Chapter XI
Emerging Topics and Technologies in Information Systems

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ABSTRACT

Technology programs are a means to facilitate the development and commercialization process of new innovative technologies. They are forums for the exchange of information and for networking between companies and research institutes. The programs provide opportunities and financial support to carry out ambitious research and development projects and to build business expertise. The core of technology programs are joint research projects between companies and research institutes. The objective of the study is to increase understanding of how such joint research projects within technology programs evolve in practice. The emphasis is on identifying factors that enhance the commercialization of new technologies and on finding barriers of commercialization. Based on the findings, practical recommendations are given on how the concept of technology programs can be further developed to utilize the unused potential in such programs. The empirical sample of companies in the study represents information technology. In the study, the microanalysis approach is used. The dominant approach in corresponding innovation
research has been the macro perspective approach. The research data was gathered via personal interviews with key informants of joint research projects within a technology program. All the projects were new product development projects which the companies taking part in the technology program were conducting together with research institutes.

**INTRODUCTION**

Technology programs are a means to facilitate the development and commercialization process of new innovative technologies. They are forums for the exchange of information and for networking between companies and research institutes. (Hänninen, 2007) The programs provide opportunities and financial support to carry out ambitious research and development projects and to build business expertise. The essence of technology programs are joint research projects between companies and research institutes. The objective of the present study is to increase understanding of how such joint research projects within technology programs evolve in practice. The emphasis is on identifying factors that enhance the commercialization of new technologies and on finding barriers of commercialization. It is a top priority for the society that resources invested in technology programs enhance, in practice, the commercialization processes of companies as effectively as possible (Balthasarin et alii, 2000).

A dominant approach in innovation research has been the macro perspective approach. Earlier innovation research has typically been based on macro perspective innovation models (Cooper, 1990). Macro economic cluster analyses and general economic factors have been central for the macro perspective approach in innovation research. The macro perspective approach has focused on strategic factors defined by a company’s market position and other organizational relationships (Johnson et alii, 2003).

On the other hand, the microanalysis approach is a more novel approach in the context of innovation research (Serkkola et alii, 2009). In it, detailed analyses of the organization’s internal processes, for example, of the daily tasks, work practices, work conventions, work flows, decision making, chosen solutions, and organizational processes, are conducted in order to obtain a deeper understanding of the phenomena under investigation (Brown et alii 2000). The micro analysis approach is especially helpful in understanding the initial creation processes of innovations and the forces driving new product development.

In the present study, technology programs are analyzed using the microanalysis approach. This is done using in-depth analyses of individual joint research projects initiated and supported by a technology program (Hänninen et alii, 2007). Such joint research projects between companies and research institutes constitute the core of a technology program and, thus, attaining a deeper understanding of individual research projects will help to understand the essence of technology programs in general.

The research method was qualitative. In order to facilitate rich analyses of the technology project concept, as much information as possible was gathered from each individual joint research project. Generalization of the conceptual results attained in this activity-oriented multi-case study will be done by further studies applying quantitative research methods (Yin, 1994). Another direction for future research is the parallel use of the macro perspective approach and the microanalysis approach as Nieto (2002) recommends.

The research data was gathered via personal interviews with key informants of joint research
projects within a technology program in the field of information technology. Because of the unpredictable character of the new product development, experts and other actors working in the organization and collaboration processes’ interface are important key informants of the joint research projects (Johnson et alii, 1997).

All the projects were new product development projects which the companies taking part in the technology program were conducting together with research institutes. The sample includes 10 projects where each had one or more companies and research institutes participating. The interviews were conducted in 2004. Both successful and unsuccessful cases of commercialization were included in the sample. The companies in the technology program developed new products based on the Internet, telecommunications, GPS navigation systems, and other cutting-edge information technologies.

The technology program focused on user-orientated information technology applications. In user-orientated information technology application, innovations are based on the recognition of end-users’ contextual expectations, and then the necessary applications for the needs are provided. In the present study, the development of these socio-technical applications was observed and general conclusions were drawn.

POSITIONING OF THE PARTNERS IN THE JOINT RESEARCH PROJECTS

New product development of an information technology application is a very complex and demanding process. No single company can master all the skills and knowledge needed for the development and launch of a new innovative product. Technology programs are a strategic option for a company to gain access to the latest technological knowledge required for new product development. Partners in such technology programs negotiate and agree on mutual goals. Then, with the support of the organizer of the technology program, an individual joint research project is launched. The technology program offers support in the form of expertise and, often, financing.

In the technology program under investigation, most of the companies were interested in utilizing the latest cutting-edge technological research in their product development. Respectively, the participating research institutes were mainly interested in learning which new technologies could have commercial potential in the future. Even though the partners had agreed on the aims in advance, in some cases conflicts emerged between a company’s short-term market-orientated goals and its partnering research institute’s longer-term scientific-orientated interests.

