success could not be found significant.

6.2. Structural Equation Model B on Innovation Efficiency

In model B we assume an impact of KM on the per staff innovation productivity. Thus the basic model is the same; we only use different innovation success measures to test our supposed impact of KM on the intangible asset of human resources. Accordingly, our null hypothesis is

H_0: The implied covariance matrix of Model B differs significantly from the observed covariance matrix.

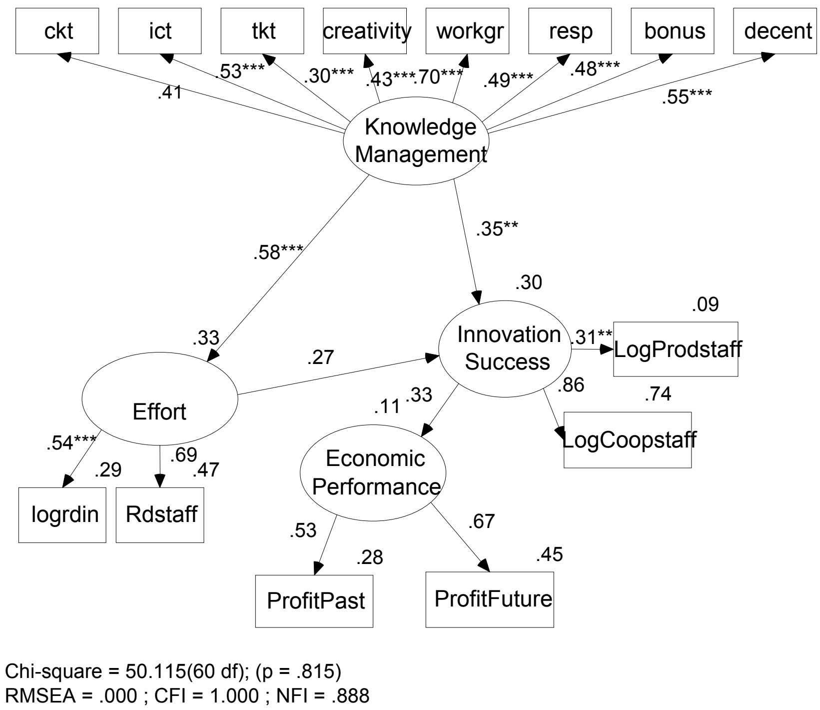

Figure 4: Structural Equation Model of KM impact on employees innovation productivity; standardized estimates, p-value: < 0.01 *** ; < 0.05 ** ; < 0.1 *

Path coefficients. In figure 4 we illustrate the path diagram of Model B[7]. In opposite to the former model, we can confirm the hypothesized and expected impact of the latent construct KM on the achieved innovation success per employee. The respective standardized path coefficient is 0.35, the impact of KM on innovation effort is estimated with 0.58 on a 0.05

[7] The complete path diagram is presented in Appendix D, a complete overview of estimation results and of the correlation matrix of Model A can be found in appendix E.

significance level. The other supposed interdependencies turn out to be insignificant, despite we have an increase of determination coefficient.

Global Fit. As can be seen in the underlying goodness-of-fit indices, we have a chi-square of 50.115 which is not significant at the p-value of 0.815. Again, we have an insignificant departure of our estimated Model B from the data. Besides chi-square as indicator of model quality other measures of global fit are verified additionally. The RMSEA of our model fits with a height of 0.00 the quality requirement. Both CFI (1.00) and NFI (0.888) are achieving or close to the required goodness-of-fit measure.

6.3 Model comparison

Since both models are only slightly differing in their goodness-of-fit indicators, we conduct a model comparison to verify which of the model fits better the data. In table X we present a comparative overview of the global fit indices as well as the required domain for the quality measure.

