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# The Role of mediator organisations in the making of innovation systems in least developed countries. Evidence from Tanzania

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# The Role of mediator organisations in the making of innovation systems in least developed countries. Evidence from Tanzania

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## Abstract

This paper examines the linkages and interactive learning processes between foreign and local actors in an innovation system in Tanzania. Specifically, the importance of a mediator organization to absorb and transfer knowledge from the foreign to the local sector is examined. The potential application of emerging knowledge spillovers to wider local users is thus evaluated. Empirical evidence suggests that although the potential exists for the wider application of technology and knowledge spillovers, a number of key constraints partly hinder the achievement of this potential and the proper functioning of an innovation system.

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## Biographical notes

Astrid Szogs is research fellow at the Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE) at Lund University, Sweden and affiliated to the Research Policy Institute, Lund University, through the LEAP4D (Learning Economy Analysis and Policies for development) group. She is being trained by leading scholars in the interdisciplinary field of innovation studies and in particular systems of innovation. Her main research interest is the role and impact of science, technology and innovation policy in a developing country context, in particular Africa. Ms. Szogs is serving as faculty member in the African Science, Technology & Innovation Indicators Initiative.

# Introduction

Innovation is considered to be the engine of growth and development (Nelson & Winter, 1982; Nelson, 1993; Fagerberg et al, 2005; Lundvall 1992, Archibugi & Michie, 1998) and, as a consequence, innovation studies are paying an increasing attention to how innovation can support growth, development and catching-up in less developed countries (Muchie et al, 2003; Lundvall et al forthcoming, Mytelka, 1993; Ernst & Lundvall, 1997). It is generally accepted that innovation is the result of interactive learning (Kline and Rosenberg, 1986). New knowledge is created when different organizations interact and share knowledge. The concept of systems of innovation puts interactive learning at the core of their discussions on innovation, growth and development (Lundvall, 1992). In the literature, the concept of innovation systems (Lundvall, 1992, Edquist, 1997) has mostly been applied to developed countries, which have strong and well-developed systems. In developing countries, less empirical and theoretical material can be found. The inadequacy and inappropriateness of the institutional infrastructure and physical and human resources in least developed countries (LDCs), can be considered as a challenge to examine whether this approach is useful in a developing country context.[1]

Interactive learning can take place between firms and other organisations such as knowledge providers (universities) (Mowery, 2005; Vang et al, forthcoming 2008), other customers (Lundvall, 1988) and technology service providers (e.g. Archibugi & Michie, 1997, Edquist, 1997) or among firms. In a developing country context, interactive learning taking place between multi-national enterprises (MNEs) and indigenous firms is considered to be particularly relevant (e.g. Marin & Bell, 2006; Barnard & Cantwell, 2006). MNEs generate both specific technologies and organisational expertise consociated with the management of human and physical assets which are fundamental both for the generation of innovation as well as for its use (e.g. Dunning, 1993; Dunning, 1995; Zanfei, 2000, Cantwell, 1989). The extent to which this advanced knowledge might be transferred to indigenous firms through knowledge spillovers has been subject of a large debate (Dunning, 1995; Cantwell & Piscitello, 2007; Zanfei, 2005). In order to learn from the MNEs and to be able to diffuse the technology, the absorptive capacity of the indigenous firms in the host country is of great importance (Durham, 2004). It is argued that the more indigenous firms invest in their own technological capabilities, the more they will be able to absorb knowledge from external

[1] Muchie et al (2003) have provided several examples of the making of innovation systems in different African countries and how the concept of national systems of innovation can be applied in Africa.

sources. The problem is that in the least developed countries, the absorptive capacity of the indigenous firms is very low and thus, few firms can potentially benefit from knowledge spillovers from those MNEs established in the country or region. Importantly though, even when the knowledge is "transformed" to what might be absorbed by the local firms, the fact is that there are other factors that might be hampering the transfer of knowledge, such as e.g. the absence of demand. The literature is very limited when it comes to discuss possible mechanisms by which knowledge can be transferred between MNCs and indigenous firms in less developed countries when the absorptive capacity of the indigenous firms is low.

