CREATION OF INNOVATION THROUGH KNOWLEDGE MANAGEMENT

PROJECT REPORT

of

CIKM

Creation of Innovation through Knowledge Management

Report of the project

CIKM – Creation of Innovation through Knowledge Management

Authors: Ahmed Bounfour, Annette Leslie, Fiona Lettice, Mark Neumann, Norbert Jastroch

This project was funded by the European Commission's 5th Framework Programme for Research and Development in Europe under project no IST-2001-34442.

FOREWORD

The role of knowledge is increasingly seen by economists and strategists as the determining factor of successful innovation performance.

Large bodies of literature focus on how to strengthen knowledge flows between different actors to explore the potential of enhancing national innovation systems and hence the competitiveness of European companies. However the CIKM research team feel, from both practical research and literature, that Knowledge Management does not always meet the objectives and expectations of industry by providing a powerful tool to enhance innovation.

This mismatch of expectation may be due to the fact that many organisations have overemphasised the IT approach and underestimated the cultural side of Knowledge Management, i. e. the organisational issues, learning concepts, and behavioural elements of the people concerned.

Acknowledgements

We would like to acknowledge and thank the companies who took part in the CIKM study and provided valuable input to our research. Many were anonymous, but those who agreed to be named included:

Abbey National plc, Business Excellence Training, Commerzbank AG, Delphi Automotive GmbH, Deutsche Telekom AG, DoCoMo Communications Laboratories Europe GmbH, Dutton Engineering, Hella KG, Gebr. Heller Maschinenfabrik GmbH, Hewlett-Packard Company, Hummingbird Fulcrum Technologies GmbH, ISTAR, Le Banque de Development des PME, HypoVereinsbank AG, Rockwell Automation Ltd., SFR, Siemens AG, Software AG, T-Mobile International AG & Co. KG, Wittmann (U.K.) Ltd., WVC France Sebim.

We would like to thank the specialists in the fields of Innovation and Knowledge Management who shared their insights with us in the expert interviews of the project. Special thanks go to Professor Dosi, Dr. Hofer-Alfeis, Professor Tidd, Dr. Tovstiga, Dr. Trott and Professor Pawlowsky.

Table of Contents

1 EXECUTIVE SUMMARY....5
2 THE TEAM....6
3 THE PROJECT....7
4 CONCEPT OF KNOWLEDGE AND ITS DYNAMIC LINKAGE TO INNOVATION....9
5 PROJECT PERSPECTIVE AND RESEARCH MODEL....11
6 CASE STUDY PARTICIPANTS....12
7 KEY RESULTS – OVERVIEW OF FINDINGS....14
8 THEME 1: DRIVERS FOR INNOVATION....15
9 THEME 2: STRATEGY....16
10 THEME 3: OWNERSHIP OF INNOVATION ROLE....18
11 THEME 4: METRICS....19
12 THEME 5: KNOWLEDGE PROCESSES & KNOWLEDGE TYPES....20
13 THEME 6: CULTURE....21
14 KM PRACTICES USED IN EARLY PHASES OF THE INNOVATION PROCESS....23
15 INFORM. SOURCES USED IN EARLY PHASES OF THE INNOVATION PROCESS....26
16 INNOVATION OVERPERFORMERS....30
17 PECULARITIES OF THE DIFFERENT INDUSTRIES....31
18 KM RECOMMENDATIONS FOR THE THREE INDUSTRIAL SECTORS....32
18.1 Finance....32
18.2 Mechanical Engineering....34
18.3 Information & Communication Technologies (ICT)....36
REFERENCES....37

1 EXECUTIVE SUMMARY

The CIKM project was successfully completed on October 31st, 2003. During 20 months of project work, the interrelationship between Knowledge Management (KM) practice and Innovation in European companies has been analysed and empirically investigated.

A theoretical and practical foundation was laid by reviewing a broad range of literature on KM and Innovation, by conducting a series of expert interviews from academia and business in Europe, and case studies within the four industrial partners in the CIKM consortium. From that, a number of research questions on KM and Innovation interdepencies were derived, and a research model was built as the starting point for the subsequent empirical validation.

The empirical field study focused on the industrial sectors of ICT, Financial Services and Mechanical Engineering, and was conducted in France, Germany, Sweden and the UK. Two Focus Group workshops, in the UK and Germany, provided initial perspectives on KM and Innovation strategy and concepts in companies. An online survey - attracting 54 companies throughout Europe to respond, although requesting rather complex input - delivered valuable data upon KM and Innovation practice. Though **not claiming to be representative** or generalisable, statistical evaluation of this material rendered interesting **indicative results**. These were triangulated with findings from additional indepth investigation of KM and Innovation practice in 17 case study companies.

The CIKM field study findings basically correspond to state of the art in literature and expert opinions that there is no measurable direct interrelation between KM practices and Innovation Performance. However, there are a number of indicative interrelations between KM practices and the early stages of innovation which could be identified. These are summarised as follows and are based on the research conducted in 54 companies having responded to the questionnaire plus 25 companies participant to the case studies and focus group workshops:

- The ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities.
- Organisational, face-to-face, people and culture based KM practices - such as workspace layout and discussion forums to encourage increased communication between people involved in innovation activities - were found to be key elements fostering innovation in the early stages of the innovation process.
- Good practice companies employ technological KM practices (ICT tools) as an “enabler” to KM.
- Through cluster analysis, specialties have been identified for the different industries investigated, as well as those practices and sources that were used by innovation over-performers. Practices and information sources can be named in which the innovation over-performers are different compared to the under-performers across the whole sample of surveyed companies.
- The triangulation of data from the survey data, case studies and focus groups showed the importance of 6 themes:
    - Drivers of innovation
    - Strategy
    - Ownership of the innovation role
    - Metrics
    - Knowledge processes and knowledge types
    - Culture
- A number of recommendations for companies to introduce and practice KM are suggested, taking into account the specifics of the different industrial sectors.

2 THE TEAM

This report is the result of an 20 month research which ran from March 2002 to October 2003. The project team had representatives from eight organisations across four European countries:

Company	Country	Team Member
Cranfield University	United Kingdom	Annette Leslie Dr Fiona Lettice
Empolis GmbH	Germany	Sven Schoener Andreas Heger Ralph Traphoener Dr Carsten Tautz
Fraunhofer Institute		Mark Neumann Karin Auernhammer
Hoffmann	Germany	Jörg Roth Viviana Roth
MET	Germany	Norbert Jastroch Susanne Lehr
RCS	France	Dr Ahmed Bounfour
Skandia	Sweden	Scott Hawkins
Vodafone Pilotentwicklung GmbH	Germany	Torsten Herzberg Dr Christiane Hipp

Project Team Members, left to right: Karin Auernhammer, Ahmed Bounfour, Susanne Lehr, Mark Neumann, Jörg Roth, Norbert Jastroch, Viviana Roth, Fiona Lettice, Torsten Herzberg, Carsten Tautz, Annette Leslie

3 THE PROJECT

The increased demand for new ideas in the knowledge economy, brought about by shorter technology lifecycles as well as the increasing sophistication of customers, has increased the need for organisations to focus on innovation.

At the same time as calls for increased innovation have been made, so there has been an increasing interest in how to more effectively manage the knowledge that organisations have. Some key questions arise:

- How can new knowledge be created to support innovation?
- How can existing knowledge be re-used or applied in different contexts to support innovation?

Companies have been seeking answers to these questions and investing in tools and techniques to support them in the creation and re-use of knowledge within the innovation process.

The CIKM project set out to find out which knowledge management tools and practices were being used by companies and whether these could be seen to be having an impact on their innovation performance.

To focus the study – 3 industrial sectors were chosen:

- Financial Services
- Information and Communication Technology (ICT)
- Mechanical Engineering

The companies in the study came from four European countries:

- Germany
- United Kingdom
- France
- Sweden

Data was collected from the companies by questionnaire survey and by interviewing employees involved in the innovation process.

What is Innovation?

The simplest way to describe innovation is as the development of a new or improved product or service. This definition is often extended to distinguish innovation from invention. To truly be a successful innovation, the product or service must be brought successfully to market.

Within the CIKM study, we were interested in what knowledge management tools and practices companies used in the early phases of innovation. This meant that the focus was on knowledge management tools and practices that were being used to support:

- Generating ideas for new products and services
- Searching for future trends in technologies
- Understanding the needs of customers and exploring future market trends

What is Knowledge Management?

Knowledge management is the term used to describe how companies can ensure that they have in place effective processes, tools and practices to ensure that they can:

- Capture knowledge that is being generated within the company
- Find, assimilate and apply knowledge that does not already exist within the company, for example from suppliers and customers
- Understand who knows what and who can do what within and outside the company
- Share knowledge effectively between people and departments internal to the company

It is widely believed that the better knowledge can be managed in this way, the better the performance of the company will be against its competitors.

There is also a widely held belief that improved knowledge management will improve an organisation's innovative performance. This was one of the key assumptions that this CIKM study set out to investigate.

4 CONCEPT OF KNOWLEDGE AND ITS DYNAMIC LINKAGE TO INNOVATION

In order to make the linkages between knowledge management and innovation performance more explicit, the project team has **focused on** the **knowledge management practices** and the **information sources** of knowledge used by companies within the early phases of innovation.

The reason for including the information sources lies in the importance of a capability called absorptive capacity, which the consortium saw as increasingly important in its interviews and literature review: “The ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities. We label this capability a firm’s absorptive capacity and suggest that it is largely a function of the firm’s level of prior related knowledge”. (Cohen & Levinthal, p.128, 1990)

In Paul Trott’s work (1998), he describes this as a knowledge accumulation process – with four phases identified being adoption, application, acceptance and assimilation. The assimilation phase appears vital, enabling individual knowledge to be incorporated into the core routines of the business, thereby expanding the organisation’s learning capability.

The linking of the importance of prior relevant knowledge is key to the concept of absorptive capacity as we know ourselves there is an enormous difference between acquisition of knowledge, for example reading a publication, and the value to its usage, which comes about from the links and connections we make between our existing knowledge and the new knowledge.

Reflecting the importance of internal and external knowledge sources for absorptive capacity the following list of **information sources** for knowledge management was developed for the field study in this project:

- Industry
  - Competitors
  - Suppliers
  - User/customers
- Knowledge Providers
  - Universities and Research Organisations
  - Consultants
  - Professional information services
  - Exhibitions/Fairs
- IT
  - Internet/Intranet
  - Patent databases
- Network
  - Informal internal communication/other departments in the company
  - Short-term and long-term partnerships
  - Internal and external personal network

Knowledge Management practices are those practices which can be implemented and applied by companies to help find, structure, store and distribute knowledge within the innovation process.

The provided list of KM practices is derived from interviews with industry partners and scanning of KM literature; it was used and reflected in the Focus Group workshops, the questionnaire and the Case Study interviews.

Two main categories were established:

Organisational, face-to-face, people and culture based practices – such as workspace layout and discussion forums to encourage increased communication between people involved in innovation activities. In detail:

- Face-to-face/People:
    - Work space layout
    - Job rotation
    - Cross functional project teams
    - Communities of practice
    - Discussion forums
    - Idea workshops
    - Lessons learned sessions
    - Internal project presentations
    - Training and qualification management
    - Knowledge exchange incentive schemes
    - Yellow pages
    - Free time for scanning
    - Knowledge dissemination agents (gate keepers, boundary spanners), Knowledge facilitators
- Culture:
    - Open doors culture
    - Knowledge friendly workspace layout
    - Incentive system for knowledge sharing

Technological, IT-related practices – such as shared files and databases to store and structure knowledge and make it easily accessible to others. In detail:

- Shared files and folders
- Shared calendars
- Best practice data bases
- Knowledge maps
- Knowledge repositories
- Searching tools

Many of these practices and information sources quoted in this report are illustrated in the report with supporting data from the case studies, questionnaire survey and focus groups that were conducted during the project.

The diagram below in figure 1 depicts the relationship enivsaged by the CIKM team between trend detection and idea creation from those knowledge management practices and information sources.