Quality Measure	Abbreviation	Goodness-of-Fit Requirement	Model A	Model B
Minimum discrepancy divided by degrees of freedom*	CMIN/DF	≤ 2.0	0.921	0.835
Root Mean Square Error of Approximation	RMSEA	≤ 0.08	0	0
Normed Fit Index	NFI	≥ 0.9	0.887	0.888
Tucker-Lewis-Index**	TLI	≥ 0.95	1.018	1.042
Comparative Fit Index	CFI	≥ 0.9	1	1
Hoelter's critical N for a signifcance level 0.05***	Hoelter's N (0.05)	≥ 200	257	287
Hoelter's critical N for a signifcance level 0.01***	Hoelter's N (0.01)	≥ 200	283	316
Akaike information criterion	AIC	(in comparing two or more alternative models, the smaller value to be preferred)	173.285	168.115

* Minimum discrepancy between observed and (by the model) implied covariance matrix
** Should be close to one, but is not restricted to the range of 0 and 1
*** Critical and not to exceeding sample size, up to which the model can be accepted at the respective significance level

Table 1: Comparison of Goodness-of Fit-Measures, based on own calculations and on Eberl & Zinnbauer (2005), Zinnbauer & Eberl (2005), Garson (2007),

We have two types of quality indicators, global goodness-of-fit indicators with reference values, which were already discussed; and relative goodness-of-fit indicators. Accordingly, one way to compare two or more models under investigation is to verify which of the models fits better the underlying data. As we can see in table 1, both models do not differ extensively, except for the relationship of chi-square and the degrees of freedom, which is smaller for Model B. The implication, that Model B has a better goodness of fit can be verified by taking into account the relative goodness-of-fit indicators. Zinnbauer and Eberl (2005) discuss Akaikes' information criterion as decision help for model comparison, which investigates the complexity of the hypothesized model. That model with the smallest complexity (the smallest AIC value) should be preferred. In our case, again Model B fits the data better and provides a better explanation of firms' complex innovating and knowledge managing activities. Thus we derive the conclusion that Model B has a better explanation. In this way we support the proposed method to take into account the relative innovation success: the innovation productivity of the intangible human resource asset.

7. Interpretation of results

The preliminary results of our finding can be divided into an interpretation of the detailed KM measurement model as well as the implications to be drawn out of the analysis of KM action paths and causalities in the firm.

7.1 KM measurement model

The aim of analysing a measurement model is above all to verify its quality. Interpretation of the indicators is possible only to a limited extent. Our aim was to examine the relevance of different KM tools for an overall KM strategy which is represented in the latent variable Knowledge Management. Our KM tools belong to three categories which refer to the dimension of knowledge addressed (or the type of knowledge work to be done) and the incentive structures for ensuring a knowledge-intensive culture. As expected, not all KM tools are equally building concepts of the recent KM strategy followed by firms. The five tools are *Intranet, virtual database, platform use, Installation of specialized working groups*, *bonus systems for ideas and knowledge exchange*, *increased self-responsibility during work*, *decentralized decision structures*. These five tools covariate in the same way and thus as part of Knowledge Management do represent this latent concept most reliable. Thus the KM of the firms under investigation is predominantly consisting of those 5 KM tools. The other tools are widely accepted and in use, codified and tacit knowledge transfer e.g. are above average in use for example[8]. Nevertheless, they do not decisively make up the overall KM strategy of firms.

Our results support the important role of ICT and knowledge providing technical infrastructure for a firms' KM, as already discussed e.g. in Gold et al. (2001), Alavi & Leidner (2001) and Swan et al. (1999). Elaborated IT equipment for knowledge storage and distribution contributes to the KM capabilities of innovating firms and prevents from knowledge leakage. Specialized working groups are the only managerial measure belonging to tacit KM tools which is constitutive for the overall KM strategy of firms. Incentive-based KM is an additional management measure, addressing the human capital in the firm, the employees, and their willingness to contribute their knowledge to the firm. All three incentive KM tools are important indicators of the latent KM.

Despite not all measured KM tools are good indicators of the latent variable KM, the assessed quality of the measurement model based on Cronbach's Alpha is satisfyingly high. Due to this, we used our measurement model for the SEM. In further research, there is a need to check for other methods to assess measurement quality, as e.g. convergent measurement and differentiation in constructs (Bagozzi, 1981).