Joint research projects can be organized as a one-to-one cooperation or as a multilateral cooperation. In the sample, small sized single technology companies and startup companies seemed to prefer one-to-one contracts in their joint research projects. One reason for this was that these companies were cautious of losing full control of the technology which their competitive advantage was based on. With their limited knowledge about immaterial property rights, selecting only a single research partner seemed safer.

One of the important contributions of technology programs is that in them, a company and a research institute share the financial risk of research and development. In addition, the technology program usually allocates financial support to the joint research projects done within the program. In radical or early stage technology development, potential rewards can be particularly high, but at the same time there are high risks of both technological and commercial failure. In the sample companies, most
of these kinds of development projects would not have been launched without the help of the technology program offering potentially high financial rewards and limited financial risks for the companies.

In some of the case companies, the interest in benchmarking competitive new product development projects defined the companies’ position in their joint research projects. One driver in this—often at least partially hidden—position was also a possibility to network with some specific technology experts as potential recruits. This position was especially tempting if the company could participate in several joint research projects at the same time or in related fields.

Some companies adopted a very passive strategy for their acquisition of the latest technological knowledge. They obtained access to research results with very little resource allocation from their own end. The downside of this position is that these companies had very little influence on decisions concerning the joint research project, which considerably lowered the value added they received themselves.

An interesting observation which has implications for the organization of technology programs was that the goals and the corresponding positioning of the participating companies and research institutes were not at all static but typically evolved during the joint research programs. For example, in some cases a company was a very active contributor to the joint research project at the beginning, but when the company did not seem to benefit in its own new product development as it had expected its position changed to one of being a passive spectator.

**HOW THE JOINT RESEARCH PROJECTS IN THE TECHNOLOGY PROGRAM EVOLVED**

Technology programs are aimed at supporting high-risk technology development projects. In the joint research projects, it was in reality easier for the companies to accept the relatively high risk related to technology development. However, when the companies applied the research results, the new products tended to be incremental—not radical—in character. The joint research helped to minimize technology development-related risks, but the risks related to the commercialization process were still perceived as very high by the companies. To mitigate the commercial risks, companies applied the new technologies only to commercially safer incremental product upgrades.

Although technology programs aim to support market orientated research and development projects, many of the joint research projects in the present study were more technology oriented than genuinely end-user orientated. A typical situation was that the joint research project started as a technology-driven project, and only in the later phases was the technology adapted to meet the end-user needs. Had the end-user needs been emphasized earlier in the project, the research efforts would have harmonized better with the company’s market orientation.

The smaller sized companies were generally more interested in directly commercializing the research results, while the larger companies had more opportunities to take advantage of the longer-term benefits of knowledge building. Some of the larger companies just wanted to follow the latest developments in their field of research in order to be better prepared for future developments in their fields.

The companies in the present study often had unrealistically high expectations about the maturity level of the technologies developed during the technology program. Turning the research results into commercial applications required a company to have the necessary capabilities, motivation, and commitment for its own development efforts after the technology program had ended. In some cases, after the end of the joint research project, the company was still consid-
crably dependent on the outside technological expertise. In such cases, these companies succeeded in continuing the development process to reach the desired commercial applications only with the continuing consultancy from the experts of joint research projects.

In many cases, the expertise provided during the technology program to the companies was not sufficient for the application development of the companies as much of the knowledge transfer was limited only to the narrow area of each specific development project. As a result, the companies themselves needed to have a wide range of skills to be able to transfer the new technologies to their commercial applications. Some of the companies realized rather late in their joint projects that the expertise provided by research institutes would not be sufficient and ended in difficulties in finding the missing expertise.

There was often some discontinuity between the joint research project and the company’s new product development process, especially with the larger sized companies. In these cases, there was not much interaction and iterative feedback between the organizations, and thus the research institute was not thoroughly aware of the end-user needs.

Experts in the research institutes proved to be, as expected, very research orientated, and did not necessarily recognize limitations set by the commercialization process. Some consequences of this were that the research experts sometimes neglected factors such as production cost, market competitiveness, and immaterial property right issues.

The different organizational cultures and work methods in companies and research institutes created problems. However, in none of the participating companies did this hinder the possibility for cooperation. Mutual commitment and trust were a prerequisite for successful cooperation, and they were strengthened in longer-term contacts and collaborations.

Many of the participating companies deemed the administrative management and formal reporting requirements of the technology program as being too heavy. This derailed attention from the real essence of the cooperative projects and consumed resources.

The small sized companies tended to collaborate with regional research institutes, while the geographical distance was not as important for larger companies. The small companies were not aware of opportunities provided by research institutes located in areas that are more distant.

Many joint research projects emerged from previous contacts, while some came from unintended random connections between individual people. In addition, it was easier to collaborate with research institutes with whom the company had had cooperation before.

