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Linking intellectual capital and intellectual property to company performance

Laury Bollen, Philip Vergauwen and Stephanie Schnieders

Accounting and Information Management Department, Faculty of Economics and Business Administration, Universiteit Maastricht, Maastricht, The Netherlands

Abstract

Purpose – The purpose of this paper is to link empirically the value of intellectual capital and intellectual property to firm performance.

Design/methodology/approach – Survey data from managers in the (German) pharmaceutical industry is used to conduct a regression analysis focusing on the correlation between human, structural and relational capital, intellectual property and firm performance.

Findings – The results of the study show that including intellectual property in models linking intellectual capital to firm performance enhances the statistical validity of such models and their relevance for management.

Practical implications – Intellectual capital is an important source of an organization's economic wealth and is therefore to be taken into serious consideration when formulating the firm's strategy. This strategy formulation process can be enhanced by fully integrating intellectual property and intellectual capital into management models, as shown in this paper.

Originality/value – This empirical paper builds on and extends the Bontis research on the relationship between intellectual capital and firm performance. Contrary to Bontis the authors include intellectual property into the intellectual capital framework and focus on the role of intellectual property in the relationship between intellectual capital and firm performance.

Keywords Intellectual capital, Intellectual property, Company performance

Paper type Research paper

1. Introduction

It is often argued that companies in today's new economy do not primarily invest in fixed assets, but in intangibles, since these are today's value drivers (Daum, 2001). Among these intangible assets intellectual capital (IC) plays an important role. Due to the investments in IC, its volume necessarily increases and the measurement of IC becomes an important topic given the direct and indirect advantages that can be gained from it. Such advantages may include the added value of the knowledge that is processed, the learning process included in the measurement of IC (Roos and Roos, 1997), its strategic power (Bontis, 2001), the optimal exploitation of limited resources and its usage as a motivational factor (Edvinsson, 1997). Exploiting these advantages of IC measurement purportedly give companies an edge in a tight competition on the market, which should be reflected in enhanced firm performance.

The measurement of IC is both difficult and expensive due to information collection, processing and dissemination costs (Revsine *et al.*, 1999). Although a large number of IC measurement methods have been developed, including market capitalization methods (e.g. Tobin's Q), return-on-assets methods (e.g. economic value added or

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EVA©), direct methods (e.g. technology broker method) and scorecard methods (e.g. intangible asset monitor), few of these methods provide opportunities for empirically linking the value of IC to firm performance (see, e.g. Bontis (2001) for an elaborate discussion).

Bontis (1998) provides a conceptual basis for IC measurement and for the interconnecting IC and firm performance. Bontis (1998) explicitly excludes intellectual property (IP) when defining IC. As a result, when linking IC to firm performance, the role of IP is not considered in any of the models developed. In this paper we introduce IP as part of the relationship between IC and company performance for three reasons. First, IP can be regarded as the more "tangible" part of IC, as IP consists of patents, copyrights, trademarks, etc . . . that can be more easily valued than the more intangible IC assets. Indeed, studies such as, e.g. Smith and Hansen (2002), but also "professional reports" by, e.g. PriceWaterhouseCoopers and Morgan Stanley show that companies use generic and widely recognized and accepted IP valuation methods (PriceWaterhouseCoopers and Morgan Stanley, 2003, 2004). Smith and Hansen (2002) further argue that these valuation methods and performance measurements often are used rather independent of the firm's strategy. A second reason for including IP into our analysis therefore is to explicate the link between IP on the one side and human, structural and relational capital on the other side. In doing so, IP strategies become more visibly embedded in the companies overall strategic decision-making process. In other words, IP and IC are to be associated with the most intangible dimensions of the whole organization, such that the implications of the maxim "what gets measured, gets managed" are fully captured (Roslender and Fincham, 2001; Nerdrum and Erikson, 2001). A third reason for including IP is that IP from a conceptual and a managerial point of view is a relevant part of a company's IC. Smith and Hansen (2002) argue that IP is strategic to the extent that it is part of a company's chosen capabilities, i.e. to the extent that it is part of either the know-what or know-how aspect of core capability. In this sense, strategic IP management is the way to leverage intellect and to lead the company to increased overall performance (Quinn *et al.*, 1996) and, therefore, is intrinsically linked with IC. Companies, however, often treat all of their IP and IC alike, failing to distinguish the strategically crucial intangibles from other assets and failing to understand the links between these strategic intangibles and its (future) IP (see also PriceWaterhouseCopers and Morgan Stanley, 2004, p. 35.)

The remainder of this article is organized as follows. Sections 2 and 3 briefly focus on the theoretical foundations IC in this context and discuss the role of IP and elaborate on this paper's main hypothesis. Section 4 presents the research method whereas sections 5 and 6 outline and discuss the results of the survey research. Section 7 concludes the article with a discussion of the results and some general conclusions and an agenda for further research.

2. Theoretical foundations of IC measurement

Until the 1980s, and in line with neo-classical thinking, business economics focused on the competitive advantage of firms given a certain environment. As resources were assumed to be evenly distributed within industries and freely accessible by firms, the resources inside the firm only played an inferior role (Roos and Roos, 1997). During the 1980s the resource-based view of the firm gained importance: managers no longer really "believed" in perfect competition, and became more convinced that firms need

access to differentiated and – if possible – unique resources, capabilities, and endowments in order to create and sustain a competitive advantage. As resources were assumed to be sticky, it followed that companies could not that easily acquire new ones. Consequently, companies were assumed to optimize the exploitation of existing resources in order to gain a strategic advantage (see also Llewlyn, 2003; Canibano and Sanchez, 2003). Questions such as "Which are my most important intangibles? Which earn most money and which keep most of my competitors at bay?" increasingly became priority questions triggering attention at boardroom meetings (PriceWaterhouseCopers and Morgan Stanley, 2004).

Next to the resource-based view, the (re)organization of companies became a major issue, specifically the transformation from vertical organizational structures to global matrix structures: significant investments in structural capital were made, in order to enable companies to optimize their resources, to consolidate business processes, to supply major customers worldwide and to exchange knowledge and best practices (Daum, 2001).

During the time when the resource-based view of companies gained awareness and companies were subsequently restructured, Sveiby published *The Know-how Company* in which he describes how non-traditional knowledge companies should manage their knowledge (see Sullivan, 2000). Simultaneously, Skandia AFS, followed by a large number of Swedish companies introduces such measures and in 1993 the Swedish Council of Service Industries adopted it as their standard recommendation for annual reports (Sullivan, 2000).