7.2 Model A: Innovation Success

The central causal paths under investigation are between KM and innovation effort and innovation success respectively, as well as the interdependency occurring between innovation success and economic performance. In our structural model the supposed hypotheses are visualized. As not expected we could not find a significant covariance and thus interdependency between the deployment of a KM strategy and the overall firm innovation success. Instead, the innovation effort is significantly covariating with KM. With this finding we confirm the hypothesized interdependency between KM and the amount of innovation effort, also seen as innovation assets. Thus, a firms' possession of innovative resources goes along with the additional possession of knowledge capabilities, operationalized as Knowledge Management. Another explanation would be a lack of discriminancy between the concepts of KM and innovation effort. This is object of ongoing research.

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[8] See descriptives statistics in Appendix A

Model A confirms the hypothesized relationship between the amount of innovation input and the overall innovation success. Thus, the impact of KM on the firm-level leads to the implication that KM, by the intermediator of innovation assets, contributes significantly positive to the innovation success of firms. Despite we could not find a direct causality, the indirect impact of KM on innovation success can be discovered.

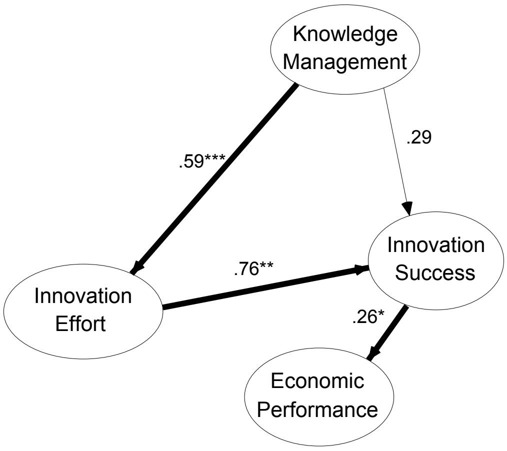


Figure 5: Mechanism of action of KM

7.2 Model B: Innovation Productivity

In Model B we used per staff innovation measures to focus on the recipient of KM, the skilled employee as intangible asset. By switching to innovation productivity of employees, we are able to assess KM as meta-resource. Our hypothesized impact on innovation success is the same. We focus however especially on the "exploitation" of knowledge inherently to skilled workers. We can confirm the supposed influence of KM on especially the human capital performance, thus receive a direct and significant interdependency between KM and innovation success. Thus, firms which follow a KM strategy can better benefit of knowledge and skills of each of their workers. A deliberate KM strategy contributes significantly positive to the workers' innovative productivity. Contrary to Model A, in Model B, the innovation effort is no more significantly explaining the innovation success; despite we have still relatively high correlation coefficients between variables.

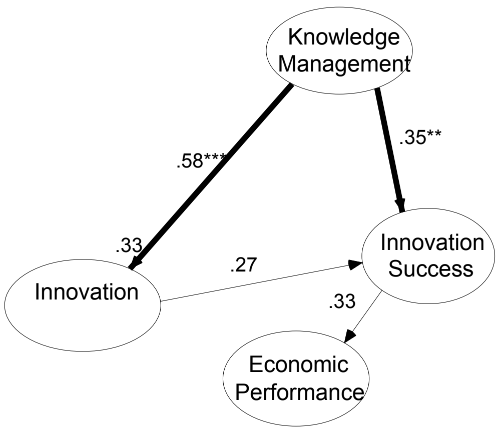


Figure 6: Mechanism of action of KM

8. Conclusion

The aim of our paper was to assess Knowledge Management as innovation enhancing capability. We apply SEM to pay special attention to complex interdependencies between variables under investigation, and to create latent constructs for those economic concepts which are a priori not perfectly measurable in empirical investigation. Our understanding of the aim of KM is that it focuses on the processing and handling of different dimensions of knowledge and initializes knowledge exchange and sharing. In addition, we emphasize in our paper the role of motivation of employees to enhance their attitude towards knowledge work. The knowledge worker as carrier of valuable intangible knowledge assets is thus the central recipient of KM (Grant, 1996). Willingness to share, use and create knowledge can be increased by a knowledge-friendly firm culture and incentive structures which honor those efforts.