5 PROJECT PERSPECTIVE AND RESEARCH MODEL

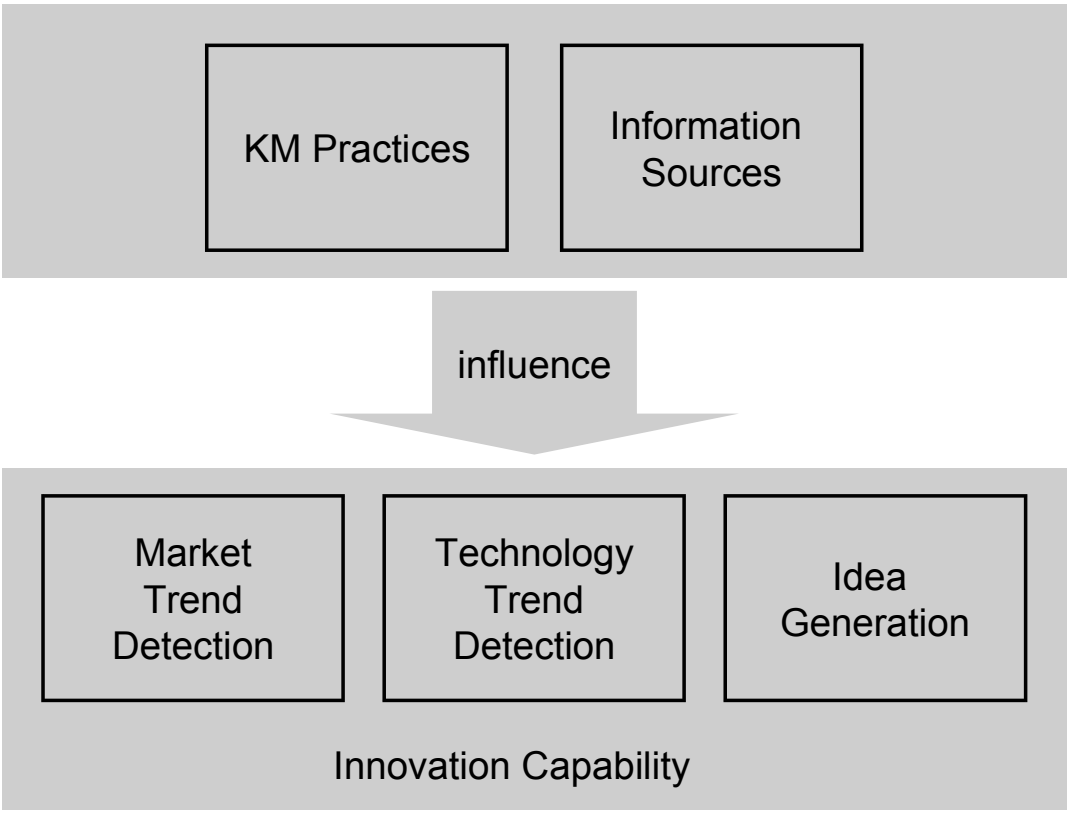


Fig. 1 Envisaged relationships in the project

The CIKM project complements existing work and elaborates on the following issues:

- To explore the contextual factors for Knowledge Management and Innovation Performance
- To evaluate the effectiveness of different knowledge management practices and information sources
- To appraise the concept of absorptive capacity as a means of a company's ability to use knowledge for innovation
- To investigate innovation 'high performers' in terms of their knowledge generation, dissemination and use
- To derive recommendations for enhancing the competitiveness of European organisations in the sectors of Finance, Mechanical Engineering and ICT.

The following model outlines the main areas for investigation and builds the basis for the derivation of the research questions (The grey shaded elements were used for the investigation). The model was strongly driven by the need for an 'artificial' separation of Knowledge Management (KM) and Innovation Management (IM) in order to examine the relationship between KM and IM. To consider IM and KM in relation to different situational and contextual factors the research focuses on four 'contingency' factors, being company size and maturity, the competitive pressure of the market and the cultural environment.

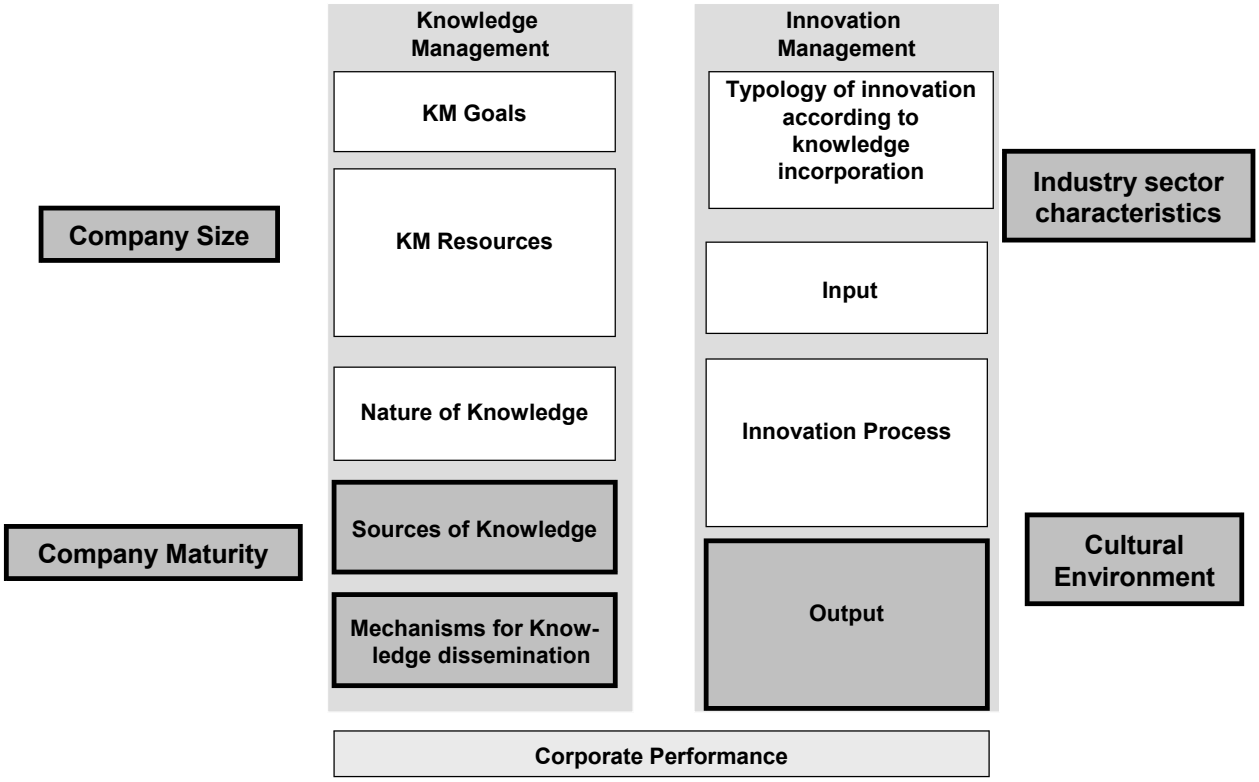


Fig. 2 Research Model from which research questions were derived

6 CASE STUDY PARTICIPANTS

Range of Industries:

The responses to the initial questionnaire were unified across industries and company staff sizes. 29.6 % of the respondents are from the mechanical engineering industry, 25.9 % from the finance industry and 44.4 % from the ICT industry. Within each industry, different sectors participated:

- Within the ICT industry the respondents almost equally came from the software-, service- and consulting sectors.
- Within the finance industry 42 % were insurance companies, followed by 25 % each banking and funds management organizations.
- Within the mechanical industry 50 % were manufacturer of automotive products, 36 % of machinery and equipement and 14 % of electrical and optical equipment.

Company and staff size:

Regarding company staff sizes 38,5% of the respondents were SME's, 38,5% from enterprises with between 251 and 5000 employees and 23,1% from companies with more than 5.000 staff. The following table shows the distribution in a crosstable of industries and staff size.

STAFF SIZE	ICT	FINANCE	MECHANICAL
Below 20	16.7 %	7.8 %	-
21 – 100	20.8 %	23.1 %	26.7 %
101-250	4.2 %	7.7 %	6.7 %
251-1000	16.7 %	23.1 %	33.3 %
100 – 5000	20.8 %	15.4 %	6.7 %
Over 5000	20.8 %	23.1 %	26.7 %

Tab. 1: Crosstable of company staff sizes and industry

Within 72% of the responding organisations, up to 25% of the staff are directly involved in the early phases of the innovation process.

Innovation Performance criteria:

As performance output criteria, four variables were included in the survey:

- Number of new products developed,
- Time-to market,
- Innovation performance compared with competitors
- Percentage of turnover generated with new products. The following table shows an indication about the number of new products in the three industries

NUMBER OF NEW PRODUCTS	Industry		
	ICT	FINANCE	MECHANICAL
0 to 20	64,7 %	72,7 %	64,3 %
21 to 100	17,6 %	9,1 %	28,6 %
101 to 500	5,9 %	9,1 %	7,1 %
over 500	11,8 %	9,1 %	0,0 %

Tab. 2 Crosstable of new product categories and industry

Regarding their time-to-market compared with competitors, 32% of the respondents see themselves as average, 32% as faster and 25% as very fast. Only 11% see themselves slower .

7 KEY RESULTS – OVERVIEW OF FINDINGS

This section presents the findings from the analysis of the data from the three sources. Considering these findings it has to be borne in mind that the study underlied some limitations of the three research instruments that were used: So the survey provides quantitative data however the structured questions miss more informative data. The focus group sessions provided rich and qualitative data, but the data could only be collected from a limited number of companies. Finally the case studies provided very rich and qualitative data, enabling the research team to get a very deep understanding of the innovation and KM process. Hence the results are based on a triangulation process between the results of these three research instruments. While the results cannot be said to be generalisable beyond the research sample (due to the relatively limited data set), they deliver valuable explorative insights in the issue.

Because a variety of company sizes and maturity were present in the sample, it is reasonable to assume that the results will be generally applicable to companies in the financial services, mechanical engineering and ICT sectors. The strong cluster result revealed in the statistical analyses of the survey data suggests that the findings are typical to a particular sector, so the results could not be easily translated to other industry sectors. This does not mean that other industry sectors would not benefit from learning about the CIKM project findings, but they should carefully consider the results in the context of their particular sector.

The project results revealed six themes:

Drives for innovation – Companies see different drivers for their innovation (->Page 14).

Strategy – Participants of the study do not see an explicit knowledge management strategy within their organization. (->Page 15)

Ownership of innovation role – Innovation as an information-creation process arises out of social interaction. (->Page 17)

Metrics – Barrier to creativity and innovation or simply too complex? (->Page 18)

Knowledge processes & Knowledge types – Diversity of tools and techniques. (->Page 19)

Culture – In general seen as an integral success factor for the creation of knowledge and innovation. (->Page 20)

8 THEME 1: DRIVERS FOR INNOVATION

Drivers for innovation as indicated by the participants of the study included:

- Customers
- Market
- Application
- Technology
- Competition
- Supply Chain in which the companies belonged.

The drivers identified by the companies address market positions and technological paths but appear not to focus on the third of Teece & Pisano's framework organisational processes (1994). Rothwell's (1977) five generations of innovation models describes the fifth generation as having systems integration, extensive networking, flexible and customised response, working on continuous innovation. We might see that many of our participants appear to be missing this 5th generation perhaps by only focusing on the market and technological issues rather than including the organisational processes necessary.

The survey data stated that a percentage of companies from each sector saw themselves as more innovative than their competitors:

- ICT 45.8%
- Financial 21.4%
- Mechanical Engineering 43.8%

However the reverse of this finding and a starting point for analysis and commentary might be to point out that in each of the above sectors, the organisations saw more than 50% of their competitors as being more innovative than themselves with the financial sector in particular worryingly seeing itself as trailing its competitors – the questions why and how spring to mind.

Whilst many of the organisations saw themselves as proactive, they were really being driven to innovate by their customers or the marketplace in general (i.e. reactive). Only a handful of companies identified their innovation work as being driven by the need to develop solutions/applications to issues that might not yet have been identified by the marketplace. One case study company, trying to be proactive, stated, 'our main goal is to exceed the range of customers beyond the auto industry and offer integrated parts in connection with a related plastic body'. A second case study organisation who are seen as proactive spoke of using new technology to create advantage. 'We take technology coming down the line and do our best to make it do something for us as a company'.

