Towards the Knowledge Economy: the Technological Innovation and Education Impact on the Value Creation Process

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Abstract: Emerging as one of the most important corporate assets, there is evidence that, in some developed countries, the impact of knowledge capital in the GDP now surpasses the fixed capital. This paper uses quantitative data to broadly qualify the impact of the two main building blocks in the knowledge management integration process: information and communication technologies (ICT) and Education. The data analysis suggests that by providing efficient network platforms, knowledge can be captured, transformed and disseminated to individuals, groups and organisations. Investment in ICT seems to enable to connect people and support knowledge sharing and interpersonal interaction and therefore facilitate knowledge management processes and strategies. A case-study of Portugal is used to illustrate the conclusions drawn.

Keywords: Knowledge Economy; Knowledge Management; Intangible Assets; Information and Communication Technologies.

1. Introduction

It is well accepted that knowledge and information have become new organisational and resources and assets. Determinative of deep changes in the behaviours of the individuals, teams and organizations, these assets have been used to reach sustainable standards of development and growth. The emergence of a new economic paradigm is rooted in the need for the management of these new resources. The new models of business, emerging in a global economy throughout complex networks, have its hard nucleus in a basic activity of the modern value chain: the knowledge management and the creation of value. Therefore, during the last decade, terms like "digital economy", "information society", "knowledge society" and "knowledge economy" have arisen as areas of interest and research both in academic and organisational milieus. In this paper, we have decided to adopt the term "knowledge economy" (KE).

Many companies, investing in the most recent technologies, tried to implement and develop solutions in order to achieve sustainable positions throughout their ability to acquire, develop and transform knowledge into expertise. The same approach has been followed at national levels. The questions this paper aims at addressing are: Are European countries in different stages of development? Which structural blocks provide these countries with competitive advantages? Some investigation is required in order to answer those questions and give an appropriate view of the European scenario.

2. Aims and objectives

The aim of this paper is to investigate and discuss the classification of knowledge and its impact in the KE as a new economic paradigm. Based on the ontological and epistemological classification proposed by Nonaka and Takeushi (1995), we examine the relevant issues, that based on empirical evidence, support productivity and competitiveness at the corporate level.

Secondly, our purpose is to identify the main structural blocks that support KE, which we denominate KE pillars. Within this framework, and based on a quantitative approach, we present the European scenario based on the most important pillars. Using an econometric model, we also analyse the impact of knowledge capital investment in the Gross

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Domestic Product (GDP), at the European level.

Finally, we explore some data available for Portuguese firms, concerning information and communication technologies (ICT). We characterize ICT diffusion and we underline some issues related to the impact of ICT on firm-level performance.

3. Knowledge, knowledge economy and knowledge society

The changes occurred since the middles of 1990s in the information and communication technologies and their impact in the economic and corporate growth, place knowledge as the most important and valuable asset in organisations today. Derived from the minds of workers and their values (Davenport and Prusak, 1998), it is seen as information, beliefs and commitment (Nonaka and Takeushi, 1995:58, Dretske, 1983:85). As stated by Davenport and Prusak (1998:5), "k*nowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices and norms*". Thus, knowledge arises as a dynamic learning process that occurs between individuals, teams, organisations and communities (Hawkins, 1994:9).

Generally and according to modern economic theories, knowledge is a subjective asset that appears directly associated to connectivity, information, technological and organisational convergence, and mobility. It appears as the main source of competitive advantage (Wasko and Faraj, 2000; Smith and Webster, 2000; Alavi and Leidner, 2001), responsible for the organisational productivity improvement. It is also understood, as the capacity to transform data, to use information, to learn, to test results, to interpret, to support decisions and to take sustainable advantage.

From a strategic perspective (Zack, 1999; Sullivan, 2000), it is disaggregated in strategic or advanced knowledge (long term perspective), in tactic or essential knowledge (short term organisational positioning) and support or innovative knowledge (maintain effective internal structural activities).