Two models based on our hypotheses were established. Both examine the impact of KM on innovation effort and innovation success, one focusing on the overall innovation success, the other in detail on the per staff innovation success. Firstly, our findings figure out the complexity of KM action paths. Behind the positive impact of KM and innovation success are underlying mechanisms, which we could track in our SEM. We especially showed the mediating role of innovation effort or innovation assets. KM guaranties an enhanced deploitation of innovation efforts, which leads to increased innovative performance. Secondly, our results support our perspective on KM as a meta-resource or capability behind the assets of firms. KM is a useful capability for successful innovation effort. It furthermore directly impacts the per staff innovation productivity. Thus, the investigation of quantitative success of KM measures should take into account the main recipient of KM, the firms' employee. In this way, the characteristics of KM as a meta-resource or capability are better observable. In ongoing research the quality of measurement models will be verified further and the interpretation of results will be elaborated.

Literature

Arbuckl, J.L. (2006), AMOS 7.0 User's Guide

Alavi, M. & D. E. Leidner (2001), Review: KM and KM Systems: Conceptual Foundations and Research Issues, MIS Quarterly Vol. 25, No 1, 107-136

Barney, J. B. (1991), Firm Resources and Sustained Competitive Advantage, Journal of Management, Vol. 17, No. 1, 99-120

Davenport, T. H.; L. Prusak (1998), Wenn Ihr Unternehmen wüßte, was es alles weiß… Das Praxishandbuch zum Wissensmanagement, Verlag Moderne Industrie, Landsberg/Lech.

DeCarolis, M & Deeds, D.L. (1999), The impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry, Strategic Management Journal, 20, 953-968

Dick, M. & T. Wehner (2002), Wissensmanagement zur Einführung: Bedeutung, Definition, Konzepte. In: Lüthy, W.; E. Voit & T. Wehner (Eds.): Wissensmanagement-Praxis. Einführung, Handlungsfelder und Fallbeispiele, 7-27, Zürich

Earl, L. & F. Gault (2003), Knowledge Management: Size Matters. In: OECD (Ed.): Measuring Knowledge Management in the Business Sector, Ch. 7, OECD Publications Service, Paris

Earl, L. (2003), Are we Managing our Knowledge? The Canadian Experience. In: OECD (Ed.): Measuring Knowledge Management in the Business Sector, Ch. 3, OECD Publications Service, Paris

Eberl, M. (2004), Formative und reflektive Indikatoren im Forschungsprozess: Entscheidungsregeln und die Dominanz des reflektiven Modells, Schriften zur Empirischen Forschung und Quantitativen Unternehmensplanung, LMU München, 19

Eberl, M. & Zinnbauer, M. (2005), Strukturgleichungsmodelle in der Anwendung, WiSt, 10, 591-596

Edler, J. (2003), The Management of Knowledge in German Industry. In: OECD (Ed.): Measuring Knowledge Management in the Business Sector, Ch. 3, OECD Publications Service, Paris

Eisenhardt, K. M.; J. A. Martin (2000), Dynamic Capabilities: What are they?, Strategic Management Journal, 21, 1105-1121

Emrich, C. (2005), LISREL interaktiv. Einführung in die interactive Modellierung komplexer Strukturgleichungsmodelle, Deutscher Universitätsverlag, Wiesbaden

Garson, D. (2007), Structural Equation Modeling, called up 01.06.2007, http://www2.chass.ncsu.edu/garson/pa765/structur.htm

Gibbons, M. (1994), The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies, Sage, London

Gold, A. H.; A. Malhorta & A. H. Segars (2001), Knowledge Mangement: An Organizational Capabilities Perspective, Journal of Management Information Systems, Vol 18, No. 1, 185-214

Grant, R. M. (1996), Toward a knowledge-based theory of the firm, Strategic Management Journal, (Winter Special Issue) 17, 109-122

Hall, R. (1993), A framework linking intangible resources and capabilities to sustainable competitive advantage, Strategic Management Journal, 14, 607-618

Howells, J. (1996), Tacit Knowledge, Innovation and Technology Transfer, Technology Analysis & Strateggic Management, Vol. 8, No. 2, 91-106

Hoyle, R. H. (1995), Structural equation modeling: concepts, issues, and applications. Sage Publications, Teller Road

Huergo, E. (2006), The role of technological management as a source of innovation: Evidence from Spanish manufacturing firms, Research Policy, 35, 1377-1388

Johannessen, J.-A.; J. Olaisen & B. Olsen (2001), Mismanagement of tacit knowledge, International Journal of Information Management 21, 3-20