Reactive behaviour may lead to the companies creating less value for themselves or their position in the supply chain. In contrast, the companies focusing on solution drivers may find their innovations able to generate more potential and a clearer differential between them and their competitors.

Also this may position only two or three of those interviewed in the category of radical innovators as opposed to the majority who seem to be interested in incremental innovation. The majority might seem a little too focused on the present, whilst their market (and their clients) could potentially be taken away by a more radical innovation.

From the data, there appears a clear difference between companies who stated drivers in general to be their competitors, clients and the market, and those who specifically had in place a strategy for working with their customers. A typical quote from one case study is 'our company works extremely closely together with the development teams of the customers from the earliest idea'.

9 THEME 2: STRATEGY

Strategy is often seen as being a plan or a navigational route map of the future innovation tasks in terms of content and process. However Mintzberg (1998) suggests that strategies are to organisations 'what blinkers are to horses; they keep them going in a straight line but hardly encourage peripheral vision'. He concludes that the presence and/or deliberate absence of strategies may be vital to an organisations' well being. Does the lack of a knowledge management strategy in so many companies enable 360 degree vision of sources and practices available to their innovation work or are these very early days in terms of route planning? Tidd, Bessant and Pavitt (1997) propose that "an essential feature of corporate strategy should be an innovation strategy, the purpose of which is deliberately to accumulate firm-specific knowledge."

Portfolio Management (Cooper et al, 2001) is a relatively new term to innovation, implying that organisations can make strategic decisions about which innovations to push as a market leader, and which might offer the better return as a 'me too' follower. This detail of planning can enable a balance of financial investment, risk, and resources to be managed for both the short and longer term view; potentially giving the organisation the opportunity to also balance incremental and radical innovation work into the portfolio plan.

Knowledge management strategy:

Participants do not see an explicit knowledge management strategy within their organisation. They felt that a KM strategy was not visible, either it was missing or implicit only. Views put forward by Nonaka & Takeuchi (1995) would appear to flag this lack of visible strategy as a topic for concern. They comment that "from the viewpoint of organisational knowledge creation, the essence of strategy lies in developing the organisational capability to acquire, create, accumulate and exploit knowledge. The most critical element of corporate strategy is to conceptualise a vision about what kind of knowledge should be developed and to operationalise it into a management system for implementation". Additionally, Vera & Crossan (2003) propose that "when a firm's learning/knowledge strategy matches its business strategy, the impact of knowledge and learning is positive. If this match is not achieved, knowledge and learning may have no impact or even have a negative impact on performance".

- 'Links between KM practices used at the bottom of the organisation to corporate strategy developed at the top were not directly visible'
- 'Explicit km strategy is missing',
- 'Our company is considered not to have a KM strategy although several practices are carried out under a KM umbrella, KM is not seen as a priority'

Fig. 3: Case Study Data stating that no explicit KM strategy is in place within the organisations

Two organisations saw there to be no need for a strategy, relying instead on their experienced staff. The first company reported 'we don't have an explicit or formalised strategy in place, we are a company who capitalise on the knowledge of its employees, many of them are long term experienced specialists who bear considerable knowledge gained from experience.' The second company stated that considering a strategy would be contradictory to their innovation approach: 'The assumption that knowledge management contributes towards the creation of innovation is contradictory. We see knowledge management mainly as being the reuse of knowledge and innovation needing new perspectives and approaches.'

Innovation Portfolio Management

Several of the companies interviewed saw the need to balance their innovation effort, in terms of resources, risk and effort, between being first to market with being a quick second.

However for some organisations deciding which innovation ideas to pursue is a purely subjective decision, sometimes based on customer interaction.

Innovation management in that sense turns out to originate to lesser extent from initiatives of corporate staff units in companies, but to larger extent from the operative business unit management. In the latter case, business managers develop the knowledge strategy according to their business goals and then derive the knowledge management strategy, concept, and implementation.

- 'Enjoyed being first to market but realised they had to take balanced portfolio view to create some new product and also quick off the mark as a 'me too''
- 'Innovation needs a balance with a level of 'me too''
- 'Management decide whether they want to be a innovation leader and command the premiums of innovative products, albeit for a short duration, or do they want to be fast followers'
- 'Declaring ourselves as innovative or to have a deliberate strategy of being a follower i.e. 2nd in the marketplace'
- 'We see ourselves as a company who take up innovative developments and push them into markets; therefore we are slower than our competitors'.
- 'We split our time in these early stages between 30% basic research, 30% prototyping and 30% internal mandates.'

Fig. 4: Case Study Data describing various approaches to creating an Innovation Portfolio

Issues of Scale

For the SMEs in our data sample the specific issue of scale of problem and appropriate scale of response was a significant factor and was raised several times, whilst this issue was not mentioned by the larger companies. These concerns have implications on the time and investment on knowledge management practices and sources that will be available to their company.

- 'We don't know where to start, it's too big, what small steps could we take?'
- 'SME's are overawed by knowledge management, and the size of potential change'
- 'To SME's KM means buying a computer and doing things a bit quicker'
- 'Knowledge needs to be available on devices that would be used on the engineering workshop floor, not just PC screens'
- 'The future is hard to envisage for SME mentality'
- 'Whilst as an SME time is very precious, organisational slack needs to be created for innovation'
- 'As an SME personnel resources are tight, this limits the capacity to absorb knowledge from external sources'

Fig. 5: Case Study Data detailing issues of scale of problem and appropriate scale of response

10 THEME 3: OWNERSHIP OF INNOVATION ROLE

Survey data illustrates a wide range of sources and practices currently used during the early stages of innovation. The diagram below indicates the potential range of people within an organisation needing access to knowledge in order to innovate, yet how many of these roles have access to the practices and sources necessary to emulate best practice behaviours. Rothwell's (1977) five generations of innovation models, illustrates in the 5th generation that the organisation is integrated, networked and flexible in order to achieve continuous innovation. Tidd et al (1997) support this viewpoint stating "that the continuous transfer of knowledge and information across functional and divisional boundaries is essential for successful innovation"

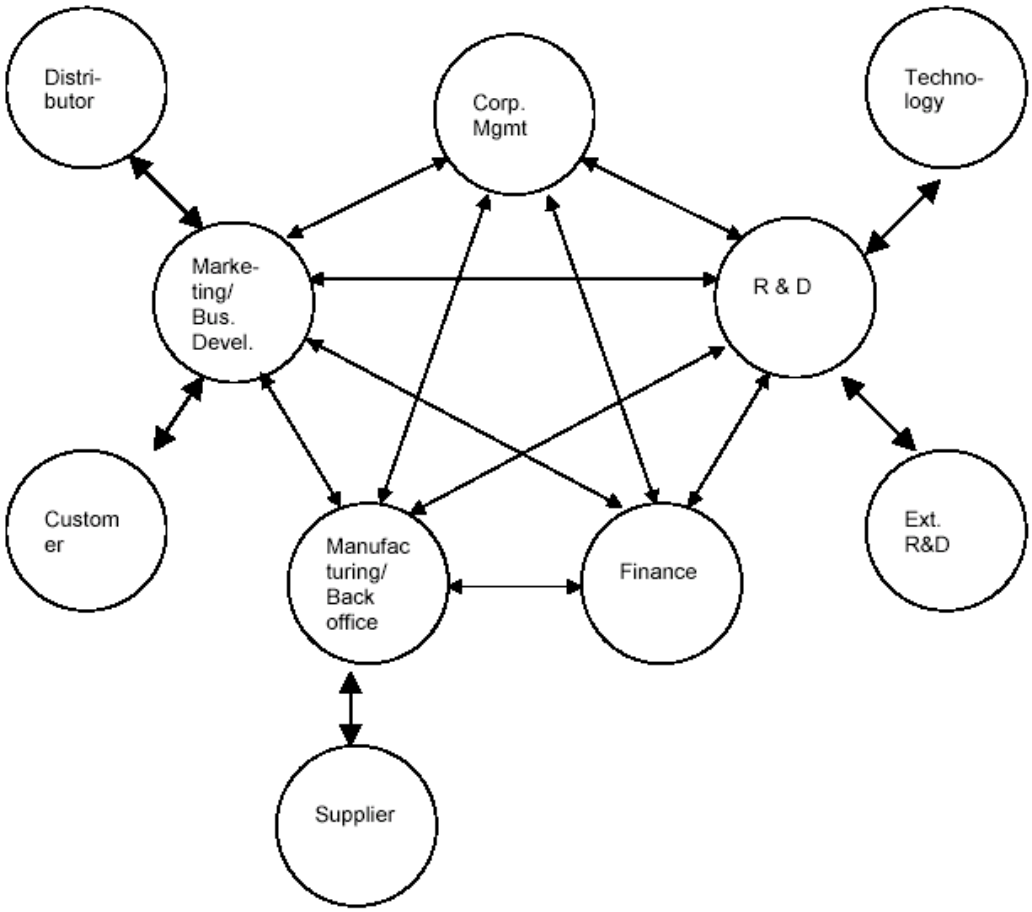


Fig. 6 Extended Enterprise

The mention of cross functional, interdisciplinary groups, networks, and communities of practice indicate the importance given to boundary spanning within organisations. These practices link in closely with the definition of absorptive capacity 'the ability of a firm to recognise the value of new, external information, assimilate it and apply it to commercial ends is critical to its innovative cabilities' (Cohen & Levinthal, 1990). Opposing views were seen from the case study companies in terms of ownership of the innovation role. One company saw the role clearly with R&D 'our R&D team take responsibility'. Whilst a second company saw innovation as everyone's role commenting 'the worst thing we can have is an R&D

department because everyone leaves innovation to them'. Mixed views were held on the value of Marketing input, one organisation saw their input as vital 'R&D working closely with Marketing who represent our commercial teams'. Whilst another case study company commented that 'Marketing have no idea of customer requirements, and create a mismatch of expectations and offerings'

Innovation as an information-creation process arises out of social interaction. This introduces a tension between the need for diversity, on the one hand in order to generate novel linkages and associations, and the need for commonality, on the other, to facilitate effective internal communications (Trott, 1998). Highly innovative companies appear to employ organisational practices that facilitate the innovation process, namely flexible structures, characterised by the absence of formality and hierarchy, and avoiding long chains of command, rigid work methods, strict task differentiation, extensive procedures and a well defined hierarchy.

11 THEME 4: METRICS

There was a genuine interest in this topic coupled with a healthy scepticism as to whether a measurement of the interrelationship between knowledge management and innovation performance could be achieved, in what timeframe and potential value.

The expert interviews and literature review completed in an early phase of this project indicated the following views on performance measurement:

- There are no universal metrics
- More specifically any development of metrics needs to be related to the organisations business context
- Metrics would need to have both strategic and tactical goals
- Performance is path dependent, and therefore has to be related to the organisation's contingency factors
- Some authors feel that Innovation and Knowledge Management cannot be measured
- Many authors ignore the topic of measurement
- There is a lack of connection between Innovation Management purpose and measurement
- Is measurement appropriate outside the production environment – what if any is the correct answer
- If to measure then perhaps process measures are better as they are indicative of behaviour.

Fig. 7: Viewpoints from Literature and Expert Interviews on the topic of Performance Measurement when interrelated with Knowledge Management

Within the case studies, one organisation saw measurement as a barrier to creativity and innovation. 'We carry out no efficiency or effectiveness measurement in the early phases of the innovation process, as the process is seen as a series of tasks that demand creativity and should be protected from any constraints like product costs or return potentials.'

None of the companies interviewed explained an official measurement system to measure innovation performance.

- 'how do you measure it'
- 'we use no official metrics'
- 'no metrics established for innovation performance'
- 'there are no official metrics for KM established within this company'
- 'we have no measurement tools for effectiveness that I am aware of'.

Fig. 8: Case Study Data explaining their position on measurement of innovation performance

However several companies explained that they had their own organisational approach to gauging innovation performance including the order book, high customer retention rate, comparison with competitors annual accounts, ROI, keeping customers happy, turnover, revenues, margins, product age, ratio of innovative projects and projects in total, time to market, ability to change, efficiency aspects, KM included in performance review.
'I'd measure the effectiveness by asking whether it actually makes a difference to our business, do they pay us for it'.