In the companies of the sample, it was felt that especially the informal communication about the research results and related issues enhanced the mutual learning process. This was emphasized by the fact that an incidental observation from the research process in several cases provided more value added to the companies than the final end results of the whole research project. By means of informal communication, companies were also able to gain deeper understanding of the new technologies. On the other hand, formal communication was more related to the negotiations and documentation of the decisions and results of the joint research projects.

An important aim of technology programs is to create new innovations. However, in the technology program under investigation, many benefits were achieved even without the emergence of new products. The participants acknowledged that valuable indirect benefits were attained purely by the partners actively exchanging essential knowledge. It was suggested that the technology programs should arrange more forums in which experiences of research cooperation could be shared and discussed in an informal manner.
FACTORS ENHANCING THE COMMERCIALIZATION PROCESS AND BARRIERS TO COMMERCIALIZATION

Based on the present research study, general conclusions on the commercialization of the results of joint research projects within technology programs were drawn. New factors that enhance the commercialization process were identified, along with new barriers for commercialization.

Factors enhancing the commercialization process were:

Involving the marketing function of the company already in the product development stage. In the successful innovation processes, the marketing function of the companies typically took part in the early stages of product conceptualization. Potential target groups were identified and the corresponding expected sales volumes estimated. A large existing network of partners was very helpful. The contacts could be used for testing the product ideas and getting other market related feedback.

Utilizing complementary expertise. In most cases it was impossible for the companies to internally develop all the expertise necessary for a successful commercialization process. Expanding the technology partnership beyond the technology program partners was often necessary. In successful innovations, partnerships in marketing were typical, especially for the smaller companies.

Correct choice of an alliance network. Most companies did not exercise refined thinking in choosing the alliance network needed in the commercialization process. An example of such refined questions is the choice between a narrow-based alliance and a broad alliance. A narrow-based alliance may mean access only to a small group of clientele, but can offer a dominant position within the network, whereas a broad alliance may offer access to an innovation for a wider group of potential users, but only as one alternative among many. There are usually several competing networks operating on the market place, and a crucial decision is therefore the choice of the best network in terms of optimizing business impact. There is no general answer to the choice of the correct alliance network. However, the successful companies had given more thought to this question and had made a choice more suitable to their specific needs.

Developing a derivative product in advance. In many cases the original product idea, against expectations and best wishes, failed. Many of the companies who were successful in the commercialization process had prepared themselves for this. They had already anticipated possibilities for derivative products based on the same product platform in their new product development stage. For them, the launch of the first product was a learning experience, the results of which were swiftly taken into use in the further derivative product development. With derivative products in mind at the new product development, the companies were better prepared for the inevitable development of their product becoming obsolete.

Conclusions concerning barriers to commercialization were:

‘Perfect technology syndrome’. Some companies seemed to concentrate their resources on attempting to maximize the performance of the technology and to achieve unrivalled technical capacities. They seemed to believe that unrivalled technological solutions would create a situation of absence of competition and, thus, generate unlimited demand. As a result, insufficient
resources were diverted to the investigation of the market, end-users, or substitute solutions to the same end-user needs. Skipping many preparatory investigations of the best practices of product development did not in reality support rapid commercial implementation. Instead, this over-focus on technological solutions actually delayed the products’ access to the market. All the companies which could be deemed to show symptoms of the perfect technology syndrome not only had poor results in their commercialization processes under investigation, but also eventually found themselves in financial trouble in general.

Uncertainty in intellectual property rights. Intellectual property rights were not always addressed at the early stages of the joint research projects. This was particularly true in the case of collaboration between the companies and universities. When confusion emerged concerning these questions at later stages of the joint research projects, it caused wasted energy, personnel resources, and capital. Problems in intellectual property rights can be disastrous to cooperation, but in the sample of the present study, no project was endangered because of these issues. By nature, the different parties in technology programs have different objectives and interests and this makes intellectual property rights more difficult to address. Intellectual property rights questions were particularly prone to cause problems in the case of non-material innovations.

Delayed input of end-user needs. None of the companies denied the need for input concerning customer needs. However, the imbedded mode of operation was to start to seek this information at later stages of the development project. A consequence of this was that when the knowledge of end-user needs was available, changes needed in the product were profound, time consuming, and expensive.

Unclear value added to the customers. Often the technological solution was carefully thought out and cultivated, but its projection as value added to the end-users remained unclear. Even if the end-users attain new opportunities by means of the new product, the fact remained: The less clear the benefits of the new product were for the end-user, the greater the resistance to its acquisition was. Clearly defining the value added to the end-users is an important part of the commercialization process and cannot be left to the marketing channels.

