HIGH-TECH SMALL AND MEDIUM SIZED ENTERPRISES' USE OF METHODS AND TOOLS FOR EXTERNAL KNOWLEDGE INTEGRATION[1]

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Abstract

External knowledge integration (EKI) is the process by which organizations identify, acquire, and utilize knowledge from their environment. While there is a vast array of methods and tools (MTs) available to support this process, it seems that high-tech small and medium sized enterprises (HTSMEs) hardly use them. This study investigates a) whether this is correct for a variety of MTs, b) what is the level of satisfaction with these MTs, and c) what are potential causes for a low usage. A survey with results from 317 HTSMEs shows that the usage of MTs to support EKI is indeed low, in particular for very specific MTs. Moreover, it appears that users are satisfied with the MTs they use and that not being aware of MTs is the most important reason for not using them. Suggestions are provided as to how usage of MTs for EKI amongst HTSMEs can be improved by increasing awareness.

1. INTRODUCTION

Given the numerous governmental initiatives for it, improving the transfer of knowledge to high-tech small and medium sized enterprises (HTSMEs) appears to be a highly relevant topic (Bougrain & Haudeville, 2002). For example, governments provide subsidies, give training, found knowledge-brokering institutes and websites, and support collaboration between HTSMEs and research institutes (Jetter et al., 2005). While governmental initiatives are undoubtedly helpful in supporting the transfer of knowledge to HTSMEs, they are not the only way to support them. An alternative way to support HTSMEs is by providing them with the methods and software tools (MTs) they need to identify, acquire, and utilize external knowledge themselves. This process of identifying, acquiring, and utilizing knowledge from their environment is called external knowledge integration (EKI) in this paper.

There exists a vast array of MTs that are potentially useful to support EKI in HTSMEs. In this paper, methods are considered to be ways of thinking and acting when approaching a problem. Examples of methods are benchmarking, gap analysis, and internal documentation procedures. Tools are considered as instantiations of such methods in pieces of software. Examples of tools are data mining software, content management systems, and groupware. As a number of studies show, the usage of these MTs, and in particularly tools, is low amongst HTSMEs – and SMEs in general (Bessant, 1999; Corso et al., 2003). This seems not surprising, since most MTs have been developed by and for large companies and most studies on MTs are also on large companies (Binney, 2001; Nissen, Kamel, & Sengupta, 2000; Paton, Goble, & Bechhofer, 2000; Ruggles, 1997). Though perhaps not surprising, I find it striking when an economically crucial group of companies like HTSMEs is not using

potentially useful MTs to support their EKI processes. This seems to imply that EKI, which is a crucial process for HTSMEs, is not supported to the extent it could be supported with the available means. It is the purpose of this study to find out to what extent this is indeed the case and why so, and to generate ideas on what can be done about it.

While some previous studies have been conducted on MTs' usage in small firms, these studies have focused on a rather narrow set of MTs, or even on the evaluation of a single MT (e.g., Bessant, 1999; Scherf & Böhm, 2005). I have found no study systematically analyzing the usage of a broader range of MTs for EKI amongst HTSMEs. To address this lacuna in the current literature, this paper presents the results of such study. The objective of this paper is to answer the following three questions:

1. To what extent are a variety of existing MTs used by HTSMEs?
2. What is the level of satisfaction with these MTs amongst HTSMEs?
3. What are the causes for a low usage of MTs amongst HTSMEs?

The answers to these three questions will provide a better insight in which MTs HTSMEs do use and which MTs they do not use and why this is the case. Based on this insight, the paper provides suggestions for how to increase the use of MTs amongst HTSMEs.

The paper is structured as follows. The next section presents the research method of a survey that was conducted in order to answer the three questions. Consequently, Section 3 provides the results of the survey. The paper ends with a conclusion in Section 4 and a discussion in Section 5.

2. RESEARCH METHOD

The answers to the three research questions were sought by means of a large-scale online and paper-and-pencil based questionnaire sent to a stratified randomized sample of 1306 HTSMEs in Germany, Israel, the Netherlands, and Spain. The complete survey concerned a wide range of topics related to EKI and was conducted as part of the European project 'Knowledge Integration and Network eXpertise' (KINX). Approximately one-fifth of this survey was reserved for the answering of the three questions related to this study.