Furthermore, the distinction between tacit knowledge and explicit knowledge is probably the most accepted approach from an epistemological dimension. In his "*Theory of Organisational Knowledge Creation*" (Figure 1) Nonaka and Takeuchi (1995:59), tacit knowledge is defined as personal, non-codified, context-specific and hard to formalize, difficult to articulate and communicate through individuals, teams, organisations and communities (ontological dimension). It is also expensive to transfer and make accessible (Teece, 1998). Greco (1999) characterizes it as intuitive, interpretative, ambiguous, not linear and difficult to quantify. This knowledge is related as the distinct ways to execute the tasks and shares (Sullivan, 2000). Can also be individual (acquired through a non systematic nor intentional form) or collective (what it is known by many individuals and that is not revealed through an explicit form) (Matusik and Hill, 1998). Smith and Webster (2000) argue that the great change in the knowledge management subsists in the capture and codification of the tacit knowledge, in its storage and diffusion throughout the potential users.

Conversely, explicit knowledge is generalized, codified, objective and transmissible through formal and systematic methods (Nonaka and Takeushi, 1995; Alavi and Leidner, 2001). It can also be held in an individual or collective form (research and development processes, written patents, rules and procedures, graphics, management decisions, among others) (Matusik and Hill, 1998). According to Teece (1998), the larger its degree of codification, the greater the velocity and minor the cost in its transference. Individual knowledge groups the individual abilities and practices while collective knowledge groups the set of organisational principles, practical routines, experiences, goals, missions, information about competitors and relations that are spread out through the organization and shared in a dynamic manner by a significant number of users (Zander and Kogut,1995). Individual

knowledge, therefore, is created by and is inherent to the individual shares and beliefs and becomes a part of the social knowledge that is created by and is inherent to the collective shares and beliefs (Alavi and Leidner, 2001). As stated by Nonaka and Takeushi (1995:72), it can be created trough four different modes: socialization (sympathized knowledge), externalisation (conceptual knowledge, internalisation (operational knowledge) and combination (systematic knowledge). Thus, this dynamic and multi dimensional process crosses the companies as a whole and broadly, epitomizes the boundaries of the economic development and growth.

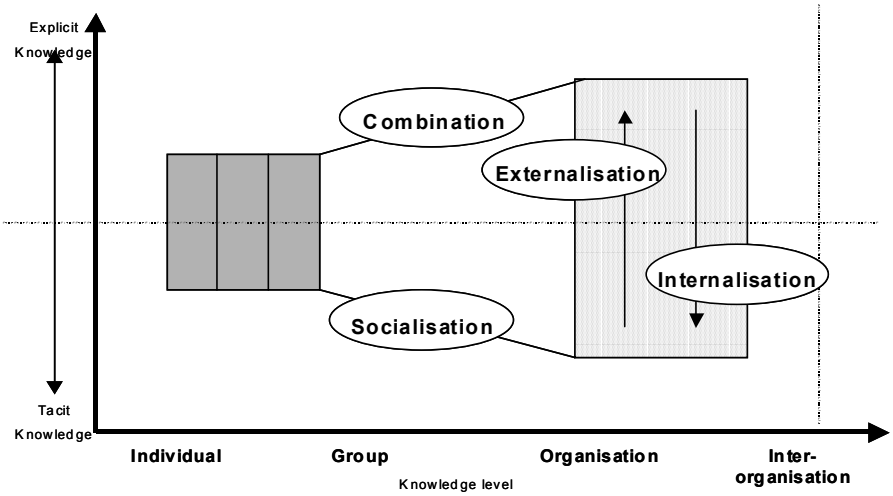


Figure 1: Organisational knowledge creation (Nonaka and Takeushi,1995)

Based on knowledge, KE is associated with the impact of the technological innovation which reflects in reduced prices, bigger levels of efficiency through the combined use of telecommunications, computers, mobile devices and the Internet. Associated to those developments, new products and services emerge, strong innovations in the financial markets grow up, new methods of payment appear, organisational cost reductions are achieved, and new improvements in the quality of products and efficiency of processes are obtained (Landefeld and Fraumeni, 2001).