This paper aims at contributing to this research gap by analysing the role of local technology service providers as mediators between MNEs and the local innovation system (IS), using the case of Tanzania. For doing so, we focus on two collaboration projects between two MNCs subsidiaries[2] in Tanzania, Tanzanian Cigarette Company (TCC) and Coca Cola Kwanza Ltd., and the Tanzanian Industrial Research and Development Organisation (TIRDO), paying specific attention to how learning takes place between the MNEs and the local technology service provider on the one hand and, on the other, to how this knowledge is transformed, transferred and applied by local users. The barriers to such transfer process are discussed, being one of them a lack of local demand of the knowledge generated through the interaction between the MNE and the local technology service provider. The paper is based on data collected through field work in Tanzania in 2002.

The paper is structured as follows. First, the theoretical framework is introduced. The concepts of innovation systems and interactive learning are briefly summarised to focus the discussion on knowledge spillovers between MNEs and the local innovation system. The methodological section is followed by the presentation and discussion of the role of TIRDO as a mediator organization facilitating knowledge transfer between MNEs and the indigenous firms. The paper is rounded up with some policy conclusions.

[2] A MNE is in its simplest way defined as "a corporation or enterprise that conducts and controls productive activities in more than one country" (Todaro, 2000:578) and engages in FDI (Dunning, 1993).

# Innovation systems and knowledge spillovers between MNEs and local IS in less developed countries

## Innovation systems

The innovation system (IS) approaches vary with regard to their main focus[3] but share all an understanding of the underlying relation between technological change and economic growth (Lundvall, 1992; Lundvall & Johnson, 1994; Edquist 1997) and view innovation as the result of social processes and hence an interactive and dynamic process over time rather than a linear process from basic research to product development (Kline & Rosenberg, 1986). The IS approach thus highlights the interactions between various components, such as institutions, public policies, science and technology. Importantly, the patterns of these interactions are shaped by a series of determinants such as a country `s institutional framework and knowledge infrastructure. Hence, the interconnections among various institutions and how they interact with each other are crucial to the definition of a national system of innovation (NSI) (Edquist, 1997).

In a LDC context, those factors that determine industrial success have also been referred to as comprising a "national industrial learning system", whereby "the main elements interact with each other in a systematic way to influence enterprise capability development" (Lall, 2002: 7). Lall uses this concept as being similar to that of NSI (Nelson, 1993) however, preferring the use of national *learning* systems to accent LDCs main concern with the mastering and use of existing technologies, rather than with the generation of new ones (innovations).

Importantly, innovation systems in developing countries are different from that of developed countries in a number of aspects. Characteristics of innovation systems in developing countries can be found in their dynamics (exogenous versus endogenous) as they are often, as opposed to developed countries, strongly dependent on external sources of knowledge and financing (Muchie et al. 2003) and most often the linkages between the various actors are of rather sporadic nature, which leads to more fragmented systems (Narula, 2002; Bonilla & Johnson, 2001). As LDCs do not have the same strong resources as developed countries their systems need to be more open.

[3]There are different ways for how to conceptualise innovation systems. Concepts of "regional", "sectoral", "national" or simply "innovation system" are common among the different system approaches.

In developing countries MNEs are of significance since they represent an important source of knowledge in systems of innovation in these countries (Pietrobelli and Rabellotti, 2007; Narula & Dunning, 2000). To examine their workings in innovation systems in developing countries and their linkages with other actors, in particular indigenous firms through case studies becomes therefore highly relevant.

## MNEs and indigenous firms

A key aspect of the phenomenon of globalization is the growing role of MNEs as major actors in international production and innovation (Zanfei, 2005; Stiglitz, 2002; Kuemmerle, 1999). Due to changes in the structure of the global economy and a trend towards globalization of R&D activities, which started around the mid 1980s, foreign affiliates have more seriously been studied as potential sources of new knowledge (e.g. Zanfei, 2000, Zander, 1999), particularly for firms located in the host country. Foreign affiliates play here the role representing the parent companies activities abroad, including strategic choices of innovation and R&D strategies. Thus, MNEs are becoming an increasingly important source of knowledge.