2.1 Questionnaire

Based on existing inventories of MTs (Bullinger, Wörner, & Prieto, 1997; KLUG, 2002; Sebastiano & al., 2002) we made a selection of MTs that should be covered in the questionnaire. The final questionnaire provided a list of 15 types of methods and 17 types of software tools that all could be used to support the identification, acquisition, and utilization of knowledge (see Figures 1 and 2). For each MT, respondents were asked to indicate whether they (had) used it and, if so, whether they were satisfied with it or not. These questions were in a simple yes/no format.

To get a better insight in the type of methods and tools that were used, a second question that was asked concerned the degree to which the methods and tools that are used are standard or customized. Respondents were asked to indicate on a 5-point scale ranging from strongly disagree (1) to strongly agree (5) to what extent they agreed with the following two statements: 1) Most of our methods and software that deal with knowledge are especially developed for our company, and 2) Most our methods and software that deal with knowledge are specific for our field.

Finally, the questionnaire asked for reasons why respondents did not use MTs more often. Based on a meeting with an expert team of HTSME managers, consultants, and academics (the KINX consortium) and 33 exploratory interviews with HTSME managers, the following options were chosen: 'Not thought about it', 'There is no need for it', 'I am not aware of any', 'There are too many to choose from', 'They are too expensive', 'There are no

suitable ones', and 'It is too complicated to learn to use them'. Also, respondents had the opportunity to choose the option 'Other reason, namely…'. This question was asked for each of the three stages of EKI (identification, acquisition, and utilization of knowledge) and for two types of knowledge (customer/market knowledge and technological knowledge).

2.2 Sample

In order to create a sample of HTSMEs, we had to specify what we mean by 'SME' and by 'high-tech'. The formal European definition of SMEs includes companies that have fewer than 250 employees (European Commission, 1996). However, while the average company in Europe has 6 employees, for those branches that are defined as high-tech manufacturing by the OECD (2001) the average number of employees is 20. This implies that the average size of the companies this study focuses on is more than three times as high as the overall European average. Therefore, we included companies with up to 500 employees in our study. For the definition of 'high-tech' companies we adopted the official International Standard Industrial Classification (ISIC) of high-tech and low-tech industries. This study includes firms of both high-technology and medium-high-technology industries (see Table 1).

A major challenge was the selection of high-quality address databases for the questionnaire. Since we are not aware of any database that covers the four countries, we had to select four different databases that allowed selection on similar criteria. Because of their high-quality reputation and similarity, the following databases were selected: Hoppenstedt (Germany), D&A HiTech Information Ltd. (Israel), National Chamber of Commerce (Netherlands), and AXESOR (Spain). From these databases, we selected a stratified random sample of 1722 HTSMEs. The sample was stratified over country (Germany, Israel, Netherlands, and Spain), size (2-9, 10-49, 50-99, and 100-499 employees), and industry (industries 24 and 29-35 from the International Standard Industrial Classification). These companies were contacted by phone, were asked to identify a key informant, and received a personal (web based or paper-and-pencil based) questionnaire with an accompanying letter. Although the validity of single-informants research has been debated, Campbell (1955) concludes that this type of sampling can produce results that are valid and generalizable. Also, we agree with Kumar, Stern, & Anderson (1993) who state that informants are not selected to be representative of the members of a studied organization, but because they are supposedly knowledgeable and willing to communicate about the issue being researched. Since smaller companies are less likely to have such informants than large companies (Mitchell, 1994), we let companies decide themselves who was the most appropriate person to respond. During the telephone calls we asked respondents whether they were indeed the right person in the company to answer the questionnaire. We had expected that this self-selection mechanism would lead to a strong overrepresentation of technology-oriented respondents compared to market-oriented respondents. This expectation was based on an assumption that NPD in HTSMEs would be associated with research and development rather than with marketing. While our expectation was partly right, also a substantial number of market-oriented persons responded. When the selected respondents did not respond within the indicated period (two weeks) they were reminded up to two times, which is reported to be the optimal number of reminders (Babby, 1995).

2.3 Response

From the 1722 SMEs that were initially selected, 416 were excluded from the sample for several reasons, including wrong addresses and wrongly classified as HTSME. A total of 317 HTSMEs responded, leading to an effective response rate of 24.3 %, which is considerably high for a randomized sample of SMEs (Huang, Soutar, & Brown, 2002; Raymond, Julien, & Ramangalahy, 2001).