For Atkinson (2002), KE typifies the reshuffling of all industries and the entire economies. It represents therefore a complex field of forces that include the reorganization of the companies, more efficient and dynamic stock markets, more economic and enterprising dynamism, more rigidity in the globalisation process, the carrying out of the economic competition and the increment in the unpredictability of the work markets. Kelly (1998) attributes therefore three basic characteristics: it is a global economy; it is based on the intangible assets (ideas, information and relations) and is intensely linked through individuals, groups, organisations and communities. These new attributes produce a new type of market and a new society highly dominated by electronic powerful networks.

The knowledge society today is dominated by the applications of the conquests of the second industrial revolution and the technological revolution, where the information, aggregated to the information and communication technologies, assumes a basic role in the sustainable development and in the country level competitiveness (Simão *et al.*, 2002). While marked by connectivity, information, convergence and mobility, KE will be expressed, independently of the perspective analysis, in a strong and deep economic and social transformation.

4. The basic pillars of the knowledge economy

4.1 The technological innovation pillar

In 21st century, economic success seems to be closely associated to the strategies and politics of innovation (Smith, 2000).

Highly dependent of strategies implemented favouring differentiation factors, competitiveness and quality assurance, economic success assumes as a main characteristic the technological innovation pillar (Simão *et al.*, 2002). Being one of most important pillars in KE measurement, the search of a portfolio of indicators, constitutes an urgent task in the effort to construct a model that can measure and compare worldwide economic cycles.

However and despite their increasing importance, intangible assets still pose problems in determining their value source and measurement (Contractor, 2001). Therefore, we identified investment in R&D and the number of patents registered (Lev, 2001; Atkinson, 2002; OECD, 2002; Eurostat, 2003) as two important pointers for this pillar. This is compatible with the views expressed by Baruch Lev (2001) that argues that the innovation, important activity of individuals and organizations, is firstly reached through the investment in intangibles, namely R&D, information technologies and continuous staff formation.

R&D is understood as the research, elementary or applied, in sciences and engineering, the drawing and the development of archetypes and processes (NSF, 1973). Thus, investment in R&D and increase in the level of patents registrations, suggests that the companies should establish strong programs of incentives for scientists and engineers who can motivate their activities of invention and innovation. Landim (2002) asserts this emergent importance of R&D and states that corporate management should plan R&D as an intellectual capital (human capital + structural capital as stated by Roos *et. al., (*1997:29)) and asset development. In particular their patents, combined with strategies that allow companies to identify and measure those assets. So, companies can obtain a better use of, explore and benefit from their intellectual capital.

4.2 The science and education pillar

The human resources qualification plays a decisive role in the globalisation process, which crosses, gradually, all the corporate activities (Lev, 2001; Junqueiro, 2002) and the entire economy. In the knowledge society creation, the education – formation pillar, constitutes an orienting burner vector that consolidates and supports the economic innovation process. Science, in any economy, is strongly linked to the information society development (Simão *et al*., 2002). Those countries that invest more in science, strongly linked with R&D investment level and education policies, can expect to grow faster than those that undervalue or ignore this important pillar.

4.3 Other pillars: cultural, citizenship and the use of information and communication technologies

The transformation process throughout the KE depends to an important degree on the use of the new technologies, specially the information and communication technologies (ICT). Some indicators suggest that besides expressing the level of integration of the citizens and countries in the KE, they equally express the quality of that integration. The use of the Internet, the development of e-commerce in purchases and sales, the e-governance and the existence of specialized personnel in ICT in the companies, are the pointers that characterize this pillar. The citizenship always has expression in the degree of participation of the citizens in the society, while the culture is linked with the existence of the person as human being, always the main factor of its development (Simão *et al.* (2002).

In figure 2, the four pillars are identified. As evidenced by Handzic and Hasan (2003), we accept that knowledge can be codified and then stored in a computerised system to be made available on demand. So, the main purpose of knowledge management is the acquisition, capture, transformation, access, diffusion and re(use) of the knowledge throughout the individuals and communities. Those activities can be more efficient, depending on the context that allows and facilitates their development.