MNEs might generate knowledge spillovers to the local industry (Cantwell and Piscitello, 2003, Lall, 1996, Narula, 2001; Ozawa, 1999)[4]. Despite the growing amount of empirical data, the available evidence of technology spillovers is, to cite Zanfei, however, rather "shaky and contradictory" (Zanfei, 2005: 8). Basically one can distinguish two rather different approaches. On the one hand, many development scholars have long argued that the potential for upgrading by the indigenous firms is highly limited as MNEs tend to retain most crucial knowledge and maintain control over their core competences (Humphrey & Schmitz, 2002; Humphrey & Schmitz, 2002a; Morrison et al 2006). On the other hand, scholars in the cluster and innovation system tradition are increasingly providing evidence that the opposite can also

[4] The opposite might also occur. MNEs units are increasingly using the location of R&D departments and subsidiaries abroad in order to get access to both local sources of knowledge and information and different application possibilities. For the MNE their external networks become crucial assets with respect to competition, due to the easy access to local skills, user needs, understanding of the behavior of actors of the host countries. Hence, it has been argued that MNEs increase their body of knowledge and can enhance their innovative capabilities by increasing their degree of involvement in local contexts (e.g. Zanfei, 2000). To achieve this, an intensification of the available linkages with local stakeholders is crucial. Importantly, Zanfei argues furthermore that foreign affiliates and the decentralized R&D units play important roles in knowledge transfer and accumulation processes and that MNEs through their presence of foreign affiliates in local contexts increase these efforts and intensify relationships with local actors.

exist, that is that the interaction with MNEs can generate spillovers in terms of knowledge that can be further absorbed by the indigenous firms thus facilitating upgrading (e.g. Chaminade et al 2007, Vang et al 2008). The existing literature argues that the extent to which this occurs is a function of characteristics of both the MNE (organizational structure, mandate of the subsidiary, etc) and the indigenous firm (absorptive capacity) (Cantwell and Piscitello, 2007; Barnard & Cantwell, 2006; Chen, 1996). The term "absorptive capacity" refers to the collective abilities which "…prior related knowledge confers…to recognise the value of new information, assimilate it, and apply it to commercial ends." (Cohen & Levinthal, 1996: 542). It is related to the "the ability to search and select the most appropriate technology to be assimilated from existing ones available, as well as the activities associated with creating new knowledge" (Narula, 2004: 6).

Only very recently some scholars have started to pay attention to the infrastructural conditions, that is, how the system of innovation can support or facilitate the transfer of knowledge between MNEs and indigenous firms and which institutions and actors are crucial in this process (e.g. Bell & Pavitt, 1997). In this respect, it is argued that the physical and human (social) infrastructure of the wider local context plays an important role to effectively absorb spillovers (Dunning, 1993, Narula, 2004, Kokko, 1993). The literature is however rather vague when it comes to describing *how* the wider context might facilitate the absorption of knowledge spillovers or, in other words, how the different organizations of the system of innovation might support the knowledge transfer between MNEs and indigenous firms. Thus, we know little about which specific actors in innovation systems in developing countries contribute to and enable effective knowledge transfer between MNEs and the local industry.

## Methodology

The empirical material consists of two specific cases of collaboration between two MNEs and a local technology service provider. The case data consists of a series of semi-structured interviews conducted at the two MNE affiliates, Coca-Cola Kwanza and Tanzania Cigarette Company Limited (TCC) and TIRDO[5] as well as documentary data (e.g.company information, reports). These companies have been chosen as they represent two successful FDI cases, and the companies also co-operate with local actors. Importantly, the two cases have been selected as they illustrate how the knowledge can fully (case 2) or cannot entirely

(case 1) be applied in the local context so that it actually leads to innovation. The interviews have been conducted during a fieldwork in Dar es Salaam in June 2002. Relevant staff, involved in the projects, has been interviewed both at the companies and at TIRDO. This included company managers, project managers and technical staff. The objective of the semi-structured interviews was to test the assumptions and to gather additional, related information. The rationale for this choice is that such interviews provide qualitative information with regard to the predefined characteristics of a system of innovation, or learning in a LDC context with the focus being on different forms of interaction between foreign affiliates, as representatives for FDI projects, and TIRDO. In the following the different actors are presented, which is then followed by an analysis of the empirical material.

TCC and Coca-Cola represent two major MNE affiliates, their FDI motives are market seeking. For Coca-Cola there is a huge potential for soft drinks, taking into consideration the climate in that part of the world. In the case of TCC, there was no other tobacco factory when they established themselves in 1961, so also here there were market reasons.