Edvinsson combined Sveiby's work with Kaplan and Norton's Balance Score Card (Sveiby, 2001), relabeled the term "intangible assets" as "intellectual capital" and published Skandia's first annual report supplement in 1995 with the title *Visualizing Intellectual capital in Skandia* (see Sullivan, 2000; Sveiby, 2001). Since then, other companies, such as Dow-Chemicals, CIBC, Hewlett-Packard and Canon, have followed the example of Skandia (Roos and Roos, 1997), as they became aware of the importance of, e.g. leadership and human capital developments as antecedents of increasing the potential of organizational culture to serve as a major source of sustained competitive advantage (Bontis and Fitz-enz, 2002; Hall, 1992).

Finally the introduction of the phenomenon "New Economy" played a major role in the development of IC (Daum, 2001). Companies in the New Economy intensively use innovative technologies in the form of computers, telecommunications, and the internet, to produce, sell and distribute goods and services. At the same time, a shift from global matrix-structured companies to e-business-network-structures is taking lace. With respect to this issue, three major publications were made in the same year, being *Intellectual Capital* by Stewart (1997), a paper by Edvinsson and Malone (1997) with the same title and *The New Organizational Wealth* by Sveiby (1997). The essence of these three publications is that a shift from the investment in fixed assets to intangibles has occurred. As a result, next to financial capital, intangibles have become important value drivers. Proof for the growing importance of the role of IC in today's economy is the fact that several interest groups are currently working on the topic of IC, considering its different aspects and developing IC statements for companies, among them the German Schmalenbach-Gesellschaft für Betriebswirtschaft eV (2003).

The growing interest in IC has revealed a certain level of disagreement on the definition on IC and, more specifically, on the components of IC. In this context, the

relationship between IC and IP is particularly complex as some authors explicitly exclude IP in their discussions on IC (e.g. Bontis, 1998), whereas others tend to a more integrative view favoring a more cohesive approach to IC and IP (e.g. Smith and Hansen, 2002; Lynn, 1998). Given the focus of our research, the opposing views on the link between IC and IP will be discussed in the remainder of this section.

Bontis *et al.* (1999) summarize the definitions of IC by Bontis (1998), Edvinsson and Malone (1997), and Roos and Roos (1997) and concludes that IC is the collection of intangible resources and their flows, where intangible resources contribute to the value creating process of the company and are under the control of the company. Since the value creating process differs among companies and therefore also the resources needed for production, it follows that IC is context-specific and thus differs among companies. Lynn (1998) defines IC as the wealth of ideas and the ability to innovate, both being factors that determine the future of the organization. These definitions provide a foundation for understanding IC. However, they do not offer practical classification schemes of IC, which are necessary to identify, classify and measure individual assets. The following economists and practitioners have defined such clusters: Brooking (1996), Edvinsson and Malone (1997), Sveiby (1997), Bontis (1998), Roos and Roos (1997) and Lynn (1998). For an overview, see Table I.

Bontis (1998) uses a definition of IC that only partly overlaps with that of Lynn (1998). Bontis (1998) divides IC into human, structural and customer capital.

Human capital (HC) comprises the organization's members' individual tacit knowledge. These are skills which cannot be articulated that are necessary to perform their functions, which exist inside the employees. The connection of the nodes implies a flow of information from one person to another. Bontis (1998) defines HC as individual tacit knowledge. Lynn (1998) identifies HC as the raw intelligence, skills and expertise of the human actors in the organizations. Given the fact that HC is linked to individual within an organization, HC cannot be owned by the company (Edvinsson and Malone, 1997).

Structural capital (SC) comprises mechanisms and structures, which help support employees. In fact, they are the organizational routines and turn individual human assets into group assets. Edvinsson and Malone (1997) define SC as everything that "supports employees' productivity" or "everything that gets left behind at the office when employees go home". In contrast to HC, SC can be owned by the company and therefore can be traded. Bontis (1998) states that SC comprises mechanisms and structures of the organization that support employees in their performance, whence, also overall business performance. Lynn (1998), who uses the term routines instead of SC, mentions that SC consists of "systems" that program intellectual efforts in order to provide more routine means of replicating them.

Customer capital (CC) mainly comprises knowledge of marketing channels and customer relationships. Bontis (1998) states that knowledge of marketing channels and customer relationships play a major role. In addition, other aspects relating to suppliers and competitors contribute to relationship capital.

CC is not part of the structure that is used by Lynn (1998). In his view, the final part of IC is IP, which is the most tangible element of IC and the one most widely embraced by management and shareholders, since methods for its measurement are included in the accounting rules. Lynn (1998) defines IP as items that have been sold. Brooking (1996) states that IP are "legal mechanisms for protecting corporate assets and

Table I.
Components of intellectual capital

Lynn	Value Distinction Tree (Roos *et al.*)	Intangible Asset Monitor (Sveiby)	Skandia Value Scheme (Edvinsson and Malone)	Technology Broker (Brooking)	Bontis
Human capital Implicit knowledge Skills Number of links to other nodes	*Human-centered assets* Expertise Creativity Problem-solving capability Leadership Entrepreneurial skills Managerial skills	*Human capital* Knowledge Skills Innovativeness Talent Values Culture Philosophy Ability	*Individual competencies* Education Experience	*Human capital* 1. Competence Skills Know-how 2. Attitude Motivation Leadership qualities of top management 3. Intellectual Agility Innovation Entrepreneurship Ability to adapt	*Human capital* Intelligence Skills Expertise Learning capability Changing capability Innovativeness Creativity
Structural capital Organizational routines Supportive culture Information systems Efficiency Transaction times Procedural innovativeness Access to information for codification into knowledge Infrastructureal activa (methods, technologies, processes)	*Infrastructure assets* Corporate culture Risk assessment methods Methods to manage a sales force Financial structure Information database Communication systems	*Structural capital* Hardware Software Database Organizational structure Patents Trademarks	*Internal structure* Management Legal structure Manual systems Attitudes R&D Software	*Structural capital* Relationship within the organizations Structure Culture Routines Processes	*Routines* Proprietary software Networks Corporate culture Policies

(*continued*)

Table I.