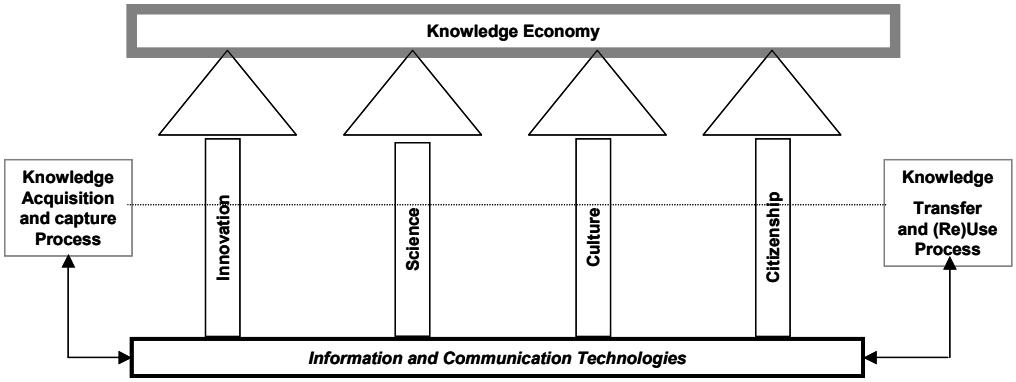


Figure 2: The knowledge economy pillars

5. How can we measure the knowledge economy

5.1 The state of the art on KE indicators

The deep transformation verified in the economic and social development, requires a model, which easily translates the real status of the KE. The need to capture the changes operated in the KE environment (Landefeld and Fraumeni, 2001), has been one of the main concerns in the definition of a global development pointer. However, the systematic use of an index system, that can measure the development state of the art for each economy (Smith, 2000; Atkinson, 2002; OECD, 2002; Eurostat, 2003) has been the most common alternative orientation followed by academics and international organisations like OECD or European Commission.

The model developed by Eurostat adds five pointers in the economic area, six pointers related with the global environment, four pointers related to research and development, four indexes measuring scientific and technological information level and five pointers based in the social context. In the same way, the model developed by the OECD focuses on the R&D investment, Internet access and in ICT use and development. The objective is to look at position of each economy, albeit limited to a single KE pillar.

In Atkinson's (2002) study, for the American economy, the main objective is to show the position of each state based on KE principles. For that purpose, some indicators have been grouped in five distinct categories, namely: jobs in ICT areas, globalisation, economic dynamism and competitiveness, transformation process for digital economy and technological innovation corporate capacity.

5.2 KE and firm-level performance

Several authors (Lev, 2001; Brynjolfsson and Hitt, 2002; Bower and Heminger, 2002) have analysed the impact of a set of variables (investment in software, investment in ICT, intangible assets and organisational practices namely the use of e-commerce in the corporate transactions) in the performance and productivity at organisational level. In fact, at a corporate level, intangible assets should be treated as a specific bundle of legal property rights, namely contracts, licences, registration documents, patents, customer databases and a set of financial statements (Reilly and Schweihs, 1999:5). To quantify the impact of such factors on performance, most of these studies used multivariate statistic techniques such as regression analysis.

Broadly, those studies have shown good correlations between the proposed variables and the productivity and competitiveness at the firm level. Therefore they can be viewed as a starting point to construct a more general model based on all the KE pillars.

6. The knowledge economy European scenario: Empirical evidence

6.1 Technological innovation and science

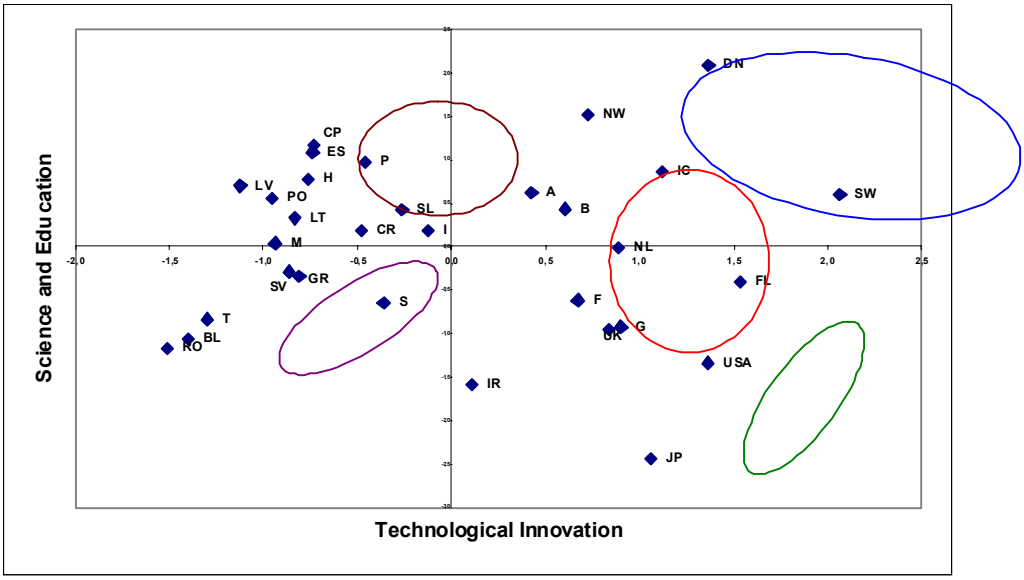
Independently of the approach used to measure the KE, Portugal has been