## The Role of intermediate organizations in systems of innovation in less developed countries: the case of Tanzania

Tanzania is the largest country in Eastern Africa and one of the poorest countries of the world. 50 % of the population lives below the absolute poverty line (ESRF, 1998). The manufacturing sector contributed with less than 8% of the GDP in Tanzania in 2001. The sector is also characterised by poor performance with the annual growth being less than 2% (UNCTAD, 2001). The country has embarked on programmes to attract foreign direct investment (FDI) in different sectors of the economy, which can have an impact on the NSI as FDI is sought to bridge the industrial, technological and knowledge gap. Thus, through the attraction of FDI and the gradual economic restructuring process Tanzania is gradually taking steps towards steering its economy towards development.[6]

In the "national science and technology policy" as expressed in the UNCTAD document it is stated that the most effective way for Tanzania to benefit from possible FDI spillovers,

[5] For more detailed information on the different participants of the collaboration see appendix 1.
[6] For a more detailed overview over FDI size, growth and inflow into Tanzania see UNCTAD (2001) Chapter 1. An overview over influences on investments of manufacturing firms in Tanzania is given in Grenier et. al (1998).

especially in technological development, is "by improving the capacity of its domestic sector to learn, adapt and assimilate technology" (UNCTAD, 2001: 92-93). In this vision the actors of a national innovation system (NIS) envisaged for Tanzania include technology service providers, learning institutions, foreign subsidiaries, the domestic sector, government ministries and business associations. This vision is endorsed by the government of Tanzania, and other local and international stakeholders, such as international organisations and foreign investors. In order for this to happen, the need for a systemic approach has been highlighted and a model for a potential SI on a national level proposed (ibid: 85). It is argued that "only by applying such a systemic perspective and formulating policies that stimulate interaction in the system and encourage the active participation of the private sector can technologically weak economies like Tanzania be able to develop a dynamic enterprise sector and maximise the impact of FDI" (ibid: 84). The domestic enterprises comprise the centre of such NSI and these are linked with varying strength to the other actors in the system. It is indicated in the proposed NSI that some links are weak or even non-existent. [7] R&D in Tanzania, is primarily carried through by governmental institutions (the parastatals) (Bongenaar & Szirmai, 1997 + 1999). It has been shown that the R&D capacity of the country is de-linked from the private sector, contributing only little or nothing to technological upgrading at the firm level (UNCTAD, 2001: 80). Wangwe (1995) suggests that the institutional framework established for the development of science and technology is not functioning ideally and he argues that the "system of coordination and cooperation among various institutions and other actors in R&D is not as effective as it is supposed to be" (Wangwe, 1995); an important issue is therefore to better link R&D institutes with industry (ESRF, 1998). These necessary linkages are poorly developed in Africa in general (Mytelka, 1993), which also applies for Tanzania. The same can be said as regards to the linkages between the subsidiaries of MNEs and the local firms. One of the possible explanations for the lack of linkages might be the low absorptive capacity of local firms. In our research, we explored the role of intermediate organizations bridging the gap between the technological level of the MNE and the local system of production and innovation.

Two specific project of collaboration between a local R&D institute and two MNEs (TCC and Coca Cola) have been chosen for the case study. These two cases were selected as the represent two successful FDI projects in Tanzania. Both projects were carried out because both MNEs had to conform to standards in relation to health and security regulations. In these

[7] For a complementing overview over technology support institutions and major public sector institutions

particular cases, the local expertise was sought after due to proximity reasons; lower costs and TIRDO conducted the different measurements, because the specific expertise needed for these measurements was not available at the companies. In both cases, market reasons explain the operations in Tanzania. For Coca-Cola there is a huge potential for soft drinks, taking into consideration the climate in that part of the world. In the case of TCC, there was no other tobacco factory when they established themselves in 1961, so also here there were business and market reasons.

## Case 1. Collaboration between TIRDO and the Tanzanian Cigarette Company (TCC)

### *Background*

TIRDO is a parastatal organisation that started operating in 1976 as an industrial research organisation. Basically TIRDO was set up for conducting research and provides consultancy to industry. The main purpose of the research is to develop products and processes that are suitable for the Tanzania industrial environment. The core of TIRDOs activities is to support the use of local resources, to promote indigenous technology and to utilise raw materials in economic ventures. Services to industry covers instrumentation maintenance and repair, chemical analysis, energy management, cleaner production, material testing, machining welding and fabrication and industrial information, in form of a collection of technical and reference books and reports, journals and catalogues. Moreover, TIRDO offers various training services to industrialist and entrepreneurs.