The profile of the responding companies and individuals is given in Table 1. A comparison (t-test and Mann-Whitney test) of respondents with non-respondents showed no significant differences on industry (2-tailed significance for t-test was .904 and for Mann-Whitney was .516). However, regarding company size the difference were significant (both tests showed a significance of .000): companies with 10-49 employees were relatively underrepresented in the response set, while companies with over 100 employees were relatively overrepresented. Also concerning company age, differences were significant (.083, respectively .002 for t-test and Mann-Whitney test). Younger companies were relatively underrepresented, while older companies were overrepresented. We had no theoretical reasons to assume that these over- and under-representations were relevant for the outcomes of the study. Moreover, a comparison (t-test) of early and late respondents on all variables in the complete study showed no significant differences (at $p<0.05$). Thus, substantial non-response bias seems unlikely (Armstrong & Overton, 1977).

Table 1 Profile of respondents and their companies

Industry			**%**	**Year of foundation**	**%**
24 Chemicals & chemical products			10.7	Before 1965	13.1
29 Machinery & equipment			28.4	1966-1980	13.1
30 Office machinery & computers			11.7	1981-1990	18.0
31 Electrical machinery & apparatus			4.1	1991-1995	14.6
32 Radio, TV and communication equipment			19.9	1996-1998	15.5
33 Medical, precision & optical instruments			12.6	1999-2001	16.2
34 Motor vehicles, trailers & semi-trailers			5.0	Missing	9.5
35 Other transport equipment			3.2	(after 2001 excluded)	
Missing			4.4		
# of employees	**Total**	**On R&D**	**Position of respondent**		**%**
2-9	14.3 %	58.5 %	Director/general manager		29.9
10-49	28.7 %	23.2 %	Manager/head R&D		37.8
50-99	16.5 %	5.2 %	Manager/head marketing		14.3
>=100	35.1 %	3.4 %	Other		12.8
Missing	5.5 %	9.8 %	Missing		5.2
Mean	89.5	14.8			

3. RESULTS

The results of the survey are presented below in Figures 1-6. Figure 1 presents how many of the 317 respondents used or have used one or more of 15 types of methods (black bars). It also presents how many users were satisfied with each of the 15 methods (white bars). The right column in Figure 1 represents the ratio of respondents that were satisfied with a method and respondents that were not satisfied with that method. Figure 2 is identical to Figure 1, but concerns tools instead of methods.

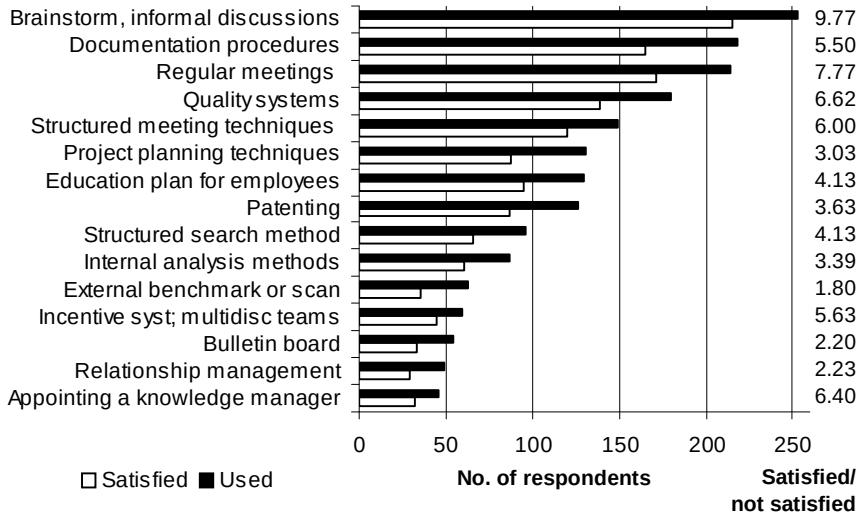

Figure 1 Number of respondents that use certain methods and that are satisfied with them (adopted from Kraaijenbrink, Groen, & Wijnhoven, 2005)

Figure 1 indicates that the methods that are used most are general methods, such as brainstorming (253 out of 317 = 79,8 %), documenting (218 / 317 = 68,8 %) and regular meetings (214 / 317 = 67,5 %). Figure 1 also shows that the least used methods are appointing a knowledge manager (46 / 317 = 14,5 %), relationship management (49 / 317 = 15,5 %), and bulletin boards (54 / 317 = 17,0 %). This implies, for example, that approximately every sixth to seventh responding company has implemented a bulletin board and appointed a knowledge manager. Though these methods score lowest compared to the other methods, we find the number of HTSMEs that have appointed a knowledge manager remarkably high.