Jöreskog, K.G. & Sörbom, D. (1986), LISREL 6: Analysis of Linear Structural Relationships by Maximum Likelihood, Instrumental Variables and Least Squares Methods, Uppsala

Kremp, E. & J. Mairesse (2003), Knowledge Management, Innovation and Productivity: A Firm Level Exploration Based on French Manufacturing CIS3 Data, In: OECD (Ed.): Measuring Knowledge Management in the Business Sector, Ch. 6, OECD Publications Service, Paris

Liao, Chuang (2006), Exploring the Role of KM for Enhancing Firm`s Innovation and Perfomance, Conference Paper System Sciences, 2006. HICSS '06. Proceedings of the 39th Annual Hawaii International Conference. Publication Date: 04-07 Jan. 2006, Volume 7

Mandl, H. & G. Reinmann-Rothmeier (2000), Wissensmanagement. Informationszuwachs – Wissensschwund? Die strategische Bedeutung des Wissensmanagements, Oldenburg Wissenschaftsverlag, München

Mata, F.J.; W. L. Fuerst & J. B. Barney (1995), Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis, MIS Quarterly, December, 487-505

Nonaka, I.; Toyama, R. & Konno, N. (2000), SECI, Ba and Leadership, Long Range Planning 33, 5-34

Porter, M. E. (1991), Towards A Dynamic Theory of Strategy, Strategy Management Journal, 12, 95-117

Probst, G.; S. Raub & K. Romhardt (1999), Wissen managen. Wie Unternehmen ihre wertvollste Ressource optimal nutzen. 3. Auflage, Frankfurt am Main

Ray, G.; Barney, J. B. & Muhanna, W. (2004), Capabilities, Business Processes, and Competitive Advantage: Choosing the Dependent Variable in Empirical Tests of the Resource-Based View, Strategic Management Journal, 25, 23-37

Rumelt, R. P. (1984), Towards a strategic theory of the firm, In: Lamb, R. (Ed) Competitive Strategic Management, Englewood Cliffs, New Jersey, 566-570

Shook, C.L., Ketchen, D.J., Hult, G.T., & Kacmar, M. (2004), An assessment of use of structural equation modelling in strategic management research, Strategic Management Journal, 25, 397-404

Schumpeter, A. J. (1911), Theorie der Wirtschaftlichen Entwicklung, Duncker & Humboldt, München

Spender, J. C. (1996), Organizational knowledge, learning and memory: three concepts in search for a theory, Journal of Organizational Change, Vol. 9, No. 1, 63-78

Swan, J.; S. Newell; H. Scarbrough & D. Hislop (1999), KM and innovations: networks and networking, Journal of KM (JKM), Vol. 3 (4), 262 – 275