Scant emphasis in building up a brand. All companies acknowledged that building a brand is necessary but, in practice, the actions taken by a few of the smaller companies in particular showed that they had not adequately understood the importance of brand capital. Typical was that in the graphic design of the products, priority was given to low production costs, neglecting the attractiveness of the design and the possibility to convey the high quality of the product by means of the design and brand. Another consequence of giving too little emphasis to brand issues was that the companies ended up spreading resources too widely as a result of trying to maintain several parallel brands at the same time.

Unintentional diversification. Every new technological innovation leads to diversification in the business logic required in the commercialization of the new product. In most of the companies, this happened unintentionally. In some cases the situation was so severe that it nearly resulted in the collapse of the company’s previous business logic knowledge base. In other cases, when the commercialization process was successful, it was very difficult to trace and understand the diversification, even though it may have been hindering greater success.
PRACTICAL RECOMMENDATIONS

The study clearly confirmed that, in general, technology programs do enhance cooperation between companies and research institutes in a manner that positively contributes to new product development and to the commercialization of research-based inventions. The new findings, however, show that there is much unused potential in developing the concept of technology programs.

The observations of the companies revealed that ordinary companies still are not very aware of the various opportunities that cooperation with research institutes could offer to them. Technology programs offer a possibility to bridge this gap. Contact forums in which companies and for research institutes could share experiences and plan for cooperation could be arranged. Technology programs should be more pro-active and perhaps should not be restricted to one field of technology in order to target a larger number of companies. Marketing should not be neglected to get the message across.

A typical problem in innovative new product development projects was that the assessment of the specific end-user needs was often conducted at a very late stage of the project. This often led to the situation that the product did not meet the market needs. Even identified end-user needs had to be neglected because, at a later stage of the product development, it was too costly to alter the product specifications. Thus, in the structure of technology programs, mechanisms to secure early market input should be developed. From the early research and development stage there should be an active contact to the potential end-users in the market place.

The natural aim of companies to minimize their risks in new product development was seen in the companies investigated. A common way of doing so was to try to spread the risk by building a portfolio of parallel development projects, each with a different risk level. While the technology programs provided the companies with a tempting opportunity to join together with research institutes in technologically challenging new product development projects, the companies at the same time implemented more incremental, low risk in-house projects. As the commercial reward was clearly in sight in the in-house projects and the risk seemed high in the joint projects with the research institutes, the companies’ attention seemed to shift towards the low risk projects. A consequence was that the development projects within the technology programs that were started as strategic projects in reality were not in the strategic focus of the companies. The joint projects, which were deemed risky, started to live their own lives. A solution to keep the joint projects initiated within the technology program in the strategic focus of companies needs to be found. One option would be to extend the support offered by the technology program further. It should cover later stages of the commercialization process in order to lower the perceived risk of continuing the projects.

The technology programs were very much focused on establishing formal collaboration between the different partners. However, the observations reconfirmed that informal communication and open interaction between people is conducive to creativity and the development of new inventions. Technology programs should pay constant attention to utilizing various means of enhancing informal contacts between companies and research institutes. Attention should not be limited to building contact between organizations: Person-to-person interaction is an important means of transferring tacit knowledge.

Immaterial property rights are a potential source of conflict in collaborative research projects. Especially in projects where small companies and large companies are collaborating with each other, large companies can dominate in immaterial property rights issues by means of their higher level of legal knowledge, their longer...
cumulative experience, and their stronger negotiation power. In the present study, some small and medium sized companies expressed a fear that in the cooperation with their larger partners they can end up losing their immaterial property rights to the larger and stronger companies. Technology programs should provide knowledge and training related to immaterial property rights issues to all participating companies. In some cases support to small and medium sized companies might be in place when the smaller companies have to negotiate on immaterial property rights questions related to their research projects. The structure of technology programs should guide the participants to negotiate and agree on immaterial property rights during the initial stages of the program.

A clear individual success factor for the collaborative projects in the study could be identified. The companies that had previous collaborative projects with research institutes were on an average more successful in their cooperation. It seemed to be easier for the partners who had previous experience in research cooperation to start with more realistic expectations, to build mutual commitment, and be more willing to work together. This observation can be utilized in many ways. The potential for enhancing company cooperation between companies and research institutes should be seen beyond the perspective of the technology program in question. A technology program should promote cooperation possibilities in future programs as well. The ultimate aim should be the establishment of continuous cooperative arrangements without the need for technology programs.

In the study, there were several new inventions that were successfully developed into new products which gained the acceptance of end-users. However, not all of these attained market success. It seemed that a large number of good ideas having market potential were not fully exploited. An idea to help overcome the obvious problems in the final commercialization process is to combine technology programs with innovation commercialization programs. Innovation commercialization programs would be based on the concerted joint effort of both traditional technology development organizations and risk financiers. Private venture capitalists as well as public financing organizations should work together. Overall, a global perspective in the commercialization should be adopted from the very beginning.

REFERENCES