Lynn	Value Distinction Tree (Roos *et al.*)	Intangible Asset Monitor (Sveiby)	Skandia Value Scheme (Edvinsson and Malone)	Technology Broker (Brooking)	Bontis
Relationship/customer capital Knowledge of marketing channels Knowledge of customer relationships Market orientation (customer orientation, competitor orientation, inter-functional co-ordination, long-term focus, profit objective) Relations with other organizations	*Market assets* Brands Customers Repeat business Backlog Distribution channels Licences/franchises		*External structure* Brands Customer relations Supplier relations	*Structural capital relationships with external organizations* Suppliers Customers	
	Intellectual property Know-how Trade secrets Copyrights Patents Trade- and service marks			*Structural capital renewal and development* R&D New plants New products BPR	*Intellectual property* Patents Royalty rights

infrastructure assets". Bontis, on the other hand, explicitly excludes IP when defining IC. In fact, within the IC literature the relationship between IC and IP, or, alternatively, the role IP plays in the discussion of IC, remains "problematic". At the one end of the spectrum, there are scholars who do not include IP into the definition of IC. They do so on the basis of the argument that IP includes much more "tangibles" such as patents, copy rights, trademarks, etc. As such, they adhere to the definition of IC as part of the company's intangibles assets. Adherents of this "school" are Bontis *et al.* (1999), Bontis (2001), Roos *et al.* (1998) and Nerdrum and Erikson (2001).

On the other hand, a number of "more integrative" scholars who focus on performance measurement, performance management and performance reporting, argue that it is ineffective to exclude IP metrics and IP performance from the discussion of how a company should manage its IC-assets. Proponents of this view are Brennan and Connell (2000), Quinn *et al.* (1996), Smith and Hansen (2002) and Lev (2001). From a managerial point of view, an "academic" or even "semantic" discussion does not contribute to the debate of how a company could increase its performance. If IP and IP-management leverages company performance, it cannot be ignored in the context of IC.

The research presented here introduces IP as a separate element in models originally developed by scholars who clearly separate IP from IC, in order to investigate the effect of introducing IP as an "interface" between (the relationships between) IC-components and overall company performance. In doing so, this study aims to enhance our understanding of the importance of IP and IP management in relation to company performance.

3. Hypothesis

The development of hypothesis presented in this section is partly based on Bontis (1998). In that study, the relationship between HC, SC, RC and firm performance is explored. The results indicate that each of the three elements of IC is related individually to firm performance, but also there are links between the various elements of IC that influence their relationship with firm performance. For example, the study indicates that although there is a direct relationship between human capital and firm performance, HC in itself has little value without the supportive structure of an organization (i.e. SC). In the following discussion, *H1* relates to the relation between the various elements of IC, as demonstrated by Bontis (1998), whereas *H2* and *H3* focus on the role of IP, an element that was not included in the models developed by Bontis (1998). Figure 1 visualizes the set of hypotheses tested in this study.

First, it is expected that the more intangible components HC, SC and RC enhance each other. HC is necessary in order to form SC and RC. The more knowledge and skills the employees possess the more they see the need for SC and RC and the more they contribute positively to its development. Hence, *H1.1* predicts a relation between HC and SC, *H1.2* between HC and RC. SC is expected to correlate with HC and RC. First, without the corresponding corporate culture, the HC cannot be exploited perfectly and also not be protected against loss – e.g. due to notice of dismissal (Stoi, 2003). Also Bontis (1998) and Edvinsson and Malone (1997) state that SC has an impact on HC. In addition, without the corresponding processes – e.g. the order processing – no loyal customer base (RC) can be established (Stoi, 2003). Therefore a dependence of HC on SC, as stated in *H1.3*, and of RC on SC (*H1.4*) is expected. Moreover RC is expected to

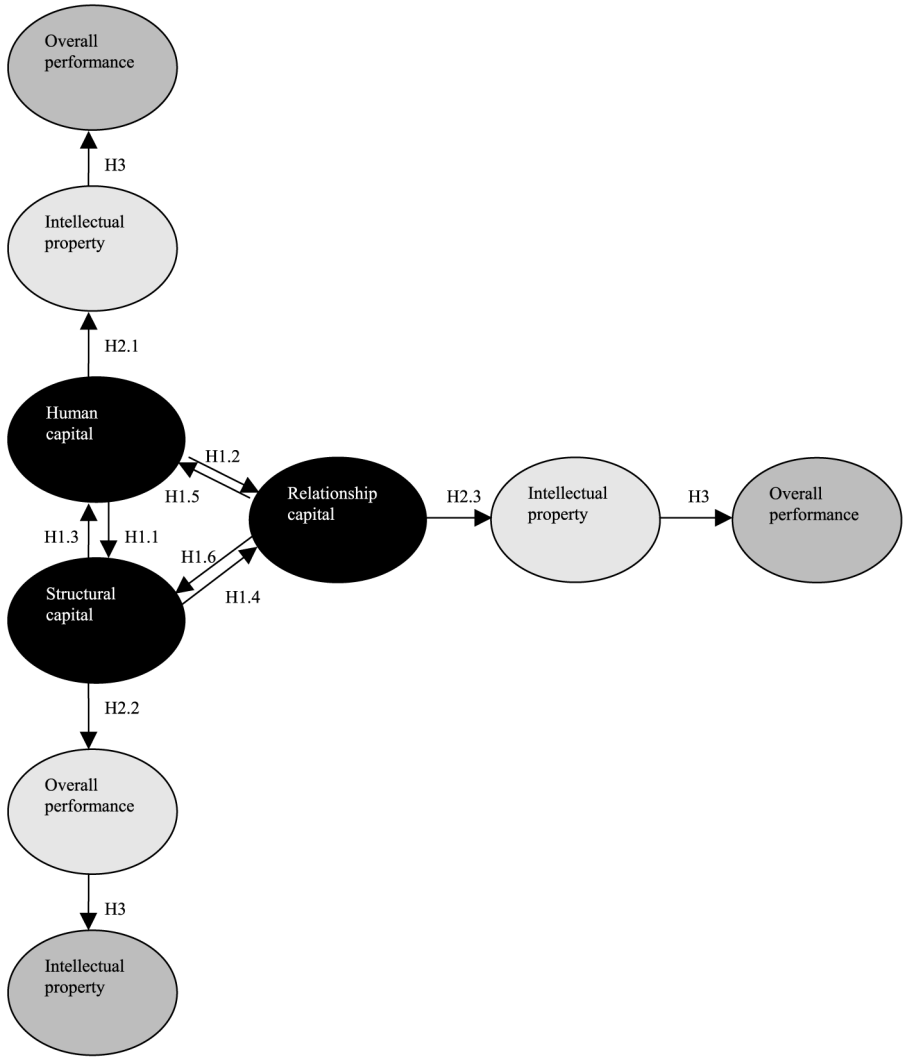

Figure 1.
Expected relations between the components of intellectual capital and company performance

influence HC and SC. With respect to HC, the better the relations of the company to external parties, the more the employees also learn from external parties' feedback (*H1.5*). Concerning SC, the better the relations to external parties, the more customer oriented operational procedures can be optimized (*H1.6*).