Companies tend to avoid simply collecting data, and use measures to drive improvement instead. Part of this usage involves understanding that there is no such thing as an absolute score (Tidd, 1997). Case studies and focus group findings support that it is business practice in innovative companies to develop a number of indicators that give some underpinning to otherwise judgments about the firm's innovative performance.

Pawlowsky stated in an expert interview with the CIKM team that all standardized approaches to establish metric systems did not succeed in practice, …, the challenge is to identify and measure work-around objectives instead of generic ones.

12 THEME 5: KNOWLEDGE PROCESSES & KNOWLEDGE TYPES

Knowledge processes include the practices and sources the company makes available to access data for innovation. The data will need to be sourced from both internal and external sources and the practices used need to be accessed by all involved in innovation within the organisation.

The survey data is supported by the qualitative data in detailing the enormous amount of knowledge needed for innovation that is not typically IT focused. Other important focuses of practices and sources include Face to Face/People, Culture, Industry, Knowledge Providers, and Network. The diagram below shows the different tools and techniques, other than those IT enabled, used by our data sample of companies to facilitate KM within their early innovation processes.

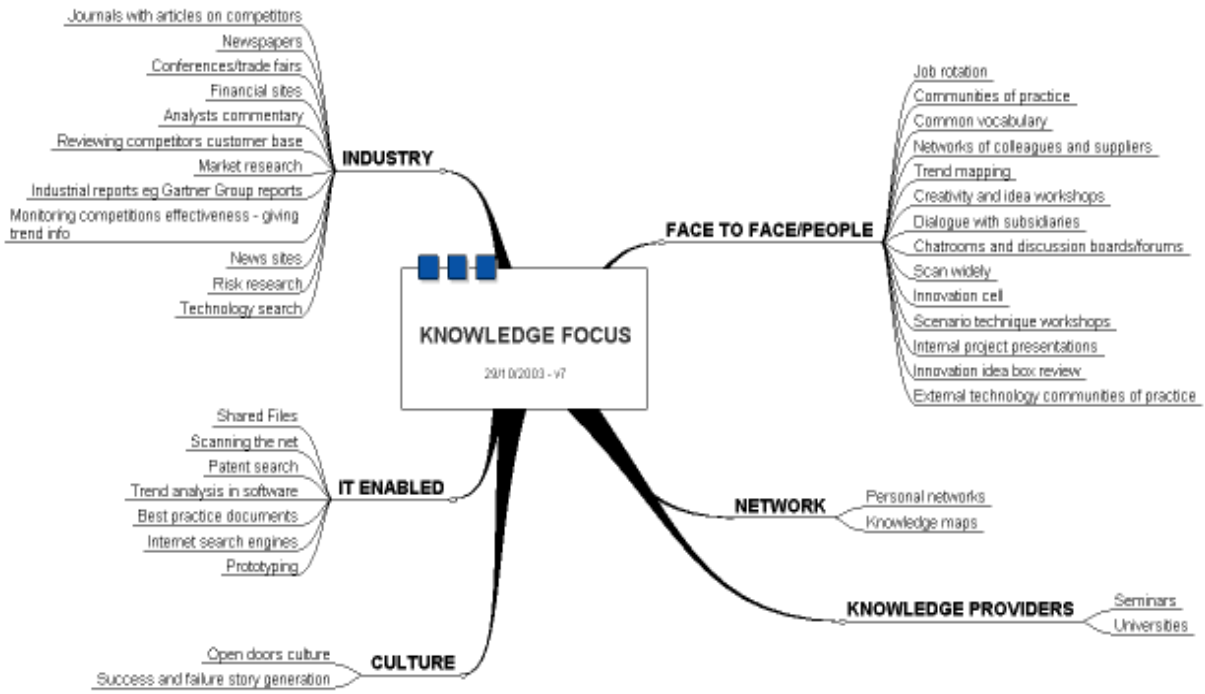


Fig. 9: Different Tools and Techniques used by Data Sample of companies to facilitate KM within their early innovation processes.

Knowledge Types:
The types of knowledge needed include both explicit (coded data, therefore available to all) and tacit (non-coded data, therefore passed from person to person individually). Knowledge gaps that are identified will enable the organisation to rectify the situation.

From case study interviews it appears that not too much awareness exists with regard to the relevance of organizational knowledge, i.e. systemic knowledge that is embedded in processes. Due to its rather non-observable nature, that kind of knowledge is hard to make explicit and to transfer (Teece, 2001). Innovative companies seem to put more focus on practices set out for the acquisition of organizational knowledge by utilizing external information sources like monitoring competition, networking with research institutions and the like.

Considering these were interviews conducted specifically around the topic of KM and Innovation. The vocabulary that literature typically uses i.e. tacit and explicit was not used. Additionally relatively little mention throughout the interviews was made of the need to code knowledge into IT systems to provide a knowledge source.

The Financial sector in particular seems to be having serious issues with 'brain drain' where employees are leaving and their knowledge is leaving with them. Also identified in this sector are issues of organisational structure/stability and culture, so perhaps the view of 'knowledge is power' is still within the industry.

Considering the survey data it becomes evident that a large number of practices and sources have been identified as being used. Frequent and particular reference was made to tacit knowledge. A case study company from the financial sector specifically commented on concerns relating to tacit knowledge, seeing it as 'knowledge locked in heads', and that their concerns now focus on 'the risk of loosing a key person in the businesses. A second case study organisation from this financial industry confirmed that 'brain drain' is a key issue 'employees have been stopped from early retirement unless they have shared their knowledge'. One mechanical engineering case study company spoke of the tacit knowledge being extremely specific and individually held. 'We require very specific knowledge, if only we could share the in-the-head-stuff as specialists bear considerable knowledge gained from experience'. The comments from the Mechanical Engineering and Financial sectors imply perhaps that the ICT sector has a better capability to encode tacit to explicit by taking advantage of its knowledge of technological tools.

When knowledge was made explicit the sharing potential was reported by various case study companies. One organisation in the financial sector spoke of 'making knowledge the most shared as possible'. A case study interview from the ICT sector describes 'developing the existing intranet to become a knowledge platform'. A second case study ICT company commented on the 'improvements gained from sharing the knowledge base across the company'

Many knowledge gaps were mentioned during the case study interviews. A financial sector company revealed 'we have a lack of understanding of the value of knowledge both in heads and books' and described finding the relevant knowledge within the organisation as 'like finding a needle in a haystack'. A case study interview within the mechanical engineering industry reports that 'we don't learn from our current projects and our library of material'.

13 THEME 6: CULTURE

Organisational culture and worker motivation can move a company towards a collective cognition, a shared set of beliefs which individuals buy into, and establish a set of routines of the way things are done in that company. Senge (1990) describes the building of a shared vision 'binding people together around a common identity and sense of destiny'. Interestingly,

during the interviews, several mentions of culture were recorded leading us to suggest that deliberate development of a corporate culture promoting the acquisition, sharing, re-use and storing of knowledge would appear to be a valuable activity to build into the company strategy.

Culture is in general seen an integral success factor for the creation of knowledge and innovation (Weggemann, 1999).Case study companies considering themselves as innovative appear to pay more attention to the establishment and maintenance of appropriate corporate culture than others. Networking, communities of practice, formal programs for the development of employees were mentioned - in particular by large organisations - as elements which support the diffusion of key cultural corner stones from the top of the company to the middle and lower levels. SME type organisations in this respect turn out to rely more on implicit diffusion through daily work practice and direct communication between the different organizational levels.

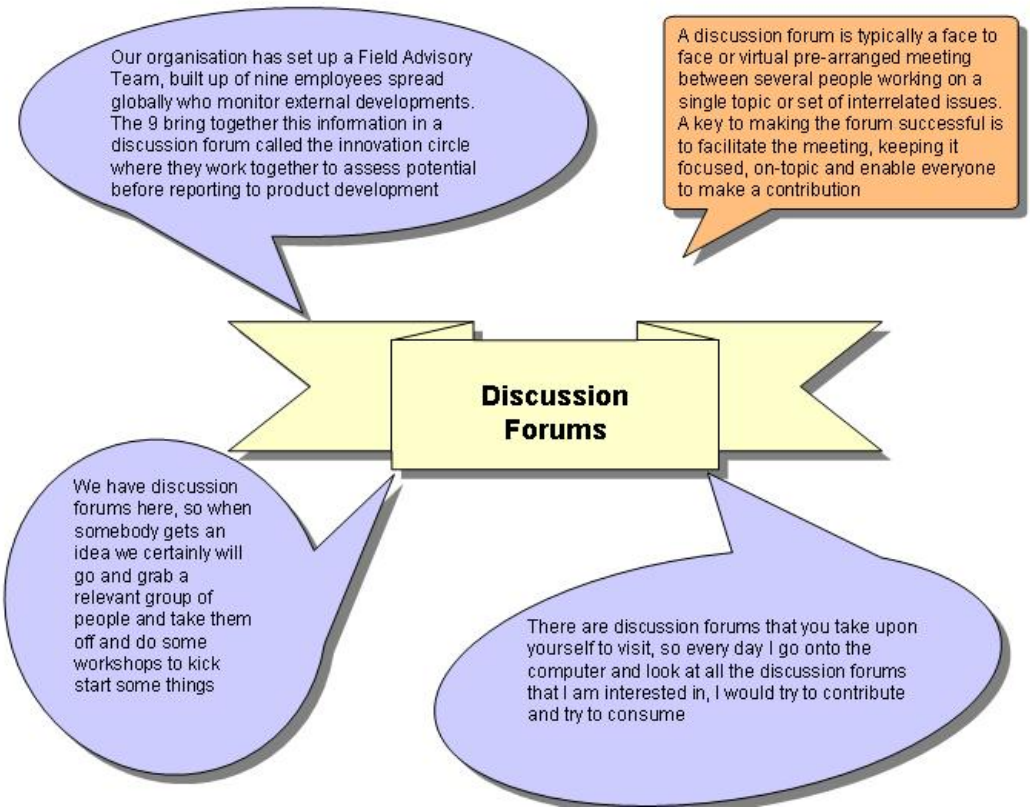
- 'Knowledge sharing and collaboration are elements of the corporate culture'
- 'Its part of the culture to participate in the communities of practice, they do it because they see so much value coming out of them'
- 'We are trying to engrain the culture; sharing knowledge should be similar to breathing'
- 'Our culture is that we use electronic mail incredibly heavily to kick something off, we recruit people from electronic interest lists to become interested'
- 'Ideas are fed into the intranet by our staff and if they go through they get a cash reward of up to 20K sterling'
- 'We encourage knowledge stealing – by using success stories we indicate our approval of certain behaviours'
- 'Appropriate corporate culture was considered key
- 'Culture should create expectations of behaviours i.e. when a project is finished a lessons learned project must be written, without it the project should not be considered finished'
- 'Main barriers mentioned in our organisation are the lack of a knowledge sharing culture'

