

## NGOs AND EDUCATION

### A CASE OF TECHNOLOGY TRANSFER IN MACEDONIA

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**ABSTRACT:** As a process of transferring skills, knowledge, technologies, methods of manufacturing and facilities among organizations, the transfer of technology is instrumental for boosting the economy through creation of competitive products, new jobs and a better quality of life. The stagnant environment for technology transfers in Macedonia in the post-privatisation era is a result of a combination of factors. Among them is the outdated educational system that does not boost entrepreneurial spirit and innovation thinking. Main purpose of this paper is to examine the current status, conditions, anomalies and challenges for technology transfer in the Republic of Macedonia, as well as the potential for development and possibilities for improvement of the process. Through a lens of the technology transfer paradigm, this exploratory study will present a case in which the Foundation Business Start-up Centre in Macedonia, as a technology transfer agent provided links and cooperative platform for creation of new technologies and innovations within the local SME ecosystem. The focus will be on a couple of initiatives for technology development and transfer in a domestic context. Results from the process of implementation of these initiatives will be discussed, along with their stimulating impact on the environment for technology transfer.

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### Introduction

In the modern society and the world of business, the rapidly evolving technologies represent a driving force. The focus of our interest is on the process of technology development and transfer, as requisite activities for increasing innovativeness and competitiveness of the small and medium enterprise (SME) sector. Through a case study, this paper describes how, in absence of a properly established national institutional infrastructure to activate the human and technological capacities, the business incubator can fill in a part of that gap by playing a facilitating role in the process of technology development and transfer. By harnessing their network, credibility and links, this type of organisation creates a participatory mechanism and

provides an enabling environment for harnessing skills and directing knowledge flows towards fulfilment of specific needs among the SMEs.

Before we present the case and delve into discussion, we will introduce the concept of technology transfer and present some background information about the entrepreneurial milieu in Macedonia, the current state and challenges of technology development and transfer, as well as the role of the business incubators in these processes.

## **Methodology**

To the best of our knowledge, there has been no prior study presenting the findings from an actual case of technology transfer on the territory of Macedonia. Thus we determined there is a scope for us to examine the occurrence of this phenomenon in the specific country context. The nascent stage of its development on the national level determined the exploratory nature of our research, which in turn justified the use of the case study method. Full account of the case study is presented in section 5.

The data for analysis was drawn from a combination of primary and secondary sources. We conducted semi-structured interviews with the team involved in the technology transfer and since two of the co-authors were members of that team, they provided direct account of the experience. The secondary data included internal sources which the small business development centre (Business Start-up Centre Bitola - BSC) has on files about the participating firms and the created technologies, as well as documents available in the public domain (in both Macedonian and English language), such as various institutions' reports, websites and presentations on the topic.

## **The technology transfer (TT) process**

### ***Characteristics and importance of TT for entrepreneurship development***

In today's knowledge-based economy, application of technology and innovation and their continual upgrade are key ingredients for competitive and sustained presence of entrepreneurial firms on the market. Both rest on knowledge, which is considered a key asset of intangible nature, leading to many tangible outputs. Thus ownership attributes and property rights apply to it; although with different intensity in different industries, intellectual property rights are still playing instrumental part in creation and dissemination of knowledge and technologies. Nonaka has conceptualised knowledge as a flow, rather than an object (Nonaka, 2008). Technology transfer knowledge transfer seeks to organise, create, capture and create knowledge, to ensure availability for current and potential users. Social capital (with its components of networks and trust), incentives and organisational culture are factors that facilitate knowledge creations and its sharing, i.e transference from one entity to another (Inkpen and Tsang, 2005). Going back to the roots about entrepreneurship theories and the works of Joseph Schumpeter, we can observe that his list of five types of entrepreneurial activity (introduction of a new good, a new method for production opening of a new market, new source of supply or raw materials, and new type of organisation of any industry) explicitly include innovative acts such as technology transfer (Baumol, 1990).