classified in the fifty most developed countries. Broadly, it is located between the 23rd and 36th position (OECD,2003; Cornelius *et al.*, 2003; Dutta and Jain, 2003).

Using a limited data set and applying Principal Components (Multivariate Statistical Method), we ranked European countries with respect to two important pillars: Science and Innovation. We used thirty-one countries (twenty-nine from Europe and United States of America and Japan) and nine variables (investment in R&D, number of patents registered in the EPO, number of patents registered in the USPTO, expenditure in education, number of graduates in science and technology, level of internet accesses, investment in information technologies, investment in communication technologies, number of mobile devices subscribers). The data had been collected from the official statistics of the Eurostat (2003).

In accordance with that methodology proposed, we identified three principal components, which explain about 85% of the total data variability of the data. The most relevant conclusions are the following: we underline the supremacy of the Nordic countries (SW - Sweden, FL - Finland, DN - Denmark, IC - Iceland, NW - Norway) as well as the one of the United States of America and Japan. We also point out the importance that some countries of the central Europe present, namely Germany (G), Holland (NL), United Kingdom (UK) and France (F). Below of the European average we find the South Europe and the East Europe countries. Portugal is stated in our sample, in the 18th position.

In graph 1, we crossed the technological innovation pillar with the science and education pillar. We clearly identified, 5 clusters corresponding to 5 distinct states of evolution towards KE.



Graph 1: Innovation and science

1. Nordic countries (SW, DN, NW, IC): characterised by important strengths both in the technological innovation capacity and in the science pillars;
2. United States of America (USA) and Japan (JP): significant strengths in the technological innovation capacity and some weaknesses in the science and education structural blocks;
3. Romania (RO), Bulgaria (BL), Turkey (T), Slovakia (SV) and Greece (GR): presenting weaknesses in the two sources in analysis;
4. Cyprus (CP), Estonia (ES), Latvia (LV), Hungary (H), Lithuania (LT), Poland (PO) and Portugal (P): although these countries show an important rate in the science and education pillar, some weaknesses were evidenced at a technological innovation capacity level;
5. Other Countries (Austria, Belgium, Holland, France, Germany, United Kingdom): characterized for

presenting satisfactory values when conjugated the two pillars in analysis.

The clear difference between the states of development, in relation to the KE, among the EU countries, illustrates the importance of defining an integrated strategy in order to gradually eliminate these asymmetries.

6.2 Knowledge capital investment impact in GDP

When the goal is to measure the KE, the GDP is the most frequently used dependent variable in multivariate regression. In our approach, we used a model where knowledge economic growth is explained by two distinct forces: changes in Fixed Capital Investment (FCI) and changes in the Knowledge Capital Investment (KCI).

The Fixed Capital Investment (FCI) encloses the investment in structures, schemes and equipment. It constitutes the diffusion way of new technologies, especially for the transforming industries. Many authors assign this independent variable to characterise the traditional economy, as stated in classical economic theories,

The Knowledge Capital Investment (KCI) is more difficult to measure. This independent variable is defined and calculated as the sum of the research and development expenses, education and software development. Thus, this variable, according to the literature, supports on a fairly basis the KE measurement.