Fig. 10: Comments from Case Study Companies on Organisational Culture

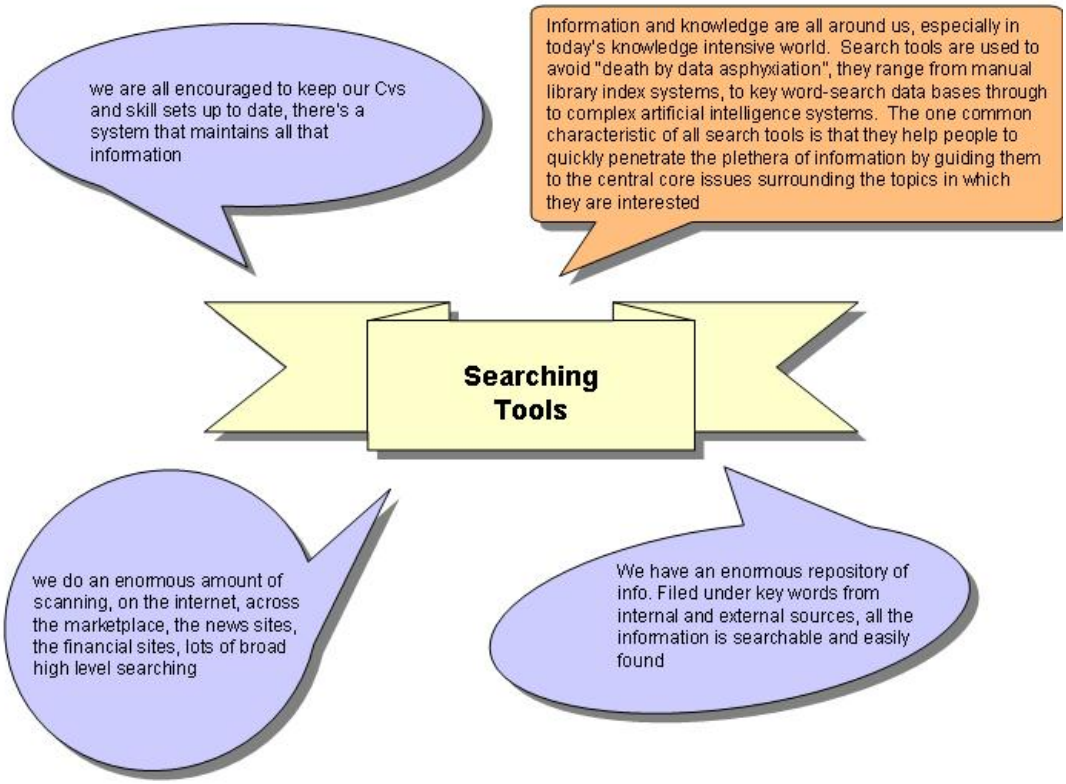
14 KM PRACTICES USED IN EARLY PHASES OF THE INNOVATION PROCESS

For a set of 21 **knowledge management practices** that could be used in the early phases of the innovation process the frequency of use was asked. Most used practices for demand and trend detection are listed below (in descending sequence) and are illustrated with statements that were given in the focus group sessions with regard to those practices:

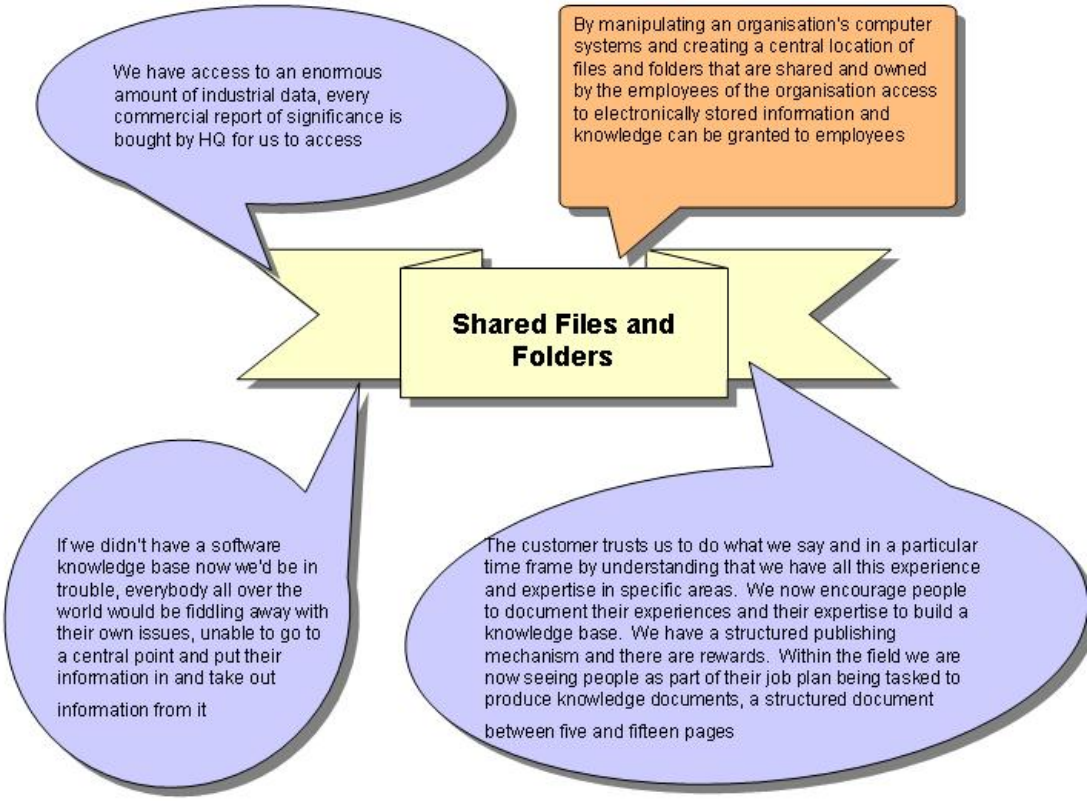
- Discussion forums



- Searching tools



- Shared files and folders

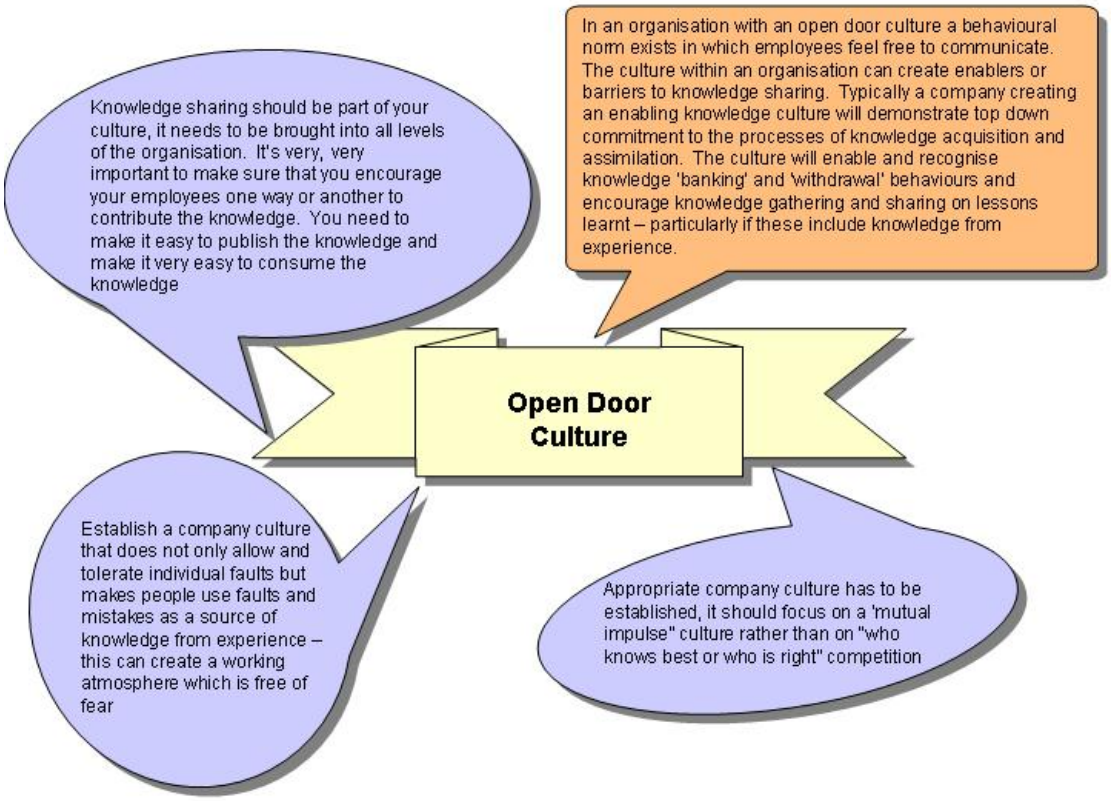


- Cross functional teams

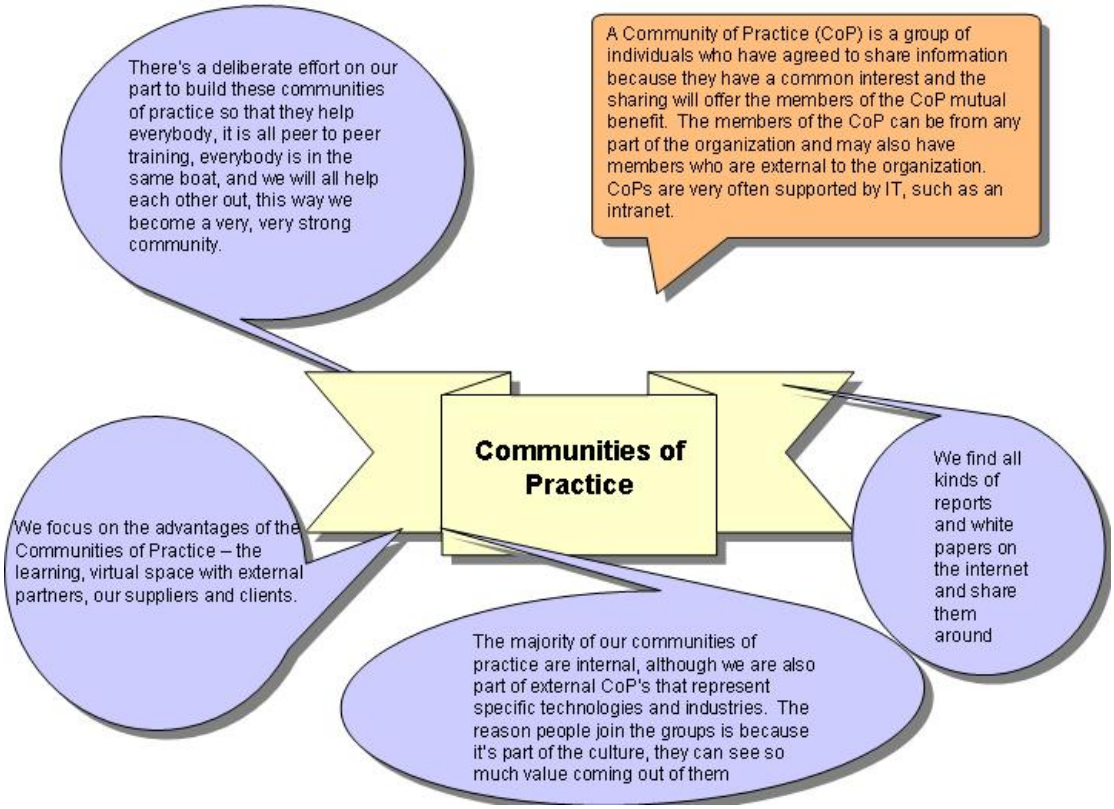
- Internal project presentation
- Internal training

For the phase of idea creation the most used practices are (in descending sequence):