In general terms, technology transfer represents an exchange or a move of technology from one organisation, enterprise or country to another. It takes an advantage of opportunities to introduce newly developed and already available technologies, suitably adapted to the local market/conditions. The process can also

include transfer of skills, knowledge, manufacturing methods and facilities. For example, conferences, student and researcher mobility, technical and scientific journals are forms of non-commercial technology transfer. Evidently, a single and clear definition of the process is lacking, due to the dynamic nature of the technology (Wahab, Rose, and Osman, 2012). The extant literature has identified a number of actors involved in this process, among them the subject who creates and transfers the technology and the subject who receives the technology. There is often a third-party transfer facilitator, who may be represented by universities and research centres, technological brokers, scientific parks or non-governmental organisations (NGOs). Their task is that of facilitating the integration between the two main entities involved and playing a neutral role, but monitoring and controlling their behaviour.

Evolutionary models of the innovation process, in particular, suggest the potential importance of academia-industry networks as sources of new technical knowledge, as a substitute, or in addition to an enterprise's own R&D effort (Ahrweiler, Pyka, and Gilbert, 2011). The fact is, universities and public research centres responsible for developing knowledge and technologies play a fundamental role in the innovation process, and make it possible for companies to incorporate this new knowledge and technology into new or improved products, services and processes. However, the technology development and transfer is complex and multidisciplinary phenomenon, so it requires engagement from a team which includes different professional profiles: scientists, engineers, economists, lawyers and marketers.

For completeness of the process and achievement of an outcome, the transfer itself is followed by a step of absorption of the new technology by the recipient, and its subsequent usage. The transferred technology can be used as originally designed and intended, or it can be adapted, i.e. customised for the new recipient in terms of applicability. After the assimilation and the optional adaptation step, the process of technology transfer is either followed by a generation of new technology with indigenous capabilities based on the adopted one, or the process concludes with the application step. So, in the process of transfer there is an inherent sub-process of technology development, which does not mean only inventing something from scratch, but includes elements of upgrade, i.e. improvements and modifications of the transferred technology to local conditions and circumstances.

Mechanisms for transfer vary, as much the types of technology, and knowledge exchange (whether codified or tacit) is integral part of the process. In case of tangible outputs, like machines or software for example, there is accompanying documentation (manuals) for use of the technology, and sometimes, provision of a training component. Distinction is made between vertical technology transfer (from research to development to production) and horizontal transfer (from one to another operational environment). After the transaction, the acquirer gains a complete command of the technology (Bennet, 2002).

### ***Business incubators as technology transfer agents***

Originated in 1959, business incubation is a relatively new concept. While the practice has started spreading in the United States and worldwide in the 1980's, on the territory of the Republic of Macedonia, it is quite a recent phenomenon. Nowadays, business incubator programmes are popular tool for business assistance in creation and development of new entrepreneurial skills and ventures in all types of economies. They have a supporting and facilitating role in the early stages of small firms, increasing their likelihood of survival and growth through diagnosis and treatment of problems contributing to lack of growth and business failure. The standard range of core services that business incubators provide, include: access to

finance, training and management assistance, marketing knowledge and other resources (office and technical facilities).

Access to knowledge flows is very important for adoption of new technologies and innovations. Successfully adopted new knowledge and applied new technologies become critical assets and competitive competencies of firms, and especially relevant for young and small firms. Given that technology inhabits an increasingly important corner for stimulating growth of any type of SME, the dimension of technology development and its commercialisation is becoming more common for the business incubation system, as part of a more holistic support for the enterprises. Technology support that business incubators offer is embodied in two principal forms: technology transfer and upgrade of original, i.e. indigenous technologies. Dissemination is another integral part of the entire process of technology development and commercialisation and it represents a horizontal transfer. The most common technology dissemination mechanisms, which are usually delivered in a package by the business incubators, include: direct transfer from the developer to the user, field-level practical demonstrations targeting relevant users and through skills development trainings.