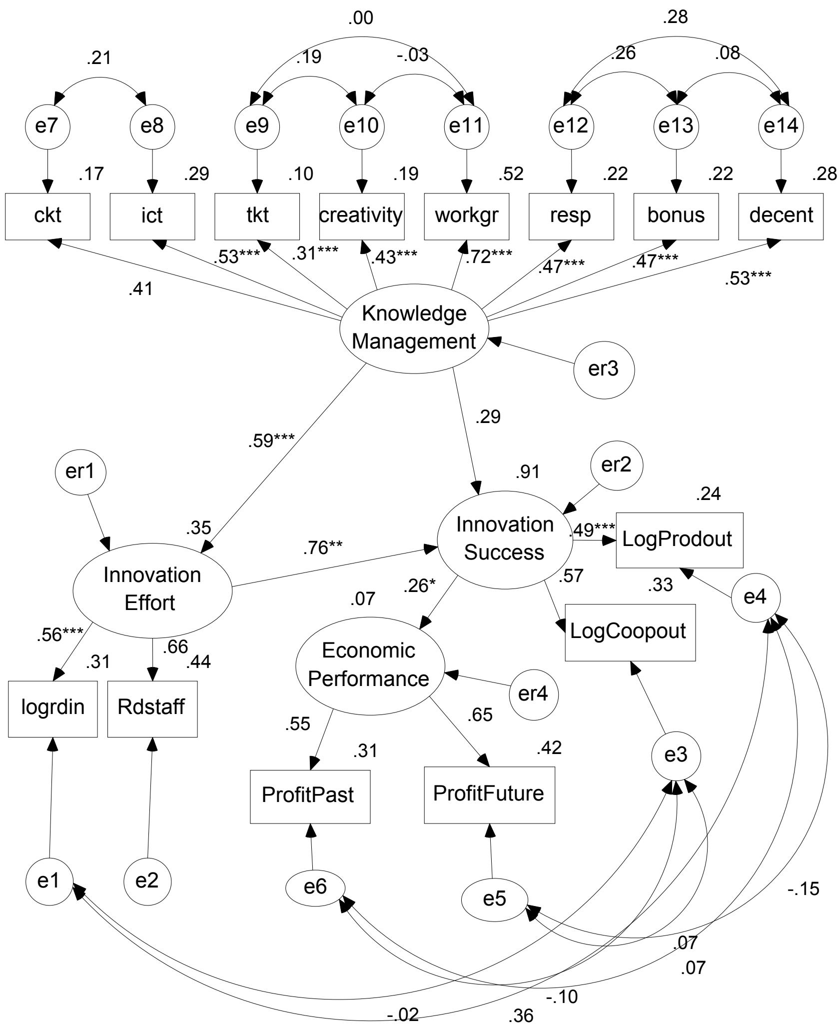
Teece, D. J.; G. Pisano & A. Shuen (1997), Dynamic Capabilities and Strategic Management, Strategic Management Journal, Vol. 18, No. 7, 509-533

Zinnbauer, M. & Eberl, M. (2005), Überprüfung der Spezifikation und Güte von Strukturgleichunsgmodellen, WiSt 10, 566-572

Appendix A Descriptive Statistics

	N	Min	Max	Mean	Std. Err.	Variance	Kurtosis
ProfitPast	180	1	5	2.933	1.348	1.817	-1.149
ProfitFuture	180	1	5	3.389	0.936	0.876	-0.036
logRDin	180	0	16.056	11.592	2.415	5.830	12.765
Rdstaff	180	0	50	5.308	7.164	51.325	14.645
ckt	180	0	1	0.733	0.443	0.197	-0.877
tkt	180	0	1	0.589	0.493	0.243	-1.888
ict	180	0	1	0.639	0.482	0.232	-1.679
creativity	180	0	1	0.444	0.498	0.248	-1.971
decent	180	0	1	0.394	0.490	0.240	-1.831
resp	180	0	1	0.717	0.452	0.204	-1.072
bonus	180	0	1	0.339	0.475	0.225	-1.546
workgr	180	0	1	0.500	0.501	0.251	-2.023
LogProdout	180	0	16.300	12.368	2.372	5.627	14.495
LogCoopout	180	0	15.761	5.438	6.253	39.104	-1.802
LogProdstaff	180	0	12.429	9.141	1.850	3.421	11.769
LogCoopstaff	180	0	12.699	3.928	4.556	20.757	-1.738