An R&D institute in a LDC context, such as TIRDO in Tanzania, does not have the same position as a similar institute in a developed country. TIRDO can be placed on a quite similar level as the local firms and the local industry in general, even though they have the competence to provide services to MNEs (Nindie, 2002). TIRDO provides more support to the local industry, or strictly speaking to industry in general, rather than doing research and development in the sense of being a leading institution in the field of science, technology and innovation. Thus, TIRDO is operating on different levels, where one is to help the local industries, and the other to conduct more sophisticated studies for foreign-owned companies.
It is noteworthy that TIRDO is operating on more levels than these two, since different forms for training, and workshops are also offered by TIRDO. Its main role to function as a

involved in FDI, as well as a diagram over the proposed NSI see UNCTAD, 2001: 76 and 81.

"mediator" between the two different spheres of knowledge is therefore to combine and integrate the different bodies of knowledge, foreign and domestic, that exist in the system.

Tanzanian Cigarette Company (TCC) is a subsidiary of the Japanese Tobacco International (JTI) Company, which has 25 factories in the world. TCC was privatized in 1997. TCC has been referred to as high profile success story with the sale of 75 percent of shares to RJ Reynolds (CTI, 2000). The company employs 700 people country wide, 250 in manufacturing, which also covers engineering. Since its foundation, the company has made substantial and continuous investment in in the factory. They also have undertaken substantial investments in machinery as well as in human resource development.

The collaboration with TIRDO took place between August 2001 and July 2002. The background for this project was the interest of the Industrial Safety and Loss Prevention Department at TCC to know the noise levels in the factory. They approached TIRDO to conduct a study on the noise levels. Thus, TIRDO `s task in the collaboration with the MNE was to measure these levels and to produce an evaluation report with the findings and recommendations. The measurements were conducted different areas of the company that had reported noise complaints by both operators and technical officers. The Safety Department wanted therefore to know if the noise from the different plants and different machineries was within the acceptable range, which means that it is not too high.

For the measurement, TIRDO used international standards, such as the Occupational Safety and Health Administration (OSHA) of the United States of America. The results of the noise level tests showed that cutter and filler and compressor room areas were within the acceptable levels of noise level for a worker of an eight hours shift. The noise levels of the make and pack, boiler house and primary section turned out to be as high as 90 dB(A), which is beyond the permissible levels, and can cause risk for the workers[8].

TIRDO presented several recommendations for the TCC technical personnel in order to reduce the plant noise level. It emerged that the maintenance of equipment plays an important role in the extent of plant noise level, in that there are several reasons and conditions that make old and worn out equipment less resistant to vibrations and noise. It was therefore

[8] Typical effects of noise exposure are tympanic ruptures, which derives normally from a sudden noise, temporary deafness, which can come up soon after exposure to loud noise but improve, permanent deafness, which can come up son after exposure to loud noise but improve permanent deafness (see also TIRDO 2002a).

recommended that old machines should be replaced by quieter, full enclosure machines; such as compressors and generator sets. Furthermore it was recommended to use personal hearing protectors, by workers who are exposed to higher noise levels. Moreover, all employees working in these areas should be informed about the dangers and this should be done regularly, say twice a year, for the workers to be aware of the hazard.

***Interactive learning between MNE and TIRDO***

Interestingly, the interviews indicated that foreign affiliates in the case study received important insights and assistance from the local R&D institute, TIRDO while at the same providing TIRDO with crucial new knowledge, hinting also the available technological and absorptive capacity of the R&D institute. Indeed, representatives from TCC have described the project as a whole, as capacity building. Local experts have been involved to carry out a study, were different kinds of measurements were required. More specific, it could be stated that the instruments, used for the measurements were new to the technicians at TCC. Therefore, most of them would not have been able to identify the actual measurements of noise level in the production environment.

***Transfer of knowledge to the local indigenous firms***

It has been argued that an MNEs like TCC are like a college (Usiri, 2002). For example, engineers employed at TCC receive a very good education based on various approaches from formal training to courses as well as other methods. This makes those engineers very attractive for the wider local context (Usiri, 2002). Furthermore, locals may learn from the general high standard at TCC (Usiri, 2002). In this case, the interaction with the MNEs has also lead to improvement of the equipment at TIRDO and TIRDO has learned how to go about such issues and to keep at pace with the technology (Nindie, 2002) which might further be incorporated in TIRDO training programs and support services for the local industry.