## **Entrepreneurial and research climate in Macedonia**

### ***Current state of the enterprise sector***

The political and socio-economic heritage has determined and is still reflected in the current entrepreneurial climate and ongoing economic development processes in the Republic of Macedonia. After its independence in 1991, the ensuing transition period state-planned to a functional market economy has been characterised by a high level of turbulence in the business environment and change in ownership structures. The single canvass of the business sector, dominated by large state-owned firms has transformed in a patchwork of small firms in various emerging sectors. The current figures from the Central Registry Office of the Republic of Macedonia show that 99.8 % of active businesses belong to the categories of micro, small and medium enterprises (MSMEs), as per the EU definition on types of enterprise in terms of number of employees (Enterprise and Industry Publications, 2005).

Over the past two decades, the private and civil sectors have lead macro and micro-level initiatives towards increase of the firms' competitiveness and improvement in their performance by supporting innovation activities, capacity building in key business knowledge and managerial skills, provision of better access to finance and business support services (Bruynooghe, Bosa, and Della Rosa, 2009). In order to counteract the social consequences of restructuring, in addition to the government initiatives there have been several supra-national institutions and international projects, which have allocated funds and directed activities towards establishment of business incubators in municipalities throughout the country (European Commission Publications Office, 2012), and have helped with establishment of four academia-based technology transfer centres as part of the national agenda for SME and entrepreneurship support (Regional Review, 2004). However, the currently reduced level of their activities testify that the utility and long-term effects of any of this kind of organisations have not been optimised due to sustainability issues, and few have even ceased to actively exist after the end of the project funding period.

These shifts in the enterprise sector have been closely related to the structural transformations in the industrialisation of the country. Although a number of specific policies, measures and initiatives have been designed and tested, they have been 'dispersed across several programmes run by different authorities, with insufficient public funding' (OECD, 2001), so there remains a wide scope to fortify the institutional

arrangements for support and development of the enterprise sector and related domains such as scientific research and development of technology and innovations, which are one of the pillars for transition from efficiency-driven to innovative economy.

### ***Challenges for technology development and transfer***

The Macedonian companies are only beginning to really recognise the importance of the technology transfer process as a distinct possibility to harness its outcomes in the running of their businesses, and thus improve their competitiveness and contribute to the society through the innovations introduced into the market.

In developed, more competitive economies, the government usually encourages the process of technology transfer between the public and private sectors and commercialisation of research and development outcomes. To this end, offices or centres dedicated to technology, as well as business and technology incubators are usually placed either at universities and public research centres, or at relevant companies engaged in intensive research and development activities. The research and technology development endeavours in developing countries are characterised as being predominantly adaptive, assuming the 'follower' path, rather than innovative one. Thus instances of acquiring external technologies are more prevalent compared to the indigenous innovations. Even though the issues arising from this process are different from those in the developed countries, models from other countries in the region or developed economies are borrowed and tested.

There is no defined best model for the process of technology transfer or successful operations of a technology transfer centre in Macedonia, since such practice between the public and the private sector is still in the nascent stages. This is partly due to the limited levels of research activities. The investment as a portion of GDP is also very low in this area. The latest available data shows the GERD (Gross Expenditure on Research & Development ) index is 0.23% as a portion of GDP, which is lower than most countries in the region and far below the average of the developed countries in the EU (3%) (Research and Development Activity, 2010).

Furthermore, the links between the technology developers and the Macedonian SMEs as users are weak and unexploited. This impedes commercial exploitation of technologies, or depresses the level of development efforts, due to insufficient external incentives for commercial application, such as existing markets (demand) and intellectual property protection mechanisms. The stagnant environment for technology development and transfer in Macedonia in that began in the post-privatisation era, among other contributing factors, is a result of the outdated national educational system, which does not boost entrepreneurial spirit and innovation thinking nor provides leadership in science and technology. The highest R&D intensity in Macedonia occurs within the public sector. In the private sector, several large firms remain sources for innovation and technology development and transfer, with the exception of the IT sector, where smaller firms prevail. Numerous companies that had relatively advanced technological infrastructure and products at the time of privatisation, or good potential to acquire modern technology through transfer and adaptation, were quickly sold or broken down into smaller entities in the 1990's. Thus the country needs to harness the SME sector and its entrepreneurial potential for development and commercialisation of technologies and innovations.