Appendix B Model A Path diagramm



Chi-square = 55.285(60 df); (p = .648)
RMSEA = .000 ; CFI = 1.000 ; NFI = .887

Appendix C Model A Estimation results

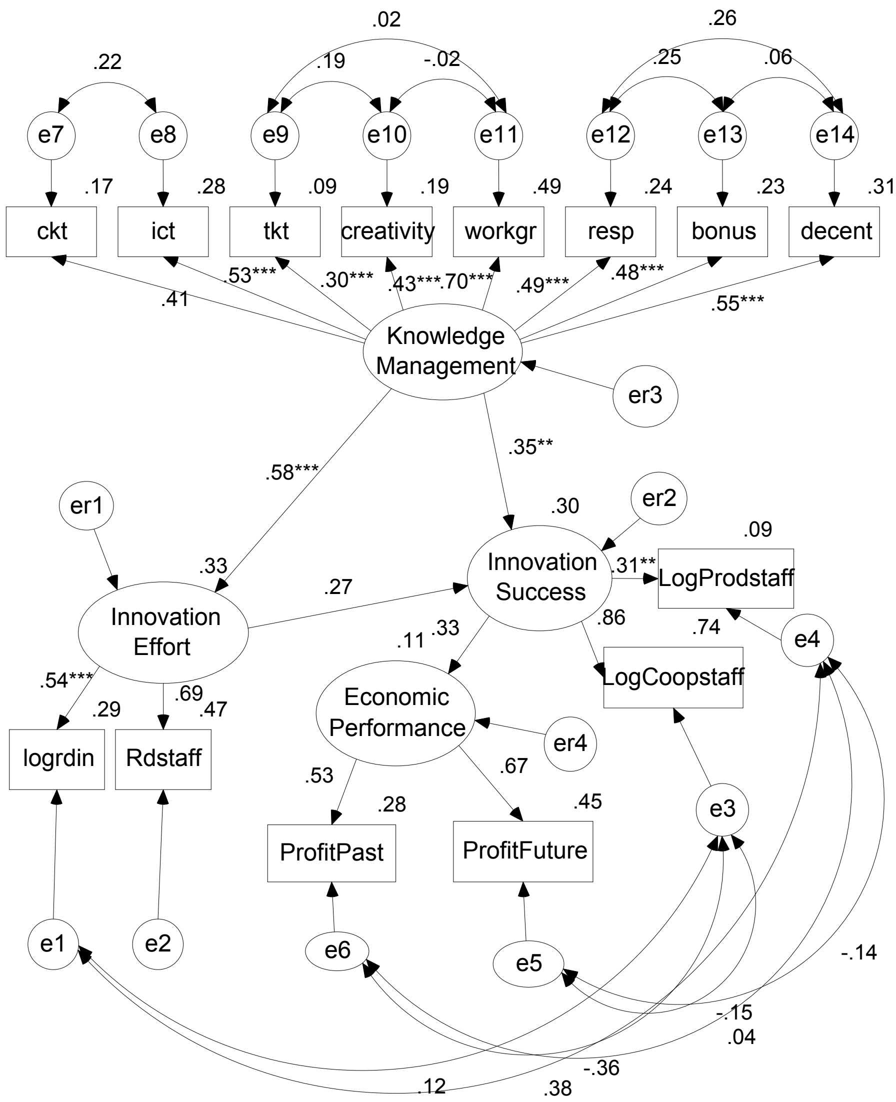
Estimation Results SEM A

Estimation Results Model A			Standardized Estimate	Estimate	Std. Err.	Crit. Ratio	P
Innovation_Effort	<---	KM	0.59	15.303	4.416	3.465	***
Innovation_Success	<---	Innovation_Effort	0.756	0.571	0.242	2.357	0.02
Innovation_Success	<---	KM	0.289	5.667	3.991	1.42	0.16
Economic_Performance	<---	Innovation_Success	0.259	0.044	0.025	1.759	0.08
LogProdout	<---	Innovation_Success	0.485	0.323	0.073	4.407	***
LogCoopout	<---	Innovation_Success	0.571	1			
Rdstaff	<---	Innovation_Effort	0.66	1			
logrdin	<---	Innovation_Effort	0.556	0.283	0.076	3.702	***
ProfitFuture	<---	Economic_Performance	0.645	1			
ProfitPast	<---	Economic_Performance	0.554	1.236	0.861	1.435	0.15
ckt	<---	KM	0.411	1			
ict	<---	KM	0.534	1.411	0.304	4.643	***
tkt	<---	KM	0.311	0.842	0.302	2.789	0.01
creativity	<---	KM	0.431	1.179	0.341	3.454	***
workgr	<---	KM	0.719	1.977	0.454	4.359	***
resp	<---	KM	0.467	1.159	0.306	3.786	***
bonus	<---	KM	0.471	1.225	0.322	3.8	***
decent	<---	KM	0.533	1.433	0.355	4.04	***