## Case 2. Collaboration between TIRDO and Coca-Cola Kwanza

### *Background*

Coca-Cola Kwanza Ltd. is a subsidiary of a South African company and produces beverages under the Coca-Cola franchise. The company with the present ownership was established in 1996. The construction and subsequent commissioning of a $25 million Coca-Cola bottling plant in Dar es Salaam also be referred to as highly successful. The affiliate employs 134 persons. Coca-Cola Kwanza started collaborating with TIRDO in 1997, in a project on energy auditing. The collaboration on indoor air quality started in October 2001 and finalised in July 2002.

The collaboration was the consequence of a re-organisation of the warehouse at the Coca-Cola plant in Dar es Salaam to meet the increasing demand of activity. The purpose was to improve the efficiency of the loading operations. The warehouse is adjacent to the production plant under the same roof of a huge building structure. The initial arrangement allows about 10 folk lifts to enter the warehouse in order to empty the bottles and pick up the filled ones. The proposed changes were to shorten folk lifts' route and therefore to led trucks into the warehouse. The Coca-Cola sub-plant management feared that there might be a risk to the added emissions from truck exhaust. So the collaboration with TIRDO aimed studying the indoor air quality. TIRDO `s task in the project was to measure emission levels and to see if it they were acceptable (for workers health and security welfare). The actual objectives of the study were to quantify six parameters emitted from forklift in the warehouse. The sampling was limited to six pollutants (Carbon dioxide ($CO^2$), carbon monoxide (CO), sulphur dioxide ($SO^2$), nitrogen oxide (NO), nitrogen dioxide ($NO^2$) and general hydrocarbons (HC) ).

Based on all sampled pollutants[9] engineers from TIRDO found that the Coca-Cola warehouse had concentrations in general accepted levels. The report states the actual measurements for the different pollutants, followed by detailed recommendations (TIRDO, 2002b).

[9] For the measurements a dry analysis was undertaken, using a detector tube kit model AP-1. This detector tube has been chosen as it met the requirements for indoor air measurements. A gas detector makes an application of a chemical reaction and a physical absorption. When a gas is sampled into a detector tube a stained layer is produced by means of reaction of the reagent as well as the gas within the tube. Such detector tube kit usually includes a hand pump that draws the known volume of air through the tube, in order to receive the reaction. The gas concentration is proportional to the length of the stained layer. Therefore the reading of concentration level can be gathered from the stained layer. The gas concentration reading method was divided into two ways, a direct reading method, where reading is obtained directly from the scale print on the tube, and a concentration chart method. Except for the nitrogen oxides the first method has been applied.

***Interactive learning between MNE and TIRDO***

In the case of Coca-Cola it has been stated that interactive learning between the involved actors was taking place at certain levels, but not at a maximum during all stages of the collaboration. Case evidence also suggested that it was during the initial stage, in which TIRDO and Coca-Cola staff was sitting together and undertaking brainstorming sessions to come up with possible solutions to the problem, in which interactive learning occurred.

Both in this case as well as in the first one (TCC-TIRDO) technicians at the companies manifest that they have leant from the engineers from TIRDO. One can therefore argue that, while collaboration has been going on, the way both parts have been dealing with each other can be characterised as being interactive. The process involved for TIRDO first coming up with a draft, which was then discussed with the company. TIRDO explained their ideas, as solutions to the company's problems. Moreover, the companies were also informed about TIRDO `s experiences, what they have tried and failed, as well as if similar studies have been conducted before; showing that they proceed together in the initial phase, and based on that, keep on interacting.

***Transfer of knowledge to the local indigenous firms***

The transfer of the knowledge generated in the Coca-cola project was on the one hand more problematic as it refers to standards or practices that were too advanced for the local factories. The knowledge absorbed by TIRDO can only be transferred to the local industries when these approach TIRDO for their expertise. [10] That is, knowledge transfer is possible when there is a local demand for certain knowledge. If the standards of the MNEs (here we refer to both Coca-Cola Kwanza and TCC) are too high to what could be demanded by the indigenous industries, then TIRDO will have difficulties to transmit the knowledge generated through the MNE collaboration project to the local industry. A very successful example, however, is the transformation and adaptation of the knowledge acquired through the collaboration with Coca Cola Kwanza in the changes in the design of traditional stoves, impacting their performance significantly (TIRDO 2002c).