However, the science and business interface remains one of the weakest links of development policies in the country, despite the notionally recognised importance of strong science, technology and innovation (STI) domains. Also, the current level of inter-sector interaction is below par and potential, with unexploited linkages and exchange flows between knowledge and technology creators and users. Public sector

actors responsible for the science, technology and innovation policy include: the government ministries, research / academic institutions and regulatory / legislative bodies (Patent Offices, etc.). Although there have been some STI development endeavours at national level, with policy-level guidelines and governmental support to institutions in the formative stages, still, the fact is that these 'government bodies currently do not take sufficient account of the importance of the scientific and R&D sector during the process of making key decisions' (Polenakovik and Pinto, 2010).

There has been an emphasis on the importance for establishment of a robust national innovation system, with the triple helix of academia-industry-government relationships in its core, which would encompass all the institutional and organisational structures which support innovation and technology development and transfer (Polenakovik and Pinto, 2010; Stankovic and Stankovic, 2002). Long-term commitment for adaptation of the current ecosystem is required, with policy tools to strengthen the scientific and technical educational institutions, stimulate successful networking and collaboration among relevant organizations which participate in production, diffusion and utilization of knowledge and technologies. Also, there is a need for market assessment and gap identification of technology demand and supply, and strengthened national legal institutions for protections of intellectual property. There is legislation on science, technology, research and development, and intellectual property, but lack of awareness among the communities and weak governance do not offer incentives for research activities for commercial application and prevent prolific output. Of equal importance is wider implementation of internationally recognized technical codes, standards and certificates, to ascertain quality and functionality of technologies. The Industrial Policy 2009-2020 aim to address the anomalies, but it will take some time before we can report successful outcome from its implementation.

### **Case of the Business Start-up Centre (BSC) – Macedonia as a technology transfer agent**

The organisation Business Start-Up Centre from Bitola (BSC in the following text) is an NGO fulfilling the role of a small business development centre, its aim is to foster sustainable economic development by supporting local economic environment and higher education institutions to promote entrepreneurship with a focus on three main strategies: poverty alleviation, capacity building and policy making (Business Start-up Centre Bitola, 2012).

The BSC targets mainly, but not exclusively, the geographical and statistical region of Pelagonia, covering nine different municipalities in the south-western part of the Republic of Macedonia. It has a strong advisory structure, embodied in a network of experienced consultants and experts from various business sectors and industries. With the help of this resource network, its business incubator provides entrepreneurs and their businesses proactive business support through trainings, consulting, access to critical tools, resources, contacts and capital, as well as technological and legal advice, such as assistance with intellectual property protection. The centre also engages in exchange of experiences and know-how with an international network of business incubators. In 2012, additional funding for technology transfer component was approved by the donor (USAID), as part of their strategy to support the enterprise sector and contribute to development of the national economy.

In a previous needs analysis among the incubator's tenant companies it was established that access to the right technology would improve their operational processes, the overall productivity of the firms and stimulate their innovative growth, which are usually impeded by a lack of internal knowledge and initiative. Thus it was

decided to design a deliberate process for upgrading the capabilities and working practices of these firms, by introducing innovation, wherever possible. This case will illustrate this process through two initiatives, which involved development of two pieces of industrial technology: a machine for drying mushrooms and a vacuum press for laminating and gluing wood.

### ***Brief narrative about the companies and the commissioned machines***

Ilce Fungi Ltd. is a micro manufacturing firm, existing since 2011 and one of the virtual tenants of the BSC business incubator. It operates on a very lean headcount, i.e. in addition of the owner it employs between four and six temporary, seasonal workers. Its main business activities cover processing of fruit (apples and plums) and vegetables (peppers and wild mushrooms), which are purchased directly from local farmers or collectors. In order to increase its competitiveness and chances of survival and growth, the owner has decided to extend its product line and start producing dry mushrooms in 2012. To achieve this, the firm needed to acquire a new technology for drying of fresh mushrooms, since their existing equipment did not allow for such process. Rather than opting for imported and adapted technology, on the advice of the BSC the owner decided to engage a domestic technology development and transfer directly from the local Faculty for Technical Sciences, which was estimated as a more convenient and affordable option.