Second, the intangible constructs are expected to correlate with the more tangible construct IP. The employees' knowledge and skills should lead to the development of new patents and brands. Moreover, SC influences the way IP is developed, since for example the financial structure and supportive culture lay a foundation for the development of IP in general and patents in particular. Finally, RC should foster IP since for example the knowledge of customer wishes should lead to the development of

patents and trademarks. It follows that a significant relationship between HC and IP (*H2.1*), between SC and IP (*H2.2*) and between RC and IP (*H2.3*) is expected.

Finally, a positive correlation between IC and company performance is predicted. IP directly influences, among others, sales and market leadership. Therefore a relation between IP and company performance is expected (*H3*). Yet, a direct link between the more intangible components and company performance is not predicted. The reason is that the influence of IP on company performance is expected to take the impact of the more intangible factors already into account, making a direct link between the more intangible components on company performance irrelevant.

4. Research design

4.1. Research method

For the measurement of IC, "direct" IC and scorecard methods are chosen. Although Sveiby (2002) stresses the fact that direct IC methods and scorecard methods lead to context and company specific measurement tool-kits, we assume that companies within the same industry have similar needs, structures, etc. and that, as a consequence, a conceptual measurement tool can therefore be developed and applied to an entire industry. Individual companies will, of course, "adapted" the "industry-relevant" scorecard to their own (idiosyncratic) needs, but important for our research purposes is the relevance and usefulness of such a measurement tool for a whole range of companies. The choice for a sample of companies within the knowledge intensive pharmaceutical industry – in which such a tool is a priori expected to be relevant for management – increases the external validity of our research.

The direct IC measurement and scorecard methods used in this article refer to the Technology Broker (Brooking, 1996), Skandia Navigator (Edvinsson and Malone (1997)), the "Intangible Asset Monitor" (Sveiby (1997), the Value Distinction Tree Method (Roos and Roos (1997)) and both the methods as presented by Bontis (1998) and by Lynn (1998).

HC. Table II indicates the subcomponents of HC, based on which questions are included in the questionnaire. In order to gain a better overview over the items belonging to HC they are divided into several subgroups. First of all innate human capabilities make up for HC. The items belonging to this group are intelligence, learning capability and talent. The second cluster of items – items 4 to 10 – indicate abilities that any employee has gained during his life: Knowledge, skills, education, experience, ability and expertise. Education will be included twice in the questionnaire, once related to learning from each other and once to learning through trainings. The next set is composed of the following items: management and leadership qualities. The items represent HC specifically related to management. The following group includes motivation, creativity and innovativeness. It is expected that in case the employees' motivation is increased, creativity will be enhanced, which in turn fosters innovativeness. Motivation can be fostered with the help of monetary and non-monetary rewards. It follows that a relationship between these components exists.

Additionally, employees' values form a single group, since this item cannot be added to any other group of items. Finally, Bijsmans (2003) argues that the problem-solving capability comprises the ability to adapt and also the changing capability. Hence, these last three variables form a subgroup.

Table II.
Items related to human capital

	Human capital					
	Bontis (1998)	Technology Broker (Brooking, 1996)	Skandia Value Scheme (Edvinsson and Malone, 1997)	Intangible Asset Monitor (Sveiby, 1997)	Value Distinction Tree (Roos and Roos, 1997)	Lynn (1998)
1						Intelligence
2			Talent			
3						Learning capability
4	Implicit knowledge	Know-how	Knowledge		Know-how	
5	Skills		Skills		Skills	Skills
6				Education (from employees)		
7				Education (through trainings)		
8						
9			Ability			Expertise
10		Expertise		Experience		
11		Leadership		Management		
12		Managerial skills			Leadership qualities of top management	
13			Innovativeness		Innovativeness	Innovativeness
14		Creativity				Creativity
15					Motivation (financial incentive)	
16					Motivation (non-financial incentive)	
17			Values			
18		Problem solving capability				
19					Ability to adapt	
20						Changing capability

SC. The second cluster of variables can be headed structural capital. Table III indicates the items belonging to SC. Again they are summarized in groups in order to gain a better overview.

The first group of subcomponents deals with what Bontis (1998) calls "infrastructural assets". They comprise technologies, methods and processes. Hence, methods, manual systems, processes and policies are included in this group of subcomponents. The following subgroup of components can be headed with "systems". This collection is composed of databases, access to information for codification into knowledge, hardware, software and communication systems. The next group portrays organizational culture and is divided into a supporting CC in general and a positive atmosphere in particular. Another group of items represents the structures in a company and comprises financial structure, organizational structure and networks. The last group of SC represents the result of all the other groups. Organizational routines should be the result of the items in the other subgroups of SC, leading finally to a decrease in transaction times and an increase in efficiency and procedural innovativeness. Organizational routines are included twice in the questionnaire, once with respect to efficiency and once with respect to quality of the work.

RC. Table IV lists the components of RC: items 1 to 7 deal specifically with customer relations. They comprise the knowledge of marketing channels, knowledge of customer relationships, customer orientation and finally customers. Customer orientation is integrated twice into the questionnaire, once related to the accessibility of customer feedback and once to the image of the company. Customers are included with respect strong relationships, satisfaction of products and services and the amount of customers. The second group of items – 8 and 9 – deal with supplier relations, which are included in the questionnaire with respect to employees' knowledge of customer relations and number of customers. The next group – items 10 and 11 – copes with competitors, more specifically relations with other organizations and competitor orientation. The final group of subcomponents – items 12 to 15 – comprises general aspects, which should be taken into account, when engaging in relationships. These items are long-term focus and profit objective, which are each related to customer and supplier relations.

IP. Lynn (1998) defines IP as items that have been sold. Brooking (1996) and Bontis (2001) state that IP consists of all "legal mechanisms for protecting corporate assets and infrastructure assets". IP includes components that directly enhance the development of protected assets. These are research and development and trade secrets. Concerning trade secrets a question related to the importance and one to the accessibility is included in the questionnaire. IP is composed of protected assets, such as patents, copyrights, trades and service marks, licenses and franchises and finally new products. Questions with respect to patents are introduced in the questionnaire related to the amount of new patents developed and to the financial success of new patents. A question related to the national market and one to the international market is included with respect to trade and service marks. Table V gives an overview of the IP components.