In this approach, twenty-four countries from the OECD have been considered: Australia, Austria, Belgium, Canada, Check Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Mexico, Holland, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States of America. The data had been collected from the official statistics of the OECD and mention to the period 1991 - 2000. Two variables were considered (FCI and KCI growth rates between 1991 and 2000). Our purpose is to quantify and to analyse their impact in economic growth. The estimated model was the following:

$$\hat{GDP}_i = 1{,}61178 + 0{,}27719\ FCI_i + 0{,}30343\ KCI_i$$

As expected, the results indicate a positive and significant impact of FCI and KCI growth in GDP growth. What is surprising is that, in this particular approach, the knowledge capital investment impact is greater than fixed capital one (FCI estimated coefficient equal to 27,7 %, with a p-value of 0,02 and KCI coefficient about 30% with a p- value of 0,033). The results from the estimation of the proposed model show the importance of the KE in the national competitiveness and productivity. Although a deeper investigation is required, this evidence constitutes for us the starting point for a larger investigation at a corporate level.

7. The ICT use in Portuguese companies

As stated in figure 1, ICT plays an important role in the KE. In this part of our study, we evidence the Portuguese scenario at corporate level. The data had been yielded by the National Institute of Statistics and refers to the "*Inquiry to the Information and Communications Technologies Use - 2002*". The sample comprises 1548 companies sprout by multiple branches of activity, namely: D - Transformation industries - 29,5%; G - Commerce and vehicles repair - 29%; H- Lodging and restoration - 1,7%; I- Transportation, storage and communications - 6,2%; J- Financial activities - 4,3% and K- Real estate activities, leases and services - 29,3%. Our analysis focuses on three main blocks: characterization of the ICT used in those companies; Type of activities developed through the Internet and information on the e-commerce use.

Activity ID	Activity Sector	Number of Companies	E-mail	Intranet	Extranet	Electronic Data Interchange	Wireless Application Protocol	Local Area Network	Wide Area Network
D	Transformation industries	**457**	83,4	51,0	23,0	29,6	0,2	54,3	27,8
G	Commerce and vehicles repair	**447**	85,7	48,1	24,6	28,4	2,46	49,9	25,6
H	Lodging and	**26**	100,0	73,1	15,4	26,9	46,2	61,5	15,4

Activity ID	Activity Sector	Number of Companies	E-mail	Intranet	Extranet	Electronic Data Interchange	Wireless Application Protocol	Local Area Network	Wide Area Network
	restoration								
I	Transports, storage and communications	**96**	90,6	61,2	32,3	34,4	21,9	65,6	36,5
J	Financial activities	**67**	95,5	84,4	47,8	40,3	47,8	80,6	65,7
K	Real estate, leases and services	**455**	81,2	46,8	26,4	16,7	9,0	44,6	22,4
		1458	**84,7**	**51,2**	**26,0**	**27,8**	**7,6**	**52,1**	**27,7**

Table 1: Types of ICT used in Portuguese companies (%)

Table 1 shows the diffusion of ICT in 2001 in Portugal. We present, the type of technologies used, namely e-mail, intranet and extranet, private networks, like Electronic Data Interchange (EDI), Wireless Application Protocol (WAP), Local Area Network (LAN) and Wide Area Network. As can be seen in Table 1, the most important tool used by Portuguese firms is the e-mail (84,7%) followed by the Intranet (51,2%) and LAN (52,1%). Otherwise, technologies like WAP, EDI or WAN do not seem to be a serious priority for the time being. These companies do not use those technologies nor are planning to use them shortly (WAP – 95%; LAN - 44% and WAN – 69%). Financial activities, lodging and restoration are, in this context, the most developed branches.

As stated in table below, the Internet is used specially for information searching, for contacts with governmental entities and for financial services (like payments, transfers, bank accounts queries). Activities such as education, R&D and employment observe a residual impact in the Internet use.