Correlation Matrix Model A

	decent	bonus	resp	workgr	creativity	tkt	ict	ckt	Profit Past	Profit Future	logrdin	Rdstaff	Log Coopout	Log Prodout
decent	1													
bonus	0.311	1												
resp	0.457	0.424	1											
workgr	0.398	0.317	0.308	1										
creativity	0.262	0.234	0.265	0.291	1									
tkt	0.12	0.193	0.276	0.226	0.293	1								
ict	0.252	0.269	0.22	0.382	0.23	0.148	1							
ckt	0.204	0.272	0.262	0.276	0.11	0.16	0.384	1						
ProfitPast	0.065	-0.026	-0.086	0.017	-0.022	-0.05	0.04	-0.021	1					
ProfitFuture	0.114	0.016	-0.002	0.012	0.047	-0.015	-0.046	-0.004	0.36	1				
logrdin	0.182	0.105	0.147	0.258	0.021	0.093	0.125	0.116	0.13	0.148	1			
Rdstaff	0.241	0.18	0.155	0.306	0.145	-0.033	0.254	0.158	0.14	0.147	0.382	1		
LogCoopout	0.265	0.192	0.271	0.327	0.224	0.182	0.278	0.206	0.01	0.138	0.272	0.293	1	
LogProdout	0.073	0.088	0.017	0.285	0.069	0.113	0.226	0.16	0.14	-0.001	0.515	0.339	0.277	1

Appendix D Model B Path diagramm



Chi-square = 50.115(60 df); (p = .815)
RMSEA = .000 ; CFI = 1.000 ; NFI = .888

Appendix E Model B Estimation results

Estimation Results SEM B

Estimation Results Model B			Standardized Estimate	Estimate	Std. Err.	Crit. Ratio	P
Innovation_Effort	<---	Knowledge_Management	0.577	15.64	4.514	3.464	***
Innovation_Success	<---	Innovation_Effort	0.269	0.215	0.146	1.471	0.14
Innovation_Success	<---	Knowledge_Management	0.351	7.595	3.407	2.229	0.03
Economic_Performance	<---	Innovation_Success	0.327	0.052	0.037	1.407	0.16
LogProdstaff	<---	Innovation_Success	0.305	0.144	0.073	1.977	0.05
LogCoopstaff	<---	Innovation_Success	0.862	1			
Rdstaff	<---	Innovation_Effort	0.685	1			
logrdin	<---	Innovation_Effort	0.541	0.265	0.075	3.528	***
ProfitFuture	<---	Economic_Performance	0.673	1			
ProfitPast	<---	Economic_Performance	0.531	1.138	1.053	1.08	0.28
ckt	<---	Knowledge_Management	0.409	1			
ict	<---	Knowledge_Management	0.528	1.404	0.306	4.595	***
tkt	<---	Knowledge_Management	0.3	0.818	0.3	2.731	0.01
creativity	<---	Knowledge_Management	0.432	1.189	0.343	3.47	***
workgr	<---	Knowledge_Management	0.7	1.937	0.449	4.318	***
resp	<---	Knowledge_Management	0.491	1.224	0.319	3.833	***
bonus	<---	Knowledge_Management	0.483	1.266	0.333	3.803	***
decent	<---	Knowledge_Management	0.552	1.494	0.369	4.052	***

Correlation Matrix Model B

	decent	bonus	resp	workgr	creativity	tkt	ict	ckt	Profit Past	Profit Future	logrdin	Rdstaff	Log Coop staff	Log Prod staff
decent	1													
bonus	0.311	1												
resp	0.457	0.424	1											
workgr	0.398	0.317	0.308	1										
creativity	0.262	0.234	0.265	0.291	1									
tkt	0.12	0.193	0.276	0.226	0.293	1								
ict	0.252	0.269	0.22	0.382	0.23	0.148	1							
ckt	0.204	0.272	0.262	0.276	0.11	0.16	0.384	1						
ProfitPast	0.065	-0.026	-0.086	0.017	-0.022	-0.05	0.04	-0.021	1					
ProfitFuture	0.114	0.016	-0.002	0.012	0.047	-0.015	-0.046	-0.004	0.36	1				
logrdin	0.182	0.105	0.147	0.258	0.021	0.093	0.125	0.116	0.13	0.148	1			
Rdstaff	0.241	0.18	0.155	0.306	0.145	-0.033	0.254	0.158	0.14	0.147	0.382	1		
LogCoopstaff	0.245	0.188	0.265	0.307	0.213	0.167	0.259	0.186	0	0.138	0.265	0.245	1	
LogProdstaff	-0.03	0.029	-0.035	0.147	0.039	0.073	0.108	0.064	0.11	-0.001	0.391	0.138	0.26	1