Company performance. In addition to the components of IC the following measures of company performance are included in the questionnaire: market leadership, future outlook, revenue, growth in revenue, growth in sales, return on assets, return on sales,

Table III.
Items related to structural capital

	Structural capital					
	Bontis (1998)	Technology Broker (Brooking, 1996)	Skandia Value Scheme (Edvinsson and Malone, 1997)	Intangible Asset Monitor (Sveiby, 1997)	Value Distinction Tree (Roos and Roos, 1997)	Lynn (1998)
1	Infrastructural activa (technologies, processes, methods)	(Risk assessment) methods				
2					Processes	
3				Manual systems		
4						Policies
5	Information systems	Information database	Database			
6	Access to information for codification into knowledge					
7			Hardware			
8			Software	Software		Proprietary software
9		Communication systems				
10	Supportive culture (positive atmosphere)	Corporate culture (positive atmosphere)	Culture (positive atmosphere)		Culture (positive atmosphere)	Corporate culture (positive atmosphere)
11	Supportive culture (general)	Corporate culture (general)	Culture (general)		Culture (general)	Corporate culture (general)
12			Organizational structure		Structure	
13		Financial structure				
14						Networks
15	Transaction times					
16	Efficiency					
17	Procedural innovativeness					
18	Organizational routines (efficiency)				Routines (efficiency)	
19	Organizational routines (quality)				Routines (quality)	

Table IV. Items related to relationship capital

	Relationship capital			
	Bontis (1998)	Technology Broker (Brooking, 1996)	Intangible Asset Monitor (Sveiby, 1997)	Value Distinction Tree (Roos and Roos, 1997)
1	Knowledge of marketing channels	Distribution channels		
2	Knowledge of customer relationships		Customer relations	
3	Customer orientation (feedback)			
4	Customer orientation (image)			
5		Customers (relationship)		Customers (relationship)
6		Customers (satisfaction)		Customers (satisfaction)
7		Customers (number of customers)		Customers (number of customers)
8			Supplier relations (knowledge of relations)	Suppliers (knowledge of relations)
9			Supplier relations (number of suppliers)	Suppliers (number of suppliers)
10	Relations with other organizations			
11	Competitor orientation	Repeat business		
12	Long-term focus (customers)			
13	Long-term focus (suppliers)			
14	Profit objective (customers)			
15	Profit objective (suppliers)			

Table V.
Items related to intellectual property

	Intellectual property				
	Technology Broker (Brooking, 1996)	Skandia Value Scheme (Edvinsson and Malone, 1997)	Intangible Asset Monitor (Sveiby, 1997)	Value Distinction Tree (Roos and Roos, 1997)	Lynn (1998)
1			R&D	R&D	
2	Trade secrets (importance)				
3	Trade secrets (accessibility)				
4	Patents (amount)	Patents (amount)			Patents (amount)
5	Patents (financial success)	Patents financial success)			Patents (financial success)
6	Copyrights				
7	Trade and service marks (national)	Trademarks (national)	Brands (national)		
8	Trade and service marks (international)	Trademarks (international)	Brands (international)		
9	Licenses/franchises				Royalty rights
10				New products	

success of the introduction of new products on the market and overall performance. Again, these items can be answered based on a five point Likert-type scale.

Hence, the composition of the questionnaire leads to the following components and variables, which will be tested in section 5: the independent constructs HC, SC, RC and IC with 20, 19, 15 and ten variables respectively and the dependent construct company performance with nine variables.

4.2. Sample design

The German pharmaceutical industry as a highly innovative, although competitive branch of high-tech industry is the perfect choice for a detailed study of IC. On the one hand this is because IC in form of employees' skills and good networks are absolutely necessary for such highly innovative companies in order to gain a competitive edge. On the other hand, pharmaceutical companies dispose of a mixture of more tangible forms of IC like patents and brand names and less tangible ones like employees' skills. This is not the case for example dot.com companies, where less tangible components prevail. Hence, when analyzing IC in the pharmaceutical industry more tangible as well as less tangible components of IC can be taken into consideration.

The nature of the questions that are part of the questionnaire used in our study, requires a research design that is not limited to one single questionnaire per company, since the answer to most of the questions is not clear-cut and therefore may depend on the perception of the person sampled. Hence, in order to increase the internal validity of the research, the questionnaires were sent to multiple people of the same company. A consequence of this approach is that the number of companies involved in the study is limited, since for each firm that is part of the study a high level of participation is required to ensure sufficient responses per firm. Five pharmaceutical companies, with headquarters in Germany, listed on the German stock exchange and included in the DAX or MDAX were chosen to participate in the research. Questionnaires were sent to different managers of the same company including top, middle and lower management. Moreover, managers being responsible for different departments within the companies have been selected, namely: marketing, purchasing, accounting, management accounting, communication, human resource, production, sales, research and development, internal audit, and logistics. In total 300 questionnaires were mailed, which could be answered anonymously.

5. Results

This section deals with the statistical analysis of the questionnaires. The results are tested for normality and reliability. Scales of the variables are formed. Finally, a regression analysis is performed in order to find significant relations between the components of IC.

5.1. Response analysis

In total 41 questionnaires were returned, resulting in a response rate of 14 percent. Multiple responses were received from all firms involved in the study. A first step in the analysis of the data is to test for normality. This is important, since the underlying assumption of several statistic tests is the one of normality. In the case at hand the Kolmogorov-Smirnov Test with Lillifor's correction is applied. In contrast to the Chi-square test, the Kolmogorov-Smirnov test is more appropriate to smaller samples,

since it can better detect non-normally distributed data in that case (Bleymüller *et al.*, 1998). Further, in contrast to a "normal" Kolmogorov-Smirnov Test, the Lillifor's correction does not assume that the population parameters (mean and standard deviation) are known. Since only a small sample exists, and the population parameters are not known, the Kolmogorov-Smirnov Test with Lillifor's Correction is used.

Every dependent and independent variable is tested for normality. If the significance level is greater than 5 percent, normality is assumed. However, this is not the case for any of the variables. It follows, that none of them is normally distributed. Hence, for the following analyses only non-parametric tests are used.

5.2. Reliability test

In a second step the reliability of the measures used in the questionnaire is calculated. The aim is to find out, how well the set of questions relating to each of the components of IC, are able to measure this component. For this analysis, the Cronbach's alpha statistic is used, which calculates the correlation of an item with the sum of the other items of the component. An alpha value above 90 percent indicates very high reliability. A value between 75 percent and 90 percent indicates a useful reliability and a value below 75 percent indicates low reliability.