When we look at the right column of Figure 1, the fact that all ratios of satisfied users and non-satisfied users are above 1 indicates that, for each of the methods, most users are satisfied. This does not seem very surprising, since people will use a method mostly when they are to some extent satisfied with it. However, we have to realize that the figures include respondents that have used a method, meaning that they are currently not using it anymore. Hence, satisfaction is not as obvious as it seems. As the ratios indicate, there does not seem to be a connection between the number of respondents that use a method and the level of satisfaction: the ratios are not higher for methods that are used more often.

When we look at tools, the results are to a large extent similar to those of methods (see Figure 2). Again it are general tools that are used most widely: e-mail and chatting (241 / 317 = 76,0 %), search engines and web crawlers (223 / 317 = 70,3 %), and catalogues (161 / 317 = 50,8 %). The relatively large 20 % drop between search engines and catalogues implies that e-mail and search engines are clearly the most widely used tools. When we look at the bottom of Figure 2, we can see that the least used tools are: intelligent agents (15/ 317 = 4,7 %), mind mapping software (21 / 317 = 6.6 %), and expert and decision support software (25 / 317 = 7,9 %).

As for the methods, the ratios of satisfied and non-satisfied users are all above 1. Remarkable are the high satisfaction rates for e-mail, extranets, and mind/knowledge mapping software. The latter two are particularly interesting since they are not widely used. Rather, it seems that they are used by a selective group of satisfied users.

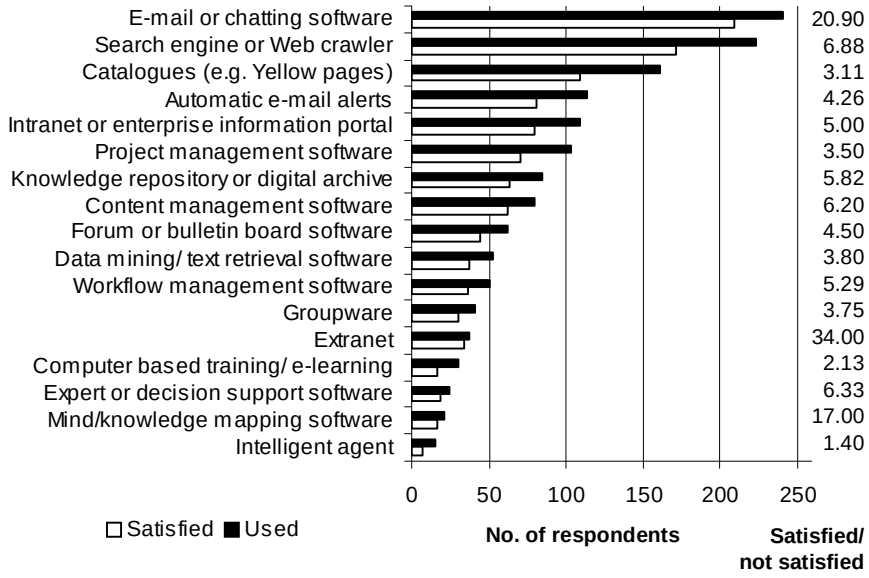

Figure 2 Number of respondents that use a certain software and that are satisfied with it. (adopted from Kraaijenbrink, Groen, & Wijnhoven, 2005)

Additional observations can be made when Figures 1 and 2 are compared. The figures illustrate that methods are used more frequently (1855 in total) than tools (1451). I suspect that, in practice, the difference is probably even higher than these number express since more types of tools (17) than types of methods (15) were included in the survey. Thus, while there was a bias in the survey to get a higher score on tools, the score on methods was highest.

Another difference is the larger spread of methods that is used compared to the frequent use of only a small set of tools. For example, the three best scoring methods add up to 685 / 1855 = 36,9 % of total usage, while for tools this number is 625 / 1451 = 43,1 %. We can also see this in the steeper curve in Figure 2 compared to Figure 1.