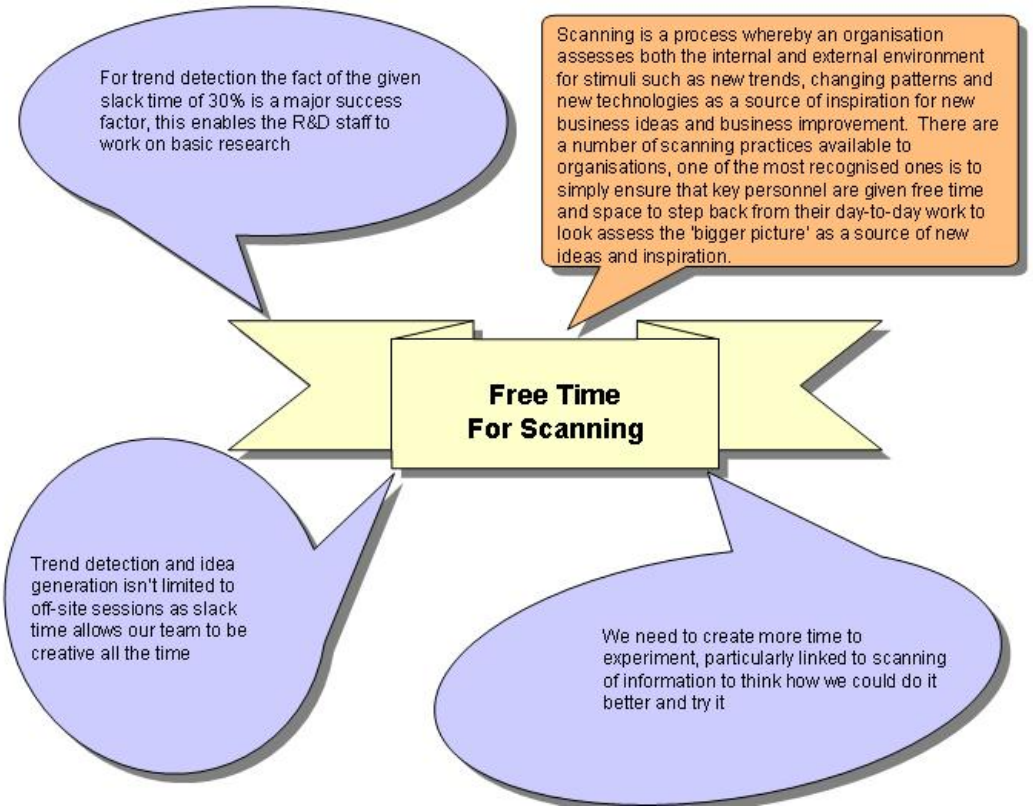
- Open door culture



- Cross functional teams/Communities of practice



- Shared files and folders
- Free time for scanning

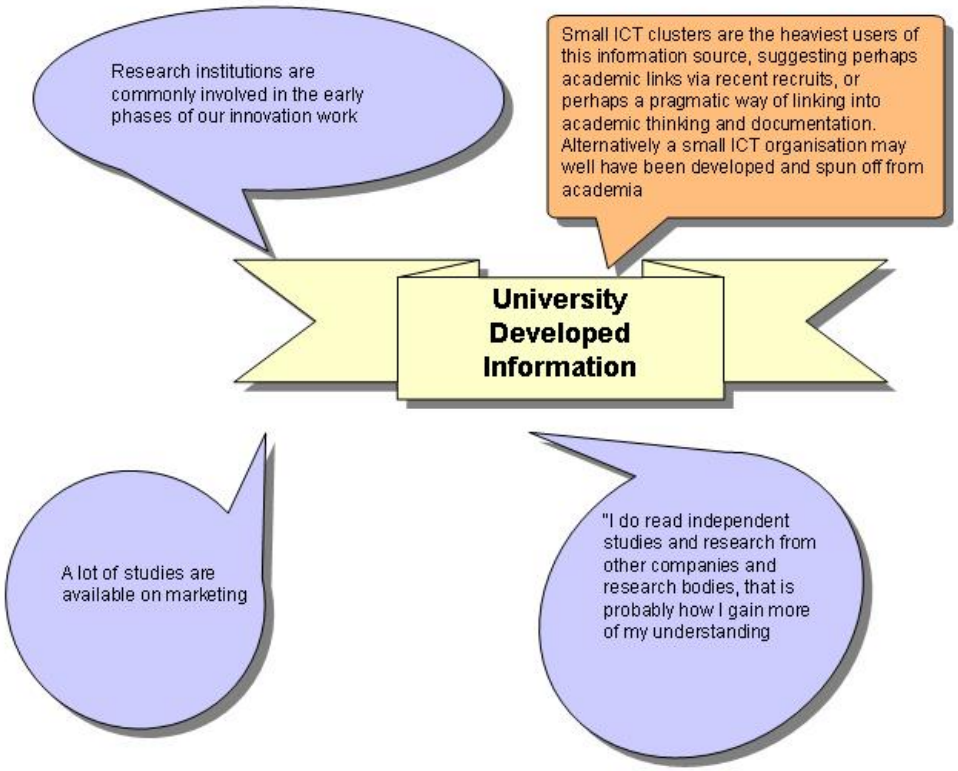


- Idea workshops
- Knowledge friendly workspace layout
- Searching tools
- Internal project presentations

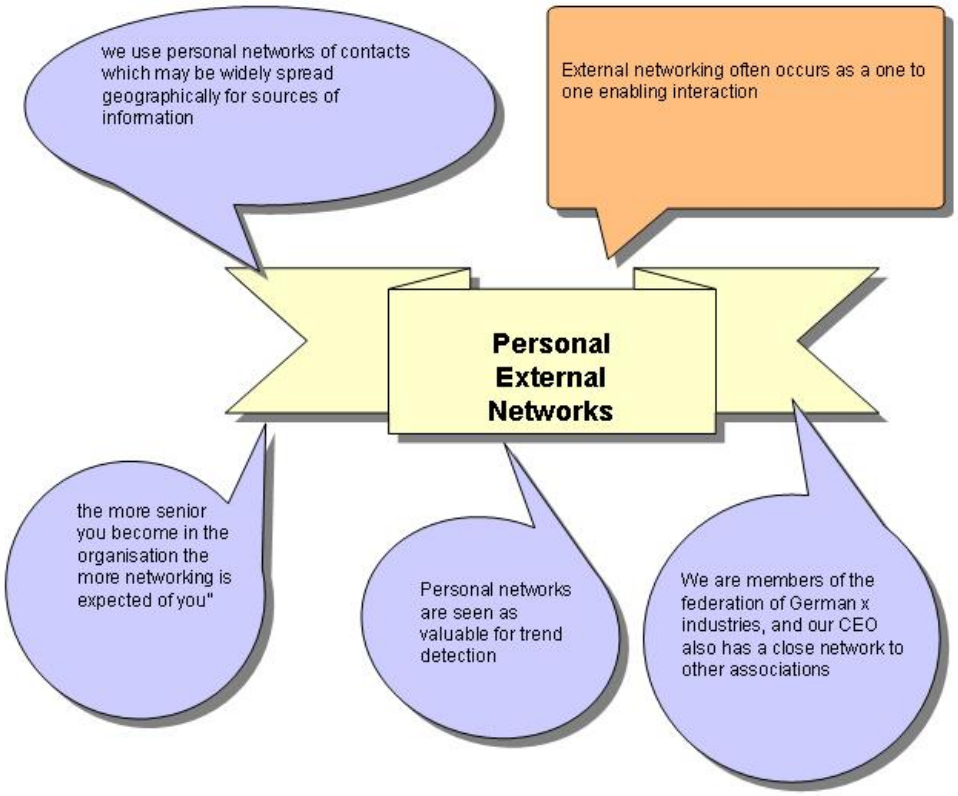
15 INFORM. SOURCES USED IN EARLY PHASES OF THE INNOVATION PROCESS

The frequency of use was also asked for a set of 18 **information sources** that could be used in the early phases of the innovation process. Most used information sources for demand and trend detection are (in descending sequence) and are illustrated with statements that were given in the focus group sessions with regard to those information sources:

- Personal networks (company wide)
- Internet
- Universities/research institutions



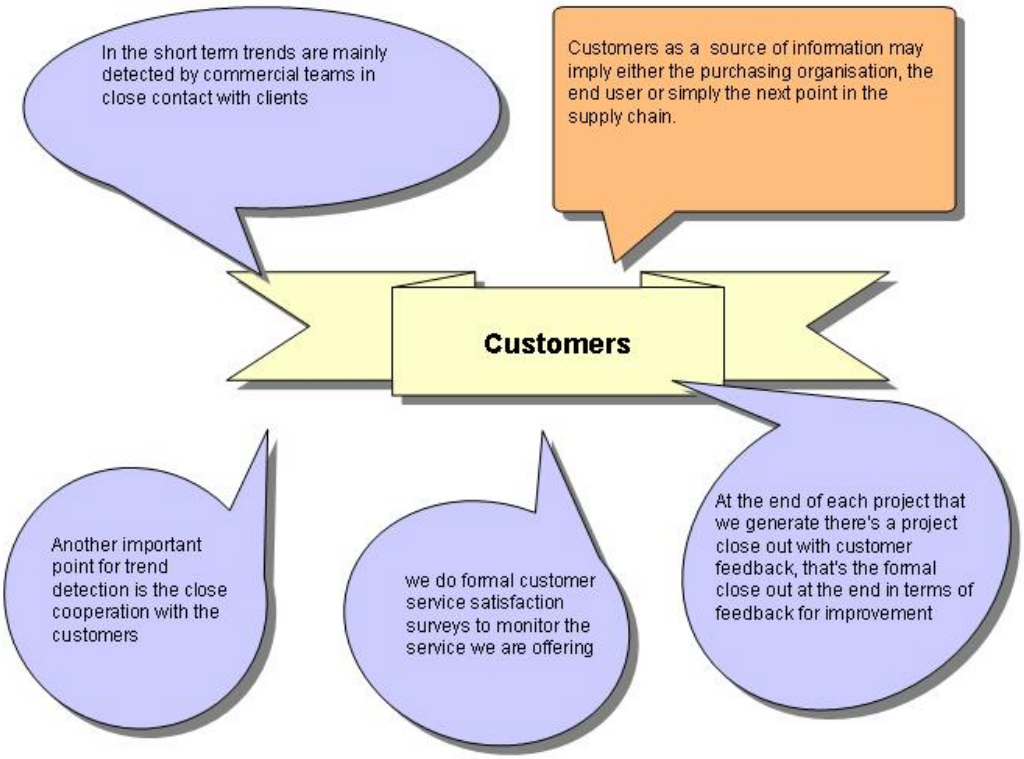
- Personal networks (external)



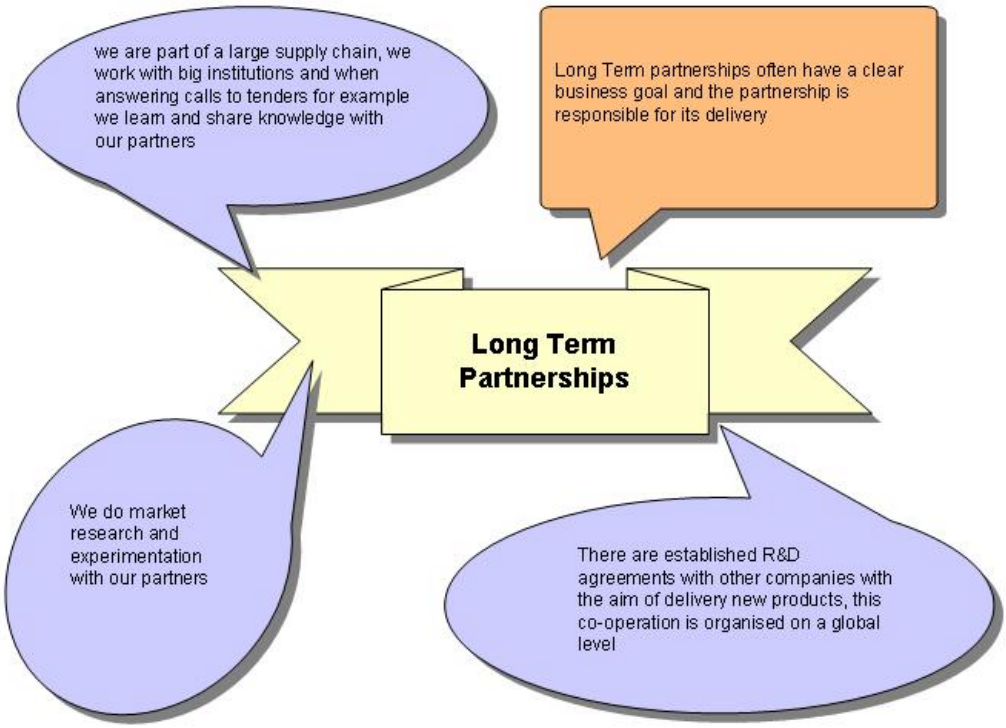
- Informal internal communication

Most used information sources for idea creation are (in descending sequence):