Including all items used in the questionnaire, the alpha values for the constructs used in this study are the following: human capital 85.78 percent; structural capital 84.52 percent; relationship capital 77.62 percent, IP 77.96 percent and company performance 85.88 percent. After exclusion of the variables with a non-significant (value of corrected item total correlation below 0.5) or negative correlations, the values of Cronbach's alpha increased to: HC 89.7 percent; SC 85.23 percent; RC 86.83 percent, IP 85.20 percent and company performance 90.14 percent. The variables indicated in Table VI all contributed positively and significantly to the Cronbach's alpha of the individual component and are therefore the input to further statistical analysis.

Construction of scale values

The variables that remain after the reliability analysis have to be reduced and summarized in order to make interpretation of the regression analysis easier (Bontis, 1998). This is done by building scale values. In order to construct scale values, the following procedure is applied. For the construction of the scale value for HC, the mean of the variables measuring HC and remaining after the reliability analysis is taken[1]. The same procedure is applied for the calculation of the scales SC, RC, IP and company performance. This results in five new variables (scales), each composed of 41 observations. These scales are the input to the regression analysis described in the following section.

Factor analysis with varimax rotation would have been another method for the summarization of data. The difference to the method applied is the following: When building scales based on the mean of the original variables, the weights assigned to the variables are equal. When summarizing variables, however, with the help of factor analysis the weights assigned to the variables vary. Yet, factor analysis cannot be applied in the case at hand, since the relation of observations to the number of variables that are to be summarized into factors is too low. A minimum of five observations per variable would have been required. Since this prerequisite is not

Table VI.
Result of Cronbach's alpha analysis

Cronbach's alpha				
Human capital	Structural capital	Relationship capital	Intellectual property	Company performance
Employees' intelligence	Infrastructural assets	Distribution channel	Research and development	Future outlook
Employees' learning capability	Database	Customer orientation (image)	Trade secret (importance)	Profit
Employees' knowledge	Hardware	Customer (relationship)	Patent (financial success)	Profit growth
Employees' skills	Software	Customer (satisfaction)	Copyright	Sales growth
Education (through training)	Communication system	Competitor orientation	Brand (national)	Return on assets
Employees' experience	Corporate culture (positive atmosphere)	Long-term focus (customer)	Brand (international)	Return on sales
Employees' motivation (non-financial incentive)	Corporate culture (general)	Long-term focus (supplier)		
Employees' problem-solving capability	Network			
Employees' changing capability	Transaction time			
$\alpha = 0.8957$	$\alpha = 0.8523$	$\alpha = 0.8683$	$\alpha = 0.8520$	$\alpha = 0.9014$

fulfilled, the results of the regression analysis would not have been stable in case of the application of factor analysis.

Regression results

Regression analysis is used to analyze the statistical relationship between the scales for HC, SC, RC, and IP, which were constructed in the preceding section, and company performance. Regression analysis is robust against non-normality and therefore applicable in the case at hand. The coefficient of determination (R^2) indicates the goodness of fit of the model. The higher the two indicators, the better the independent variable(s) explain(s) the variation in the dependent variable. The t-value indicates the significance of the relationships found (see Figure 2).

In a first step, the relationships between the independent scales for HC, SC, RC and IC and the dependent scale for company performance is tested, using a series of multiple regressions. All possible combinations of the independent factors[2] are regressed against the individual company performance variables[3], as well as the overall scale for company performance. Satisfying results in terms of R^2 and t-values are found for the following regressions:

- intellectual property/market leadership ($R^2 = 22.6$ percent, $t = 3.335$ significant at $\alpha = 0.1$ percent;
- intellectual property/future outlook ($R^2 = 17.4$ percent, $t = 2.869$ significant at $\alpha = 0.5$ percent);
- intellectual property/overall performance ($R^2 = 8.9$ percent, $t = 1.929$ significant at $\alpha = 5$ percent); and
- intellectual property/success of new products ($R^2 = 6.7$ percent, $t = 1.649$ significant at $\alpha = 10$ percent).

For the remaining company performance variables no significant relations with any of the independent scales were found. Also, for the scale relating to company performance as defined in the preceding section, no significant relationships are detected.

Since all significant relationships found in the previous analysis solely relate to the scale for IP, in a second step each of the scales for HC, SC and RC are regressed against the scale for IP. This analysis should provide further insight into the relationship between HC, SP and RC on the one hand and IP on the other hand. The best relationship in terms of R^2 (23.2 percent) and t-value (3.437 significant at $\alpha = 1$ percent) is found for the relation between SC and IP. However, also between RC and IP ($R^2 = 19.2$ percent, $t = 3.043$ significant at $\alpha = 5$ percent) and HC and IP ($R^2 = 11.6$ percent, $t = 2.237$ significant at $\alpha = 2.5$ percent) significant relations were detected.

In a third step the relationship between HC, SC and RC is analyzed. In this regression analysis, the scale structural capital is taken as the dependent variable and the scales human capital and relationship capital are used as independent ones. Again a significant relationship is detected ($R^2 = 53,5$ percent, $t_{\text{human capital}} = 2.237$ significant at $\alpha = 2.5$ percent, $t_{\text{relationship capital}} = 2.347$ significant at $\alpha = 2.5$ percent).

Also the following regressions lead to statistically significant results: SC and RC on HC ($R^2 = 52.2$ percent, $t_{\text{structural capital}} = 3.38$ significant at $\alpha = 0.1$ percent, $t_{\text{relationship capital}} = 2,082$ significant at $\alpha = 2.5$ percent) and human capital and structural capital on relationship capital ($R^2 = 45.5$ percent, $t_{\text{human capital}} = 2.082$