When we compare the satisfaction ratios for methods and tools, it appears that the variation in ratios for methods is less than for tools: For methods the values lie between 1,80 and 9,77, with an average of 4,83, and for tools the values lie between 1,40 and 20,90, with an average of 5.48. This implies that, while there are some tools that score extraordinary high on satisfaction, this is not the case for methods. It also implies that, on average, one-sixth of the users is not satisfied.

The results for the questions as to what extent most of the MTs of a company were specifically developed for the company or for the field are presented in Figure 3. This figure clearly indicates that the MTs that HTSMEs use are not specifically developed for them or for their types of companies. This observation is consistent with the results of Figures 1 and 2 where general types of methods and tools were the most used ones.

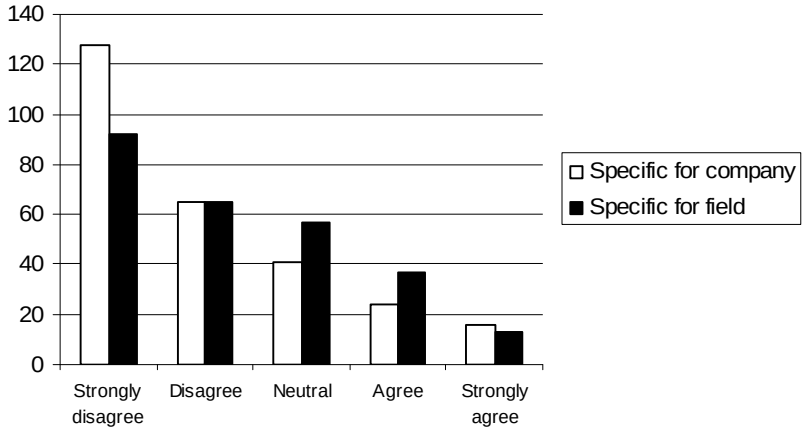

Figure 3 Extent to which methods and tools are specifically developed for company or field

As mentioned in Section 2, respondents were also asked why they did not use more specific methods and software for the identification, acquisition, and utilization of external customer/market knowledge and technological knowledge. The results for these questions are presented in Figures 4-6.

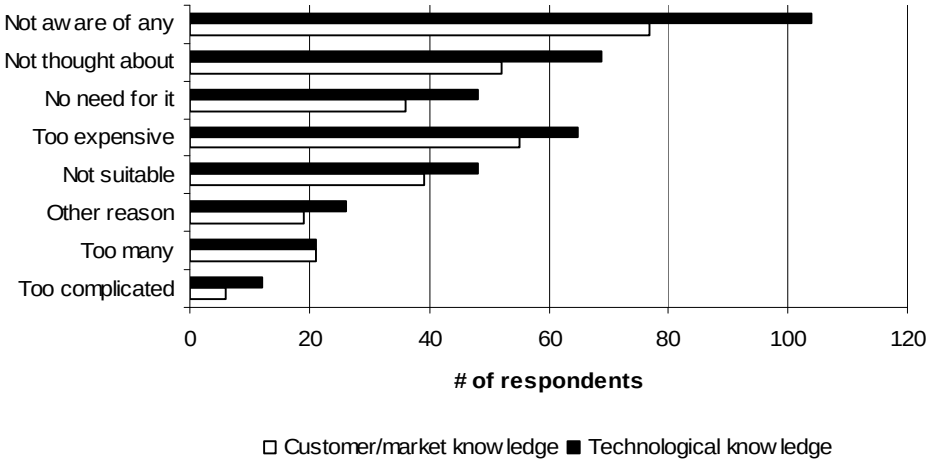

Figure 4 Reasons for not using methods and tools more often for knowledge identification