Thus, the knowledge acquired through these two cases of collaboration has been further applied in the local context in two different ways:

1. Direct application: TIRDO has been asked to undertake similar measurement projects at the Hotel Holiday Inn. This is referred to as an example for use of accumulated knowledge and technology by TIRDO in the wider local context. However, it is noteworthy that the "local context" is another foreign investment in Tanzania and that the company belongs to the tourism industry and not to manufacturing. This seems to show the "market" for certain type of knowledge and applications of technology may be limited (case 1).

2. Indirect application / innovation: The second form of transfer is more interesting. The knowledge acquired by TIRDO has been applied for indoor air measurements, information on the pollution in a living room, when using a traditional stove. These measurements have later even lead to improvements of the household stoves, as for example in the design (case 2).

## Findings and conclusion

MNEs in Tanzania represent a foreign knowledge source, which can provide significant input and, at best, upgrade the knowledge base as a whole. The domestic knowledge base is in this case developed through the technology and knowledge transferred from the foreign sources. However, the domestic system needs to be in a position to internalize the input of the foreign knowledge sources, in this case the ability to absorb spillovers from inward FDI.

The empirical material revealed that despite of the availability of local expertise for use of the technology and knowledge that has emerged from the collaboration (at TIRDO), it might not be directly transferable to the wider local context. The cases illustrate that there might be three possible situations:

Category 1: "Insufficient demand": This category refers to cases where it is more or less impossible to apply and use the "input" resulting from the collaboration, due to lack of relevance. It is obvious from the basic problems most of the domestic enterprises have to struggle with, that concepts such as pollution measurements are hardly be given priority. It is

[10] Thus, even though TIRDO has both the capacity and the competence to conduct sophisticated studies, the ability to absorb the input is limited both at the organisational level, as well as on the wider infra structural level.

in this regard, that knowledge available at a mediator institution such as TIRDO might lack relevance for direct application in the wider local context.

Category 2: "Direct application": Within this category, knowledge that is derived from collaboration with MNEs can be directly applied in a local context. An example has been the measurements undertoaken at the Holiday Inn. This category is not considered as including any innovations, as nothing new is added to the knowledge. The knowledge is simply applied in the same way.

Category 3: "Innovation": Based on concepts resulting from collaboration with MNEs, innovations can occur. In these cases, the knowledge that has been learned during the collaborations has been used as a basis for creating new knowledge, and applying in such a way that they create new products of economic value. When the knowledge acquired during the collaboration is of limited relevance for the indigenous firms (because of high international standards, for example), the capacity of TIRDO to transform that knowledge into something that might be applied to the indigenous community (quality of air in home stoves) is crucial. Thus highlighting the role of this technology service providers as mediator and "integrator" of the different bodies of knowledge that exist in the system.

Hence, based on the analysis of the empirical case, two major conclusions can be drawn. One relates to the crucial role of a local R&D institute such as TIRDO to serve as mediator between foreign and local bodies of knowledge and absorb relevant knowledge and transform it into applicable knowledge for the local context. The second is that through these foreign-local interactions the potential for the development of an IS on a national level exists. Hence, by further strengthening the existing linkages, the currently rather weak systems can in important elements be developed and improved. A challenge here is to ensure the continuous collaboration between mediator organizations such as TIRDO and MNEs on the one hand and between the mediator and the indigenous firms on the other. Both the MNEs and the mediator organization discussed in the cases in this paper expressed that they see the potential for further collaboration. However, there are no clear intentions for how a more regular cooperation could be established.

Importantly, with regards to implications for application to wider local uses, as well as an indication for a macro SI, the challenge is to develop the appropriate socio-economic

conditions. Hence, a sufficient amount of absorptive capacity would eventually have to be developed throughout the whole institutional infrastructure. A similar challenge is related to the general gaps in the systems that exist in LDCs. Even if LDCs can learn from MNEs, due to increased cross-border activities, there is not only the problem of internalising the input, but also the question of relevance of the input. Regarding the rather basic problems, which many companies in Tanzania are facing, concepts such as those, conveyed to TIRDO through the collaboration with both Coca-Cola and TCC are of secondary priority. The local firms have to struggle with problems as for example low level of human and physical resources. Therefore, aims such as creating a good working environment can not be considered as urgent. Thus, the input of ideas resulting from the collaboration with MNEs is only productive and with potential for wider application, in cases where the ideas could be transferred to different contexts, i.e. not directly from the foreign firm to a local one, but instead finding application in another local context, as shown in the example of traditional stoves.

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