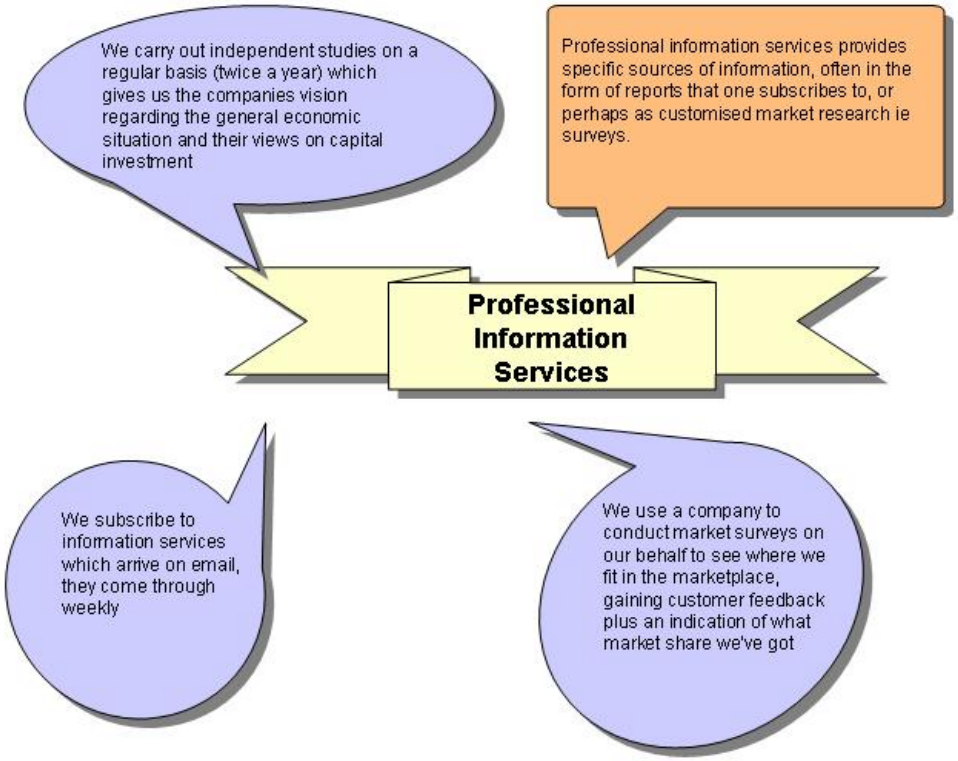
- Personal networks (company wide)
- Personal networks (external)



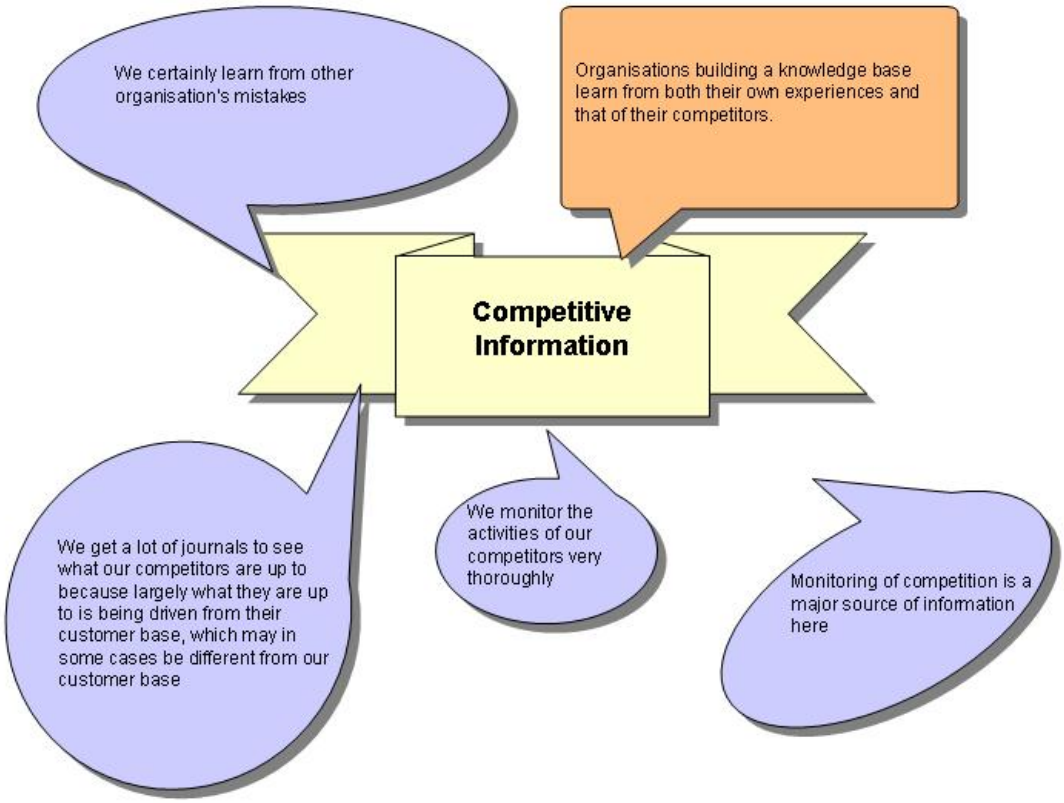
- User and customers



- Longterm partnerships
- Internet
- Literature
- Professional information services



- Competitors



16 INNOVATION OVERPERFORMERS

Perception of Innovation Performance

When comparing their **innovation performance** with their competitors, 30% see themselves as equivalent, 32% as higher and 24% as lower. Only 7% see themselves as performing very low or respectively very high. These results are shown in the distribution shown in Fig. 11 below. In result 38,9% see themselves as "higher" or "very high" which make up the group of "over-performers". 31,5 % of the participating companies makes up the group of underperformers, those seeing themselves as "lower" or even "very low".

Putting the innovation performance results into context with the three industries it appears that the majority in the finance industry sees themselves as equivalent to their competitors, whereas in ICT and mechanical industry sectors the majority sees themselves performing higher than their competition.

For 37% of the respondents **new product turnover** lies below 25% of their overall turnover. Putting this into the context of the three industries, the picture changes In the ICT industry, 44 % stated that the contribution of new product turnover is between 25% and 50%.

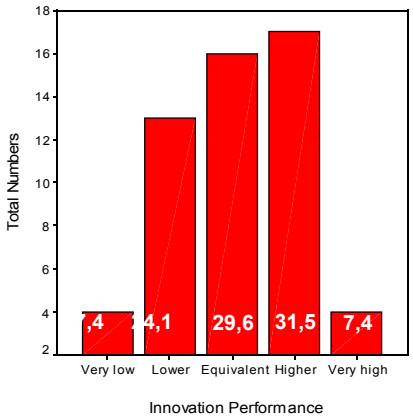


Fig. 11 Distribution among innovation performance categories

Knowledge management tools and practices being used by over-performers

The responses from this high performance group show which knowledge management practices they use most frequently in the early phases of the innovation process (see table 3 on the next page). It also shows where they source most of the information required to support the trend detection and idea creation phases of the innovation process. It has to be annotated that the case study interviews showed that there is almost no kind of "artificial" separation of the two phases in the mindset of the involved people and in the processes in the companies (which is also shown by the tight difference between the means of the two phases).

		Demand/trend detection	Idea creation
Practices	b) Communities of Practice	**1,80**	**1,86**
	d) Discussion forums	**1,95**	**1,62**
	e) Free time for scanning	**1,35**	**1,43**
	m) Knowledge friendly workspace layout	**1,70**	**1,67**
	p) Open doors culture	**2,30**	**2,29**
	q) Searching tools	**1,80**	1,67
	s) Shared files and folders	**1,95**	1,76
	t) Yellow pages	**1,15**	0,86
Information Sources	a) Competitors	1,95	**2,05**
	f) Intranet	1,38	**2,29**
	i) Long-term partnerships	**1,81**	1,05
	k) Patent databases	1,05	**2,10**
	m) Personal networks (external)	**2,29**	1,76
	n) Prof. info. services	**1,38**	**1,24**
	o) Suppliers	**1,57**	**1,67**
	p) Universities	1,29	**1,76**
	q) User and customers	**2,14**	**2,05**

Tab. 3 Mean values of particular practices and information sources used by innovation over-performers more frequently than by under-performers

(Scaling: 0 = never used; 1 = occasionally used; 2 = used most of the time; 3 = used all the time)

17 PECULARITIES OF THE DIFFERENT INDUSTRIES

A cluster analysis of the survey data based on the used practices and information sources was performed in order to identify different types of companies that use the same pattern regarding the practices and information sources. A validity of 94% was achieved for the sample of the 54 cases, providing four clusters; further statistical tests showed that the variable 'industry sector' is suited very well to characterize the clusters as it shows a very strong significance of 0.004 ($p<0.05$). Consequently the clusters were distinguished in a 'Mechanical cluster', a 'Finance cluster', a "small ICT cluster" and "large ICT cluster" (For the further analyses the small an large ICT cluster were aggregated). The following table shows the practices used most by the three industries.

ICT	%	Finance	%	Mechanical	%
Idea workshops	42	Idea workshops	64	Communities of Practice	38
Free time for scanning	37	Cross functional teams	55	Cross functional teams	38
Open door culture	32	Internal training	36	Free time for scanning	31
		Open doors culture	36	Internal project presentations	31

Tab. 4 Practices used most by the respondents in the different industries

Further statistical tests were run across the other variables for example time to market, etc.and it appeared that none of the other variables, for example new product categories, time to market and innovation performance showed a significant difference between the four clusters.

18 KM RECOMMENDATIONS FOR THE THREE INDUSTRIAL SECTORS

18.1 Finance

In the financial cluster a narrow set of only 10 practices is used for demand and trend detection, most frequently used among them are: internal project presentations, open doors culture and shared files. These are used most of the time, whereas the majority of the practices in the financial cluster are only used occasionally.

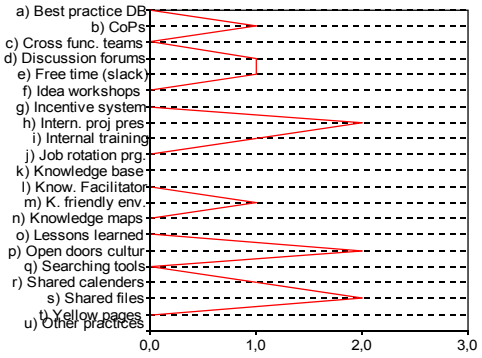


Fig. 12 Finance cluster – demand and trend detection practices

For the idea creation process a narrow set of practices again is applied among them open doors culture seems to be most important.

As information sources for demand and trend detection competitors, suppliers and user/customers are only used occasionally. Also external networking plays a minor role in the finance cluster compared to the other clusters who are using this source most of the time.

For idea creation, however competitors play a major role as an information source, also the Internet plays a major role in this phase. Overall the range of information sources is narrow (10 out of 17) and most of the sources are only used occasionally.

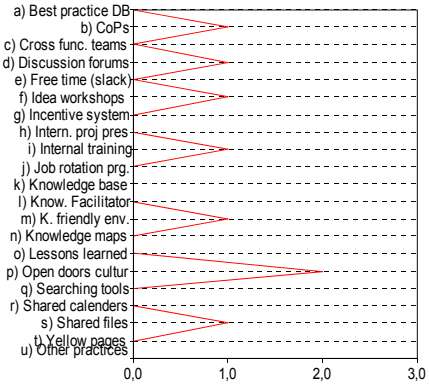


Fig. 13 Finance cluster – idea creation practices

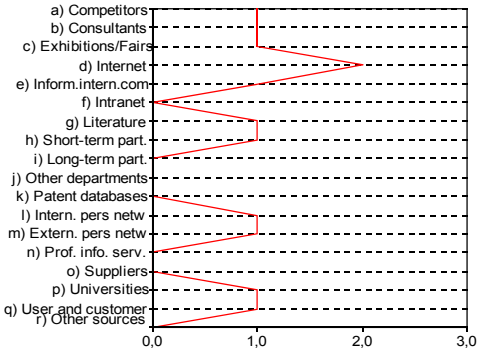


Fig. 14 Finance cluster – demand/trend detection information sources

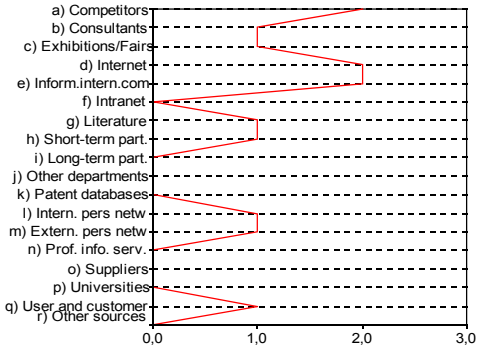


Fig. 15 Finance cluster – idea creation information sources

Based on the specifics of the financial cluster sources and practices the following KM recommendations can be given to companies that are in the financial industry or whose industry has similar characteristics.