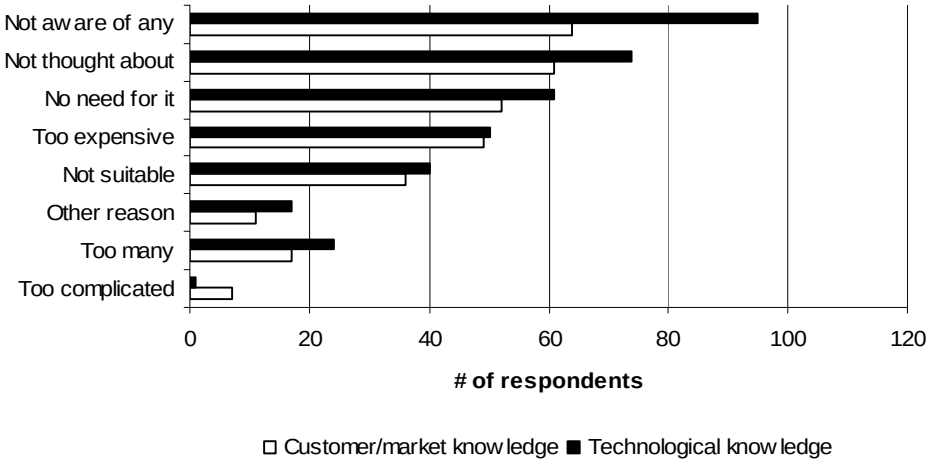

Figure 5 Reasons for not using methods and tools more often for knowledge acquisition

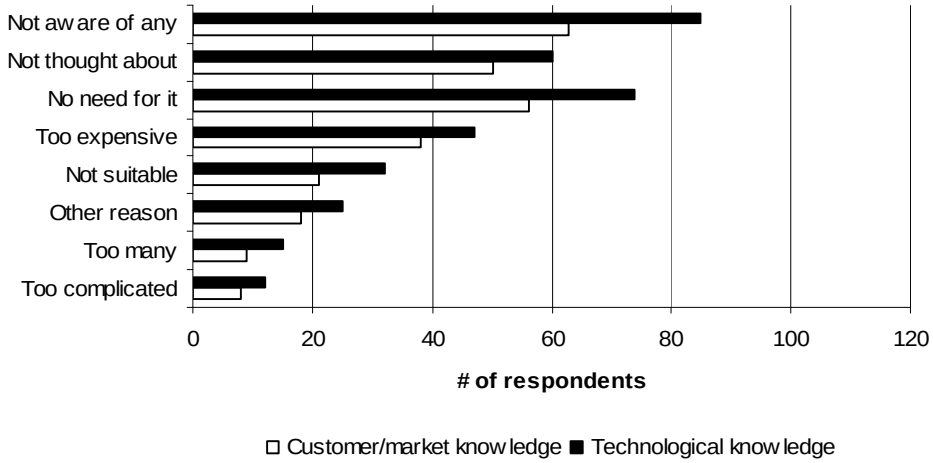

Figure 6 Reasons for not using methods and tools more often for knowledge utilization

From Figures 4-6 we can derive the following results: Firstly, it is apparent that 'Not being aware' is the most important reason for not using specific MTs, regardless of EKI stage and type of knowledge. The figures also show that 'There are too many' and 'They are too complicated' are the least important reasons, regardless of EKI stage and type of knowledge. Another observation is that 'Too expensive' scores higher than 'Not suitable', regardless of stage and type of knowledge. This indicates that for HTSMEs, the price of MTs is a larger barrier against MT usage than the suitability of these MTs.

Moving from identification, via acquisition, to utilization, we see that the reason 'No need for it' increases in importance, compared to the other reasons. This indicates that HTSMEs perceive a higher need for MTs for identification than for acquisition and utilization.

Concerning the category 'Other reasons' the reasons that were given most frequently were 'No time' and 'Company too small and/or specific', which both could be coded as 'No need for it' or 'There are no suitable ones'.

In general, we can see that when moving from identification, via acquisition, to utilization, the numbers decrease. However, I suspect this has more to do with a decrease in response because of repetitive questions than with any other reason. Also, the fact that the numbers for customer/market knowledge are lower than for technological knowledge have to do with the fact that more respondents filled out the questionnaire for technological knowledge than for customer/market knowledge (respondents could choose, based on their expertise).

4. CONCLUSION

This paper started with three related research questions: 1) To what extent are a variety of existing MTs used by HTSMEs? 2) What is the level of satisfaction with these MTs amongst HTSMEs? 3) What are the causes for a low usage of MTs amongst HTSMEs?