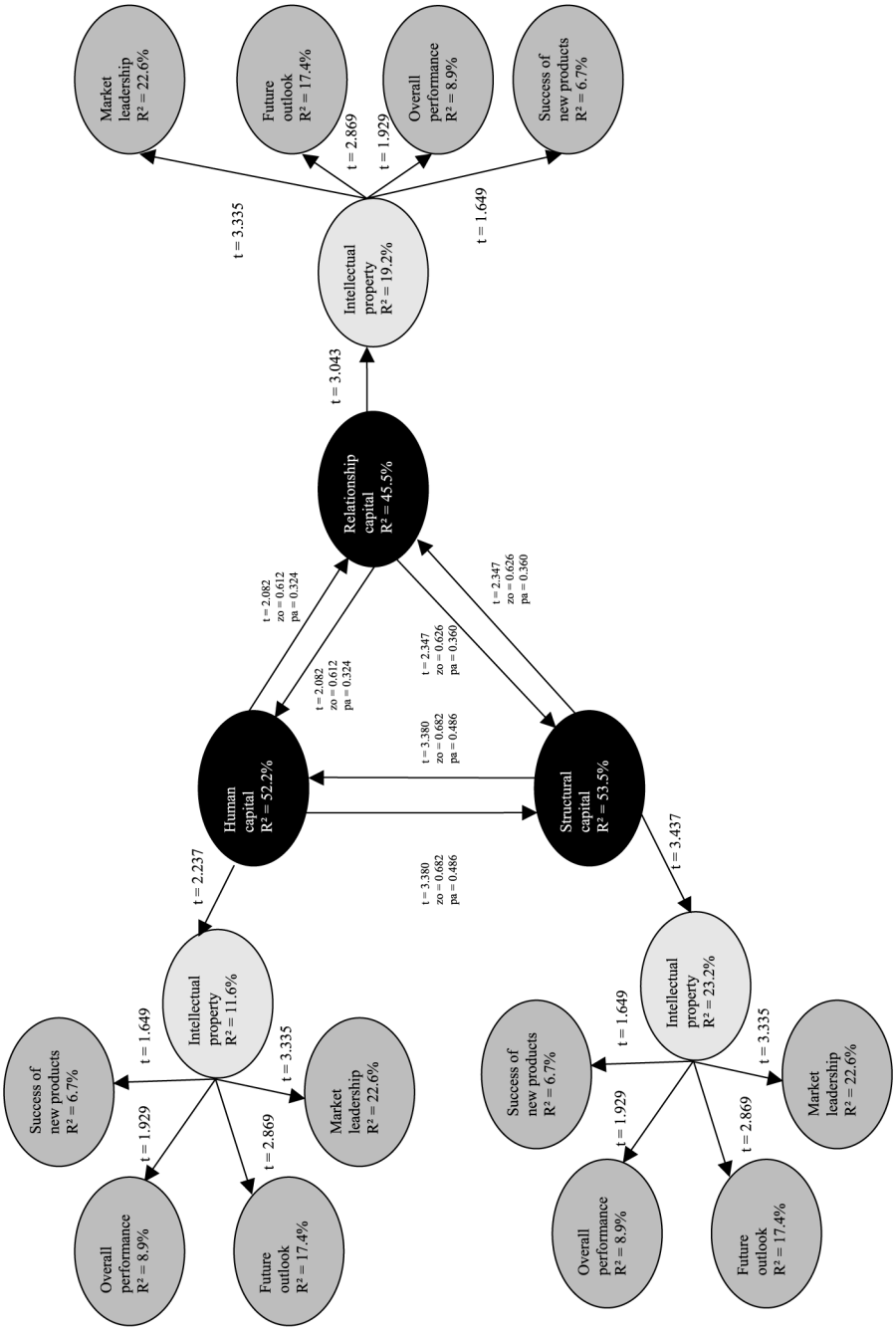

Figure 2.
Regression results

significant at $\alpha = 2.5$ percent, $t_{\text{structural capital}} = 2,347$ significant at $\alpha = 2.5$ percent). In all cases the zero order correlations are higher than the partial correlations.

6. Discussion of results

The results of the regression analysis are summarized in Table VII. The first part of the analysis indicates that the scale for IP has a significant impact on the dependent variables market leadership, future outlook, overall performance and success of new products. No significant relationship between HC, SC or RC and any of the variables pertaining to company performance can be found. In the second part of the analysis, taking the scale for IP as an independent variable, the scales HC, SC and RC show significant relationships when regressed separately. Finally, the third part of the analysis shows that the scales HC and RC show relations with SC, the scales RC and SC with HC and the scales HC and SC with RC. Also, regressing HC and RC against SC reveals that the zero order correlations (the normal correlation) of the two independent scales are higher than the partial correlations (pure correlation without the linear effect of other variables). This indicates that HC enhances the influence of RC on SC and the other way around. The same applies to the regression of HC and SC on RC and the regression of SC and RC on HC. It follows that the scale HC, SC and RC positively influence each other.

Based on these results, the following conclusions with respect to the hypotheses can be drawn.

First of all, *H1.1-H1.6* state that the less tangible components of IC are all interrelated. These hypothesis are supported by the result of the third part of the

Hypothesis	Dependent variable	Independent variable	R^2/F statistic	T value/significance
H1.1	SC	HC	$R^2 = 53.5$ percent	$t = 2.237^{*}$
H1.6		RC	$F = 21.277^{***}$	$t = 2.234^{*}$
H1.3	HC	SC	$R^2 = 52.2$ percent	$t = 3.380^{***}$
H1.5		RC	$F = 20.179^{***}$	$t = 2.082^{*}$
H1.2	RC	HC	$R^2 = 45.5$ percent	$t = 2.082^{*}$
H1.4		SC	$F = 15.453^{***}$	$t = 2.347^{*}$
H2.1	IP	HC	$R^2 = 11.6$ percent	$t = 2.237^{*}$
			$F = 5.005^{**}$	
H2.2	IP	SC	$R^2 = 23.2$ percent	$t = 3.437^{***}$
			$F = 11.812^{***}$	
H2.3	IP	RC	$R^2 = 19.2$ percent	$t = 3.043^{**}$
			$F = 9.200^{***}$	
H3	Overall company performance	IP	$R^2 = 8.9$ percent	$t = 1.929^{**}$
			$F = 3.722^{*}$	
H3	Success of new products	IP	$R^2 = 6.7$ percent	$t = 1.649^{*}$
			$F = 2.719$	
H3	Future outlook	IP	$R^2 = 17.4$ percent	$t = 2.869^{**}$
			$F = 8.228^{***}$	
H3	Market leadership	IP	$R^2 = 22.6$ percent	$t = 3.335^{***}$
			$F = 11.120^{***}$	

Table VII.
Results of regression analysis

Note: Significance levels are indicated as: * 0.1, ** 0.05, *** 0.01

regression analysis. When regressing HC and RC against SC significant relations are found. The comparison of zero order correlations to partial correlations indicate the interdependence between the two independent factors. The same results are found when regressing HC and SC against RC and SC and RC against HC.

H2.1-H2.3 predict a significant relationship between HC and IP, SC and IP and RC and IC. Also these hypotheses are supported by the second part of the regression results.

H3 states that there is a positive relationship between IP and company performance. Based on the first part of the regression analysis, a direct connection between the scale IP and individual variables assigned to company performance can be detected. Significant relationships exist for market leadership, future outlook, overall performance and success of new products. These results provide general support for *H3*. It should be mentioned, however, that no significant relationship between IP and the overall scale for company performance is found.