Activity ID	Activity Sector	Information Searching	Environmental Scanning (e.g. prices scanning)	Contact with gov. entities	Financial services	Employment	Education and Formation	R&D
D	Transformation industries	82,3	39,2	72,2	65,9	23,6	14,7	22,3
G	Commerce and vehicles repair	78,3	37,4	68,0	63,1	19,9	12,1	11,7
H	Lodging and restoration	92,3	76,9	84,6	80,8	46,2	11,5	19,2
I	Transports, storage and communications	86,5	51,0	77,1	62,5	31,3	24,0	20,8
J	Financial activities	88,1	64,2	86,6	85,1	29,9	25,4	31,3
K	Real estate, leases and services	78,2	37,1	66,2	59,6	30,8	19,8	23,3
		85,6	43,0	74,7	68,0	27,4	17,4	21,1

Table 2: Activities developed throughout the Internet (%)

As stated below, only 24,7% of the enterprises inquired declare to use the e-commerce in goods and services acquisitions. Likewise, only 13,8% uses it, till 2001, for sales purposes. Lodging and restoration seems to be the most dynamic branch. In the purchasing and payment cycle, 21,3% use the Internet to put the orders and only 5,7% use it to in the payment procedure. None use it for electronic deliveries. Relating the sales and collection cycle, Internet is used specially to promote the enterprise products and services (11,1%), to inform about prices (9,4%), to receive orders (8,9%), as a collection platform (3,7%) and for electronic deliveries (2,4%). Companies do not plan to use EDI for those purposes.

Activity ID	Activity Sector	Goods and Services	Goods and

		Acquisitions	Services Sales
D	Transformation industries	21,4	13,6
G	Commerce and vehicles repair	23,0	9,6
H	Lodging and restoration	42,3	50,0
I	Transports, storage and communications	27,1	19,8
J	Financial activities	17,9	32,8
K	Real estate, leases and services	24,2	9,2
		24,7	13,8

Table 3 : e-Commerce use (%)

8. Final conclusions and remarks

Several approaches have been used to measure the KE. These are composite indicators, and the methodology presented in this paper is based in quantitative methods. Based on o large set of variables related to KE, we clearly identified four pillars: innovation, science, culture and citizenship. However, empirical evidence shows that the innovation and science blocks are the more significant.

Portugal as other European countries does still not meet the standards shown by the most developed countries. Europe continues far away from the real convergence between countries announced in 2000s, in Lisbon. We provided evidence that Europe is being managed at different speeds towards the KE. Important weaknesses were identified, in particular in those countries, which recently joined the European Union. Therefore it seems crucial, within the EU context, to implement structural policies towards a convergence relating the KE pillars.

The knowledge capital impact in the GDP surpassed, in the beginning of the century, the impact evidenced by the fixed capital investment. Information communication technologies play a critical role in the KE environment. In the Portuguese case, strong investments and cultural change is required in order to achieve a sustainable competitive level. Information and communication technologies are not properly used as a way to achieve that goal.

The present study is an integrant part of larger investigation. Further empirical research is required that would address and confirm some of the issues stated in the paper.

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References

Alavi, Maryam e Dorothy E. Leidner (1999). “Knowledge Management Systems: emerging views and practices from the field”, 32nd Hawaii International Conference on System Sciences, Maui: IEEE.

Atkinson, Robert D. (2002). The New Economy Index, http://www.neweconomyindex.gov/states.

Bower, William D. and Alan R. Heminger (2002). “Development of a Strategic Decision Framework for Identifying and Selecting Knowledge Management Projects, 35th Hawaii International Conference on System Sciences, IEEE.

Brynjolfsson, Erik and Lorin M. Hitt (2002). “Computing Productivity: Firm Level Evidence”, working paper, MIT Sloan School of Management.

Contractor, Farok J. (2001). “Intangibles Assets and Principles for Their Valuation”, Valuation of Intangible Assets in Global Operations, Farok J. Contractor (editor), London: Quorum Books.

Cornelius, Peter K.; Jenniffer Blanke and Fiona Paua (2003). “The Growth Competitivensess Index: Recent Economic Developments and the Prospects for a Sustained Recovery”, Global Competitiveness Report, World Economic Forum [Available at: http://www.weforum.org/].

Dutta, Soumitra and Amit Jain (2003). “The Networked Readness of Nations”, Global Information Technology Report 2002-2003, World Economic Forum [Available at: http://www.weforum.org/].