Concerning the first question, the results have shown that the extent to which MTs for EKI are used by HTSMEs varies substantially, dependent on the particular MT. Figures 1 and 2 indicate that the usage of general, relatively low-profile methods and tools is high and that the use of more specific and complicated MTs is low. Also, the figures show that methods are used more than tools and that the MTs they use are usually not developed especially for their firm or field. This is also what we might expect from HTSMEs, as they usually don't have

the money or expertise available for investing in highly specialized tools or methods. Compared to existing research on HTSMEs use of MTs, this answer to the first research question refines the general observation that HTSMEs hardly use MTs for EKI. Also, I think that particularly the usage of methods is in general not as low as we might have expected. For example, Figure 1 shows that approximately every seventh company has appointed a knowledge manager. I think this is a very high number for such an expensive measure. Nevertheless, the results do confirm the observation that specific tools and methods are hardly used by HTSMEs.

The second question concerned the satisfaction level of MTs. From Figures 1 and 2 we can conclude that, in general, most users are satisfied with the MTs they use or have used. However, on average, approximately one-sixth of the users of an MT is not satisfied. From the figures we can also conclude that higher usage is not associated with higher satisfaction. Rather, there seems to be no connection between the usage and satisfaction rates. Finally, there are some tools where an extraordinary large share of users is satisfied: e-mail and chatting, mind mapping, and extranets.

With respect to the final research question, the results in Figures 3-6 show that 'Not being aware of MTs' is the most important reason for not using them, followed by 'Not thought about' and 'No need for it'. Reasons for not using MTs that were hardly mentioned are that the MTs are too complicated, or not suitable for HTSMEs, or that there are too many MTs to choose from.

5. DISCUSSION

This final section of this paper will discuss the implications of the answers given to the three research questions for research and practice.

For practice, the main implication of these results concern the question as to how the usage of MTs for EKI can be increased amongst HTSMEs. A question that should precede this question is whether an increased use is desirable. Considering the answers given to the three research questions, I think this second question should be answered confirmatively. The results show that most users are satisfied and that the most important reasons for not using MTs is that companies are not aware of any or have not thought about it. Hence, it appears that the low usage of MTs amongst HTSMEs is not caused by some general defect in MTs, but more by a lack of awareness and knowledge amongst HTSMEs.

In order to increase the usage of MTs by HTSMEs it is thus important to increase HTSMEs' awareness of MTs and to improve the accessibility and publicity of MTs. One potentially fruitful way to do this is by means of an Internet portal. Such portal can aggregate and give access to a large number of MTs and their suppliers. It can even provide a diagnosis of problems and a matching of MTs with these problems. An example of such portal is http://kinx.socintec.com.

Since the Internet is a passive medium, only developing an Internet portal is not sufficient. Additionally, it is necessary to create active and targeted communication towards HTSMEs to make them aware of the existence of such portal, or more general, to make them aware of the existence of potentially useful MTs. As they are generally well-known and well-connected to HTSMEs, SME agencies, innovation centres, and industry associations seem to be amongst the most appropriate institutions to deliver such communication. Should communication not be sufficient, such institutions can also provide training that make managers of HTSMEs' better aware of EKI as an important process and of the opportunities that MTs provide to support this process.

Given the relatively high satisfaction rates of those HTSMEs that use particular MTs, improving the quality of the MTs themselves seems of less importance. Since price was

mentioned to be a more significant barrier for the use of MTs than suitability, it seems more important to lower the prices of existing MTs. This does not only include the price of purchasing the right to use a particular MT, but also the price of implementing, maintaining, and using it. While suppliers of MTs have of course a major role in this, I expect that the institutions mentioned above can also play an important role here. For example, as representatives of HTSMEs, such institutions should be able to negotiate with suppliers of MTs. One could think of arranging collective licences for a number of HTSMEs together.

In addition to these implications for practice, this paper has also implications for further research. The paper has not only answered questions, but it has also generated new questions. As the current study has made a broad inventory of the usage of MTs by HTSMEs, it seems useful that further research consists of in-depth analyses of MTs usage an non-usage. Therefore, future research should have a closer look at MTs that have a high usage rate and MTs that have a high satisfaction rate. Questions that need answers are: What makes these MTs so good or suitable? Why are they used? and How are they different from MTs with low usage and satisfaction rates?

Also, future research should further investigate the type of companies that use and are satisfied with particular MTs. It might be not so much the type of MT that explains usage, but more the type of company that uses the MT. In order to investigate this, a comparison should be made between, for example, companies of different sizes, ages, and industries.

Finally, since it appears that satisfaction and usage do not seem to be closely related, the question arises as to what does explain usage? We get some hints from the reasons for not using MTs, but further research is needed here.

ENDNOTES

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