The face-to-face practices of KM appear to play a major role; in particular internal project presentations seem to be important for the financial industry cluster, even if they are only used occasionally.

Comparing the industry to the overall picture created by the over-performers, financial industry companies should consider using knowledge management practices such as:

- communities of practice and discussion forums, eg: "'Our employee community is supported by an IT application for knowledge sharing."
- searching tools and yellow pages

eg: "we set obliging rules regarding IT technology and infrastructure to ensure KM practice"

as over-performers use these practices most of the time.

Regarding information sources financial industry companies should consider using

- customers/users, eg: "new products have to be brought to the market in order to keep a competitive edge"
- universities
- long-term-partnerships and external personal networks, eg: 'Monitoring of competition is a major source of information here.'

more frequently than their current occasional use, as these practices are used most of the time by over-performers.

Also suppliers, patent databases and intranet are used most of the time by over-performers, but with regard to the origin of its business these three sources seem not be adequate to be used, as they are used almost not at all. However, internet seem to play a important role as an information sources especially the financial industry type of organization. For example 'to avoid brain drain, which is a major problem for companies in the banking industry, we introduce practices and applications at a department level to store and share explicit knowledge.' 'In one area mangers are retiring, we have had to implement a 'memory' practice.' based on the internet for all to access

18.2 Mechanical Engineering

The snake plots show the frequency of use of the practices and information sources at a glance and is intended to introduce the specialties of this cluster

The mechanical cluster is the only ons where job rotation is at least used occasionally for demand and trend detection, it is not used in the other clusters with this regard. In the same phase, shared files and cross functional teams are used most of the time in the mechanical cluster companies and are those two practices that are used more frequent than all the others in the set of practices in the mechanical cluster

For idea creation cross functional teams and shared files are used more frequent than the other ones in the set of practices of the mechanical cluster.

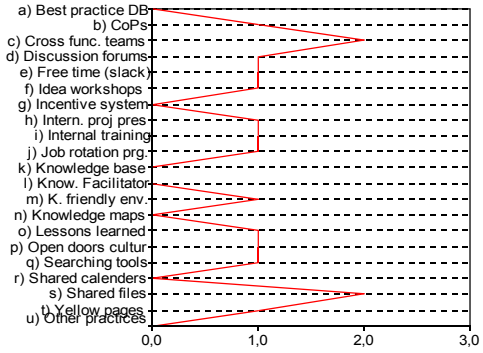


Fig. 16 Mechanical cluster – demand/trend detection practices

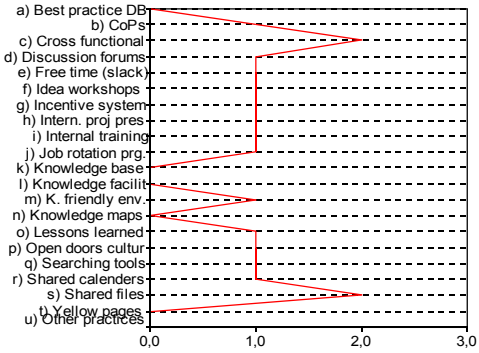


Fig. 17 Mechanical cluster – idea creation practices

Mechanical cluster companies use competitors all the time (3,0) as information source for demand/trend detection, user/customer most of the time (2,0) and suppliers only occasionally (1,0).

For idea creation, mechanical cluster companies use all sources besides patent data bases. Internal personal networking is used as the only practice all the time and seems to play a major role. The set of information sources is used about equally between “occasional” and “most of the time”.

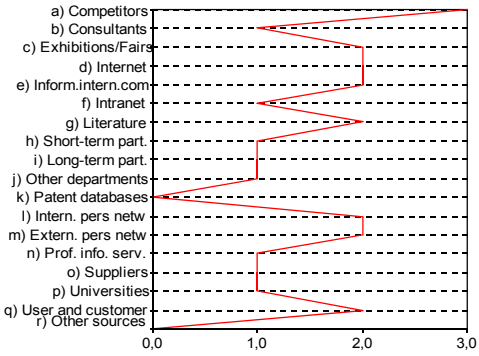


Fig. 18 Mechanical cluster – demand/trend detection information sources

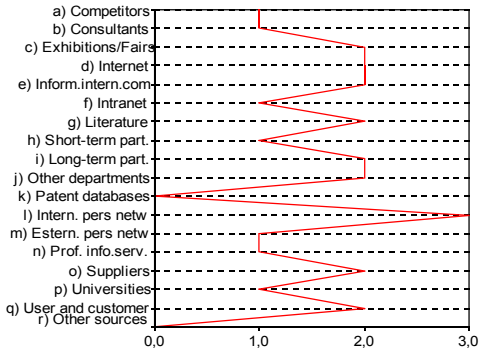


Fig. 19 Mechanical cluster – idea creation information sources

Based on these peculiarities of the mechanical cluster companies, the following KM recommendations can be given to companies that are in the mechanical industry or do have similar characteristics.

Especially face-to-face practices play a major role and with regard to information sources external partners like the competitors, suppliers and customers as well as universities seem to be important.

Looking on the set of practices used by over-performers, mechanical industry companies should think especially about using

- communities of practice and discussion forums, eg: ‘There are different levels of our knowledge available, we have a knowledge base and a product knowledge base, available worldwide
- knowledge friendly workspace layout and open doors culture
- searching tools, eg: ‘A critical problem for us is the tendency to have developments running in parallel, this requires high use of our IT to reuse knowledge

more frequent than just only occasionally, as over-performers use these practices most of the time.

Regarding information sources mechanical industry companies should think especially about using

- universities
- long-term-partnerships, eg: ‘We have a close network to other associations which supports our identifying emerging issues and trends.’
- patent data bases and intranet, eg: ‘We have built a knowledge base for our engineers and we maintain that.’

more frequent than just only occasionally in order to move in the direction of the over-performer set of used information sources. However, personal internal networking seems to play an important role as an information source especially in the mechanical industry type of organization. For example ‘We visit exhibitions regularly to build and work up our personal networks.’
‘We see the IT knowledge base as a first structured step for exchange of knowledge, but networking and working closely with the team in terms of shared capability is absolutely key to long term success.’

18.3 Information & Communication Technologies (ICT)

Large ICT type of companies are the only ones using knowledge maps and incentive systems for knowledge sharing as practices in the early phases of the innovation process. Compared with the small ICT type of organization, the large ones use the practices more intense in general, whereas slack and idea workshops are used less frequent than in small ICT companies. In the phase of idea creation, large ICT types are the only ones that seem to use best practice data base in the phase of idea creation. Idea workshops, cross functional teams and communities of practices are used within this type all the time to create ideas.

For demand and trend detection, large ICT type of companies strongly use competitors, suppliers and users/customers. Also they are the only ones that use patent data bases for demand and trend detection at all. Generally, large ICT companies seem to use the full set of practices about most of the time. For idea creation internal as well as external personal networking plays the same major role like it does for those in the small ICT cluster. They seem to be the only ones that are using patent databases in the phase of idea creation

Based on these specialties of the large ICT cluster companies and on the set of practices and information source generally used by over-performers, the following KM recommendations can be given to companies that are a large organisation in the ICT industry or do have similar characteristics.

The large ICT type of company intensively uses KM practices and information sources: Communities of practices, open door culture, searching tools, share files are used all the time by large ICT companies, whereas over-performers generally use those practices only most of the time. Also free time for scanning is used more frequently by this type of company than by the over-performers.

A similar picture has emerged for the information sources where large ICT companies apply a more intense use compared with the set of the over-performers. Suppliers as well as personal networks are used all the time – over-performers use this only most of the time. Similarly professional information services are used more frequent by large ICT type of companies. However, regarding the use of universities as information source, large ICT type of companies should consider a more intense use, as innovation over-performers use them most of the time, whereas large ICT types indicated to use them only occasionally

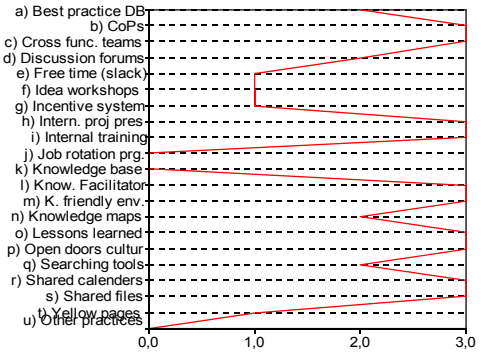


Fig. 20 ICT cluster – demand/trend detection practices

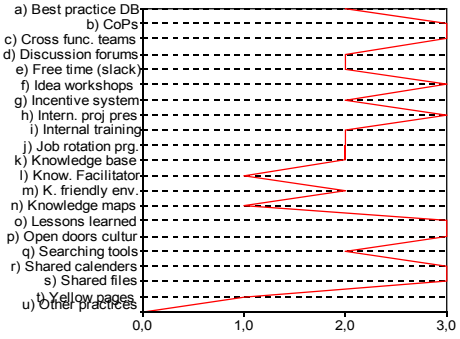


Fig. 21 ICT cluster – idea creation practices

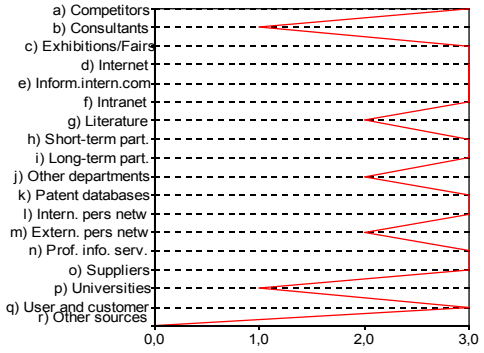


Fig. 22 ICT cluster – demand/trend detection information sources

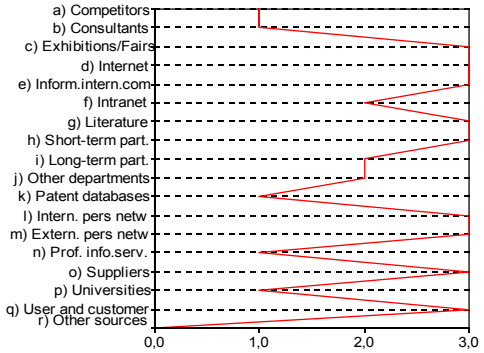


Fig. 23 ICT cluster – idea creation information sources

REFERENCES

Cohen W. & Levinthal D. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation. Adminstrative Science Quarterly 35, p. 128-152

Cooper, R.G.; Edgett, S.J. & Kleinschmidt, E.G. (2001) Portfolio Management for New Products, 2nd Edition. Perseus, Cambridge, MA

Mintzberg, M.; Ahlstrand, B. & Lampel, J. (1998) Strategy Safari. Pearson Education Limited, Harlow, UK

Rothwell, R. (1977) The characteristics of successful innovators and technically progressive firms. R&D Management, 7(3), p. 191-206

Senge, P.M. (1990) The Fifth Discipline:The Art & Practice of The Learning Organization. Century Business, London, UK

Teece, D. (2001) Managing Intellectucal Capital. Oxford University Press

Teece, D. & Pisano, G. (1994) The dynamic capabilities of firms: an introduction. Industrial and Corporate Change, 3, p. 537-556

Tidd, J., Bessant, J. & Pavitt, K. (1997) Managing Innovation: Integrating Technological, Market and Organisational Change, John Wiley & Sons, Chichester

Trott, P. (1998) Innovation Management and New Product Development. Pearson Education, Harlow

Vera, D. & Crossan, M. (2003) Organizational Learning and Knowledge Management: Toward an Integrative Framework. In: Easterby-Smith, M. & Lyles, M.A. (Eds), Handbook of Organizational Learning and Knowledge Management. Blackwell Publishing, U.K.

Weggemann M. (1999) Wissensmanagement. MITP- Verlag, Bonn

This report is available through

Fraunhofergesellschaft IAO
Nobelstraße 12
70569 Stuttgart
Germany

Contact:
Mark Neumann
mark.neumann@iao.fhg.de

MET Communications GmbH
Eschbacher Weg 10
61352 Bad Homburg v.d.H.
Germany

Contact:
Norbert Jastroch
norbert.jastroch@metcommunications.de