Three main parties were involved in the collaboration: the firm receiver of technology, the faculty as a creator and supplier of the technology, and the business incubator as a facilitator and an agent in the transfer. As a result, a team consisting of a professor and students from the faculty developed a prototype for the mushroom drying machine, based on the specific needs of the Ilce Fungi Ltd. The faculty team has already been working on similar design, but the owner was keen to receive a customized machine which was not readily available on the market and a pre-requisite was to incorporate innovative and green technology features. Thus the development team constructed a machine which operates on hot air, produced in a heating component which converts the water into air. They added an innovative element to the machine design, which would enable simultaneous use of different energy sources for heating of the water and harness them in the production process. Use of renewable sources of energy was made possible, such as biomass derived from wood cuttings, which could meet 100% of the heating needs for drying, as well as solar energy which be harnessed in the operative process and bring up to 60-70% savings, depending on the climate conditions in a given period of exploitation. The machine designers have offered an innovative solution by enabling flexibility in terms of provision of the required heat for the drying process, but also, they have managed to produce an environmentally friendly and energy efficient equipment. In addition, the mushroom drying machine can be operated by using electricity as a third energy source.

Nima Door Ltd. is another micro firm from the region of Pelagonia, which in the capacity of a virtual tenant benefited from a technology transfer facilitated by the business incubator. Established in 2009, this company produces custom-made wooden furniture and other type of carpentry and woodwork. It is run by a small team of a head constructor, who is also an owner of the total capital, and a qualified worker. The firm currently operates only on the domestic market, with a focus on the region of Pelagonia, but there are plans and some potential opportunities to expand its client base in the neighboring countries, starting with Greece.

In preparation for such expansion and increase of its opportunities for international business collaborations, the company has decided to invest in new technologies in order to increase its internal operating processes and production capabilities.

Therefore, on the initiative of the BSC business incubator, Nima Door have entered in a collaborative process of technology development and transfer with the Faculty for Technical Sciences in Bitola, for acquisition of a vacuum press for laminating and gluing wood. This machine would enable the firm to start a serial production of interior doors and woodwork, as well as semi-finished products, increase the capacity of the production unit, while at the same time it would heat the work premises.

The prototype produced by the technology team at the faculty was customized to the firm's needs and incorporated innovative solutions. This was achieved as a result of a close collaboration between the technology supplier and receiver, in iterative steps throughout the process. As with the other machine we described above, the vacuum press was designed with a possibility to operate on several renewable sources of energy. In addition to the standard electrical heaters, the process of drying of the glue could be performed by a hot air or gases emitted from a special generator, which is installed in the heating system for the premises of the production unit. In this way, the hot air can be used for the operative needs of the vacuum press and the surplus will be used for heating of the workspace. This innovative component provides environmentally-friendly and advanced features to the machine, and ensures an uninterrupted operation of the press, independent of the power network, with significant energy savings.

With the help of this investment, Nima Door is close to achieving not only increased volumes, but also reduced costs and time for production, and thus becoming more competitive in their segment of the market. This would contribute to their long-term goal, which is procurement of other types of more sophisticated production equipment in order to would enhance the production process and widen its product range. The construction of prototypes for the designed technologies was outsourced to other small, domestic companies through a public tender in May 2012. The prototypes were ready by the autumn and exhibited at the Tehnoma, an innovation segment of the Makinova Fair, which was held in Skopje in mid-October.

### ***Review and analysis of the cases***

The commissioned technologies were crucial for growth of both SMEs. Their business models and the production process were based on specific technologies not readily available on the local market. Although the technological solutions offered by the faculty were not scientific breakthroughs or new inventions, the technical adaptations provided functionalities that were new for the user firms. In addition, they enabled innovative possibilities, such as sustainable use of energy sources. The firms were involved in the selection, development and customisation of the technology from the outset and were co-financed 40% of the technology development and transfer. In this project, the incubator has brought together individuals and organisations from the entire value chain: their tenant firms as end users, academia (scientists and researchers) in the role of technology developers and other SMEs as producers of the commissioned technology, while BSC monitored and coordinated all the stages of the process. The organisation has created value for all involved parties by harnessing their social capital and credibility among the communities in the region and wider.