Eurostat (2003). Statistics [Available at: http://europa.eu.int/commm/eurostat/] .

Greco, JoAnn (1999). "Knowledge is power", Journal of Business Strategy, March-April, pp.19-22.

INE - Instituto Nacional de Estatística (2003). "Inquérito à Utilização de Tecnologias de Informação e Comunicação nas Empresas – 2002", Lisboa: INE.

Junqueiro, Raul (2002). A Idade do Conhecimento, 1ª Edição, Lisboa: Editorial Notícias.

Jobsen, J. D. (1991). Applied Multivariate Data Analysis, Vol I e II, New York: Springer-Verlag.

Johnson, R. A. and D.W. Wichern (1998). Applied Multivariate Statistical Analysis, New Jersey: Prentice Hall.

Handzic, Meliha and Helen Hasan (2003). "The Search for an Integrated Knowledge Economy Framework", http://www.kmrg.unsw.edu.au/teaching/KMBookChapter1Final.pdf

Kelly, Kevin (1998). New Rules for the New Economy, Middlesex: Penguin Books.

Landfeld, J. Steven and Barbara M. Fraumeni (2001). "Measuring the New Economy", Survey of Current Business, March, pp.23-40.

Landim, Olga da Cruz (2002). "Criar valor com as invenções", Economia Pura, Dezembro, p-30-32.

Lebart, L. Morineau, A. et M. Piron (1998). Statistique Exploratoire Multidimensionnelle. 2ª Edição, Paris: Dunod.

Lehtoranta, Olavi (2002). "Analysing the Dynamics of New Economy Enterprises, Paper submitted to the NESIS Conference, Olympia, Greece, June.

Lev, Baruch (2001). Intangibles: management, Measurement, and Reporting, Washington: The Brookings Institution.

Matusik, Sharon F and Charles W. L. Hill (1998). "The utilization of contingent work, knowledge creation, and competitive advantage", Academy of Management Review, Vol.23, Nº4, pp.680-697.

McAdam, Rodney and Sandra McCreedy (1999). "A critical review of knowledge management models", The Learning Organization, Bradford, Vol. 6, Iss. 3, p. 91-100.

McArthur, John and Jeffrey D. Sachs (2003). "The Growth Competitiveness Index: Measuring Technological Advancement and the Stages of Development", global Competitiveness Report 2001-2002, World Economic Forum, [Available at: http://www.weforum.org/].

Nonaka, Ikujiro and Hirotaka Takeuchi (1995). The knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, New York: Oxford University Press.

NSF - National Science Foundation (1973). Research and Development in Industry 1971. Washington, DC, US, Government Printing office, 19.

OECD (2003) Measuring The Information Economy, Paris [Available at: http://www.oecd.org/oecd/].

Reilly, Robert F. and Robert P. Schweihs (1999). Valuing Intnagible Assets, New York: McGraw-Hill.

Roos, Johan; Göran Roos; Nicola Carlo Dragonetti and Leif Edvinsson (1997). Intellectual Capital: Navigating the New Business Landscape, London: MacMillan Press.

Simão, José Veiga, Sérgio M. dos Santos e António de Almeida Costa (2002). Ensino Superior: Uma Visão para a próxima Década, Lisboa: Gradiva.

Smith, Keith (2000). "What is the knowledge economy? Knowledge-intensive industries and distributed knowledge bases", Innovation Policy in a Knowledge-Based Economy, European Commission, May.

Smith, Judith M. and Linda Webster (2000). "The knowledge economy and SMEs: a survey of skills requirements", Business Information Review, Vol.17, Nº3, September, pp.138-146.

Sullivan, Patrick H. (2000). Value-Driven Intellectual Capital – How to Convert Intangible Corporate Assets Into Market Value, New York: John Wiley & Sons.

Teece, David J. (1998): "Capturing Value from Knowledge Assets: The new economy, markets for know-how, and intangible assets", California Management Review, Vol.40, Nº3, pp.55-79.

Wasko, M. McLure and S. Faraj (2000). "It is what one does: why people participate and help others in electronic communities of practice", Journal of Strategic Information Systems, Nº9, pp.155-173.