Finally it was predicted that no significant relations between the less tangible components of IC and company performance subsist. This hypothesis is also supported by the first part of the regression analysis. It follows that a useful distinction can be made between the less tangible components of IC and the more tangible component. Whereas IP reveals a direct link to variables measuring company performance, HC, SC and RC have an indirect link to variables measuring company performance with IP as an intermediary.

Three limitations of the research persist. From a total sample of 300, 41 responses were useful for the analysis. Although the sample size is sufficient for the statistical tests applied, the results reported here should only be considered a trend. In order to receive more reliable results a higher response rate would have been necessary. It should also be reminded that the research design focused on multiple responses per firm to increase the internal validity of the research. However, as a result of this approach the number of firms included in the study is limited which may have an adverse effect on the external validity of the research.

The R^2 values of the regression including IC and success of new products and overall performance respectively are fairly low. This result indicates that there are other variables that may predict company performance which are not part of this study. Also, these results may be related to the sample size. Nevertheless significant relations between IP and success of new products and IC and overall performance were detected.

Another problem of the research lies in the way answers to the questions could be provided, which relates to the use of a Likert-type scale in the questionnaire. The general way of reaction of the respondents influences the results, meaning that some people tend to give extreme answers whereas others prefer cautious answers.

7. Conclusions

Analyzing the role of IC, this research paper concentrated on the role of IP in the relationship between IC and firm performance, based on an empirical analysis. The research was aimed at pointing out that IP is an important asset of companies and was meant to increase the awareness among management for IC in general and for certain parts of IC in particular.

Similar research was presented by Bontis (1998, 2002), Yet, his questionnaire analysis was a pilot study using students as respondents, and the analysis of the annual reports only applied to Canadian companies. Since the outcomes of these analyses are highly content specific and therefore not readily applicable to other industries, doing such a research in another economic setting focusing on a highly competitive research-intensive industry like the pharmaceutical industry was highly valuable to verify the important role of IC found. The pharmaceutical industry was chosen because it combined all relevant four components of IC, HC, SC, RC and IP, the latter not always being present in other IC-intensive industries, making the pharmaceutical industry a perfect example for analyzing the interlude of all components.

A questionnaire based on the insights gained from an analysis of the measurement methods as well as on knowledge about the specific industry was developed for the pharmaceutical industry. The questionnaire included questions related to all components of IC as well as company performance. Statistical analysis showed the following results. HC has a significant influence on the company performance indicators market leadership, future outlook, overall performance and success of new products. In addition HC, SC and RC have a significant influence on IP and, therefore, with IP as an intermediary an indirect influence on company performance. It followed that in order to enhance company performance, companies have to focus on the items included in these variables.

In addition, the less tangible components of IC strengthen each other, meaning that when improving one of the components the other two components are improved as well. Hence, the correlations between these items have to be well understood by management in order to gain the most from investments.

Overall it could be stated that pharmaceutical companies have to understand the correlations between the components of IC and set a focus on the individual items included, which means the increase of employees' awareness of important items and the measurement of items in order to determine whether they are satisfyingly developed.

The results of our study have several practical implications. This study shows that there is a link between IP and company performance in case of the pharmaceutical industry. Yet, it also reveals that IP is a kind of "interface" linking HC/SC/RC components overall company performance. Therefore, IC as a whole, i.e. including IP, and not solely IP has a positive impact on company performance. Based on these results, it follows that the optimal procedure for pharmaceutical companies is to focus on all four components of IC in order to increase company performance. This is especially the case, since HC, SC and RC enhance each other (e.g. in case SC is improved, IC and RC are positively influenced which in turn all positively contribute to IP).

In order to focus on HC, SC, RC and IP, firms should assign importance to those aspects included in the scales for each of these components (see Table VI). For HC this means that employees have to be intelligent, they have to learn quickly, they have to have knowledge, skills and experience. Also, they have to be able to solve problems in an adequate manner and to adapt to different situations. In addition they have to receive trainings and be motivated. Concerning SC it means that sufficient "infrastructural assets" in the form of technologies, presses and methods have to

exist. A database, hardware, software, communication systems and networks have to subsist. The corporate culture has to be supportive in general and positive in particular and transaction times have to be small. With respect to RC, a sufficient number of distribution channels have to exist, the customers' image of the company is of importance, customers have to be satisfied in order to increase retention rates and to build long-term relationships. Also supplier relationships have to be based on the long term. Finally the business of competitors has to be analyzed. Focusing on IP means investment in R&D, taking care of trade secrets, development of patents that are financially successful, development of copyrights and national and international awareness of the brand name.

Table VIII summarizes the variables that are, according to the preceding analysis, most important for a pharmaceutical company to focus on.

Given the limitation of this study, there are several ways in which future research on the effect of IC and IP on company performance could be directed. First of all, this study is directed towards the German pharmaceutical industry. To test the robustness of our findings for other industries and other countries, additional research is necessary. Therefore, similar research could be applied to other industries in order to find out whether the relations between IC and company performance are similar to the ones found in the research at hand. Also, more advanced statistical techniques such as structural equation modeling may be used to test simultaneously the regression equations used in this study. For such a study, a considerably larger number of respondents would be required.

Human capital	Structural capital	Relationship capital	Intellectual property
Employees' intelligence	Infrastructural assets	Distribution channel	Research and development
Employees' learning capability	Database	Customer orientation (image)	Trade secret (importance)
Employees' knowledge	Hardware	Customer (relationship)	Patent (financial success)
Employees' skills	Software	Customer (satisfaction)	Copyright
Education (through training)	Communication system	Competitor orientation	Brand (national)
Employees' experience	Corporate Culture (positive atmosphere)	Long-term focus (customer)	Brand (international)
Employees' motivation (non-financial incentive)	Corporate Culture (general)	Long-term focus (supplier)	
Employees' problem-solving capability	Network		
Employees' changing capability	Transaction time		

Table VIII.
Aspects that are of high importance to the industry

Notes

1. Observation 1 scale value human capital = Mean (observation 1 employees' intelligence + observation 1 employees' learning capability + . . . + observation 1 employees' changing capability) . . .

   Observation 41 scale value human capital = mean (observation 41 employees' intelligence + observation 41employees' learning capability + . . . + observation 41 employees' changing capability).
2. The following combinations of dependent factors are regressed against the dependent one: HC; SC; RC; IP; HC and SC; HC and RC; HC and IP; SC and RC; SC and IP; RC and IP; HC, SC and RC; HC, SC and IP; SC,RC and IP.
3. "Market leadership", "future outlook", "profit", "profit growth", "sales growth", "return on assets", "return on sales", "success of new products", "overall performance"

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