The centre, with its business incubator is the only organisation of this kind on the national territory and among the rare ones in the region that are actively facilitating development and dissemination of technologies to the SMEs and as a result increase their capabilities. Even when the value of internal capacities for utilising technologies is recognised by the firms, it is not feasible due to their scarce resource base; we are talking about small, and often young firms. Through their network of experts, the BSC provide them with an independent and impartial advise regarding the selection of the right technologies.



The process of technology transfer can be a single transaction, or as was the case with these machines, a longer-term collaborative relationship between the acquirer and supplier of technology, aided by the transfer broker (Bennet, 2002). The process of acquiring technological capability has a cumulative character and is accompanied by learning, particularly about the application of the new technology. As a complementary step to the acquisition of technology via transfer, the BSC offers an ongoing provision of training for the incubated SMEs, aimed to raise awareness about emergent technologies and their utility in business, and facilitate increase of their absorptive capacity and knowledge base. Through inducing the demand for new technologies among the firms, the BSC indirectly assists the research institutions in their capacity of R&D providers to the business sector.

“The true cost of commercialisation does not stop with the development of technology...the true cost is creating a path to market” (Steinman, DK, 2002). Significant portion of expenses belong to technology distribution, sales and manufacturing activities. Creating a channel to the users is crucial, yet quite expensive element. Existence or creation of a market is the most important factor for commercial success of any technology and acts as an incentive for the research and development efforts. Demand from the end users stimulates and accelerates the process of development and adaptation. The BSC has successfully detected a need for application of technology and initiated a deliberate transfer to meet real needs, effectively crossing the divide between two separate sectors and facilitating collaboration and knowledge flows. They also played a significant role in raising awareness among the SME community about emerging technology trends and opportunities for business application. To aid dissemination of the technologies, the firms have volunteered to actively promote to the wider business community, not only the new technologies and their applicability, but also the process of their creation and technology transfer as an avenue for innovations.

## **Conclusion**

With the case study we illustrated how a business incubator can contribute towards the agenda for strengthening of the academia /science and business interface, and as a result positively affects not only the competitiveness of firms, but also galvanised the process of creation and commercialisation of innovations.

Both instances were cases of demand-driven technology development with an obvious commercial application, based on real needs of the clients, but also with a wider market potential. They represent 'pull' type of initiatives of technology development and transfer, which were instigated by the micro firms as end users. The transfer of the technologies was brokered through the BSC in the role of a transfer agent, but involvement of all parties and direct interaction among them were maintained throughout the process. There is also an element of active user involvement in the creation, i.e. adaptation process, since the firms participated in the consultations with the faculty teams and with the companies commissioned for the prototype construction. The whole process of technological support was aligned with the core objectives of the business incubator, and became an integral part of their agenda for entrepreneurial support. The transfer was primarily intended to increase the technological and business capabilities of the incubator tenants, by addressing the lack of research and development capacities within the firms. Visible improvement of their operations, productivity and profits are expected within the next twelve months, and real figures will be additionally reported.

Policy makers and academics have diagnosed the current less-than-favourable environment for research and development in Macedonia, and highlighted the need

for incentives and stronger links among the actors in the system, to accelerate socio-economic growth based on development and commercialisation of innovations (Polenakovik and Pinto, 2010; Stankovic and Stankovic, 2002). We illustrated an instance in which a business incubator has managed to activate unexploited links and bridge relationships among the private sector (SMEs) and the public research domain, merging the meso and micro levels of support and intervention. Thus we consider that our case study about the practice of the business incubator as a technology transfer agent makes a contribution by presenting the idiosyncrasies of the process of technology transfer in the Macedonian socio-economic landscape. It is an effort to identify a technology transfer route which would prove successful in practice in a country like Macedonia, which has limited industrial base. Our paper has reconfirmed that there is a scope for evolution of the technology paradigm within this context and suggested a pathway towards a suitable system with processes matched to the development levels and needs of the SME sector and the local economy.

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