

User innovation in the business enterprise sector of Maputo Province in Mozambique

Citation for published version (APA):

Zita, J. E. B., & Lopes, A. H. (2011). User innovation in the business enterprise sector of Maputo Province in Mozambique. (UNU-MERIT Working Papers; No. 062). Maastricht: UNU-MERIT, Maastricht Economic and Social Research and Training Centre on Innovation and Technology.

Document status and date:

Published: 01/01/2011

Document Version:

Publisher's PDF, also known as Version of record

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy

If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.



**UNITED NATIONS
UNIVERSITY**

UNU-MERIT

Working Paper Series

#2011-062

**User innovation in the business enterprise sector of Maputo
Province in Mozambique**

By Júlia Eva Baltazar Zita & Avelino Hermíneo Lopes

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)

email: info@merit.unu.edu | website: <http://www.merit.unu.edu>

Maastricht Graduate School of Governance (MGSOG)

email: info-governance@maastrichtuniversity.nl | website: <http://mgsog.merit.unu.edu>

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands

Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

UNU-MERIT Working Papers

ISSN 1871-9872

**Maastricht Economic and social Research Institute on Innovation and Technology,
UNU-MERIT**

**Maastricht Graduate School of Governance
MGSOG**

UNU-MERIT Working Papers intend to disseminate preliminary results of research carried out at UNU-MERIT and MGSOG to stimulate discussion on the issues raised.

User Innovation in the Business Enterprise Sector of Maputo Province in Mozambique

Júlia Eva Baltazar Zita

Julia.Zita@mc.gov.mz

Ministry of Science and Technology
Maputo, Republic of Mozambique

Avelino Hermíneo Lopes

EnerTerra
Maputo, Republic of Mozambique

Abstract

Evidence of user innovation in firms in Maputo Province is presented. This results from a case study of firms that had previously been identified in the Mozambican National Innovation Survey 2009 as process innovators. While the observations are too few to support statistical inferences, they demonstrate the presence of user innovation in firms and they suggest further work on the policy implications, especially related to support for innovation in firms that perform no research and development. The case study found little evidence of the sharing of knowledge gained through user innovation, in contrast with findings from industrialized countries but closer to results from the newly industrialized country of Korea.

JEL Codes: O31, O33, O34

Key words: User innovation, development, knowledge sharing

The work in this paper was undertaken as part of a UNU-MERIT Project on *Research and Training Support to Build African Capacity in Science, Technology, and Innovation Indicators*, funded by Canada's International Development Research Centre (IDRC) Grant 104753

November 2011

1. Introduction

The Mozambique Science, Technology and Innovation Strategy (MOSTIS) was approved in June 2006. It makes the case for the stimulation of innovation to promote economic development and poverty reduction. One of the points raised in the strategy is the importance of the process by which individuals and groups “devise new ways to solve immediate problems” (Ministry of Science and Technology 2006: 55). This case study probes the solution of immediate problems in the production processes of private sector firms in Maputo Province, and the economic consequences of doing this. This activity is a form of user innovation (von Hippel 2005).

User innovation in firms is important in all economies, but more so in developing economies where there is limited capacity to invest in new capital goods or software systems. An alternative to buying production technologies is to make existing technologies and practices perform better or, in extreme cases, to develop the production technologies needed by the firm. User innovation can also be done by consumers, under certain circumstances (Gault 2011), but that is outside the scope of this paper which is focused on the firm.

The purpose of this project is to establish the presence of user innovation in firms that have been identified by the Mozambican National Innovation survey 2009 as process innovators. The survey gives a wealth of data about innovative and non innovative firms but limited information about the presence of user innovation in the innovative firms. Probing for user innovation, by investigating a few firms in the Province of Maputo, has established the presence of this activity, with implications for indicator development and for the place of such indicators in the development of evidence-based policy.

2. User Innovation in developing countries: key aspects of previous research

User innovation can be defined as an innovation developed by the end user who gains benefits by using this innovation, rather than the producer who benefits from selling it (von Hippel, 2005). For instance, it is user innovation when the manufacturer modifies existing production equipment or creates a new piece of equipment for its own use to reduce costs and/or to improve product quality. As noted by von Hippel, empirical studies undertaken in developed countries have found a significant amount of user innovation activity.

This type of process-centred user innovation has also been examined in a long stream of firm-level studies of innovation in a range of developing countries at different stages of late industrialization across different countries in Asia and Latin America – but to a much more limited extent in Africa. Most of this work has centred on innovation in manufacturing industry, though only sometimes adopting the ‘user innovation’ terminology

The first major programme of research in this area was initiated by Jorge Katz and colleagues in Latin America during the late 1970s and early 1980s. A large component of their work

focused on industries producing standardized products (e.g. steel, cement and chemicals); and this highlighted the importance of accumulating capabilities in user firms to generate their own (mainly new-to-firm) process innovations (Katz 1987). Sanjaya Lall's work was particularly important for developing what came to be a widely used framework for analysing the development of firm-level innovation capabilities in developing countries (Lall 1992). Within this a clear distinction was made between firms' internal product- and process-centred innovation capabilities, and in his research on India he demonstrated the significance of the latter for generating process-centred user innovation – again in process-based industries like steel and cement (Lall 1987).

A large body of work in this area has examined experience in Korea. Much of this has focused on the development of firms' internal capabilities to introduce sequences of increasingly complex products by 'catching-up' firms in industries like automobiles, electrical/electronic goods and semi-conductors – for example, the industry case studies in Linsu Kim's study of Korea's transition from *Imitation to Innovation* (Kim 1997). Such studies appear superficially to have been about those firms' product innovation (largely new-to-firm 'imitation' of products already available in international markets). But closer examination shows it to have been very heavily concerned with user innovation, centred on the process technology that those firms required to manufacture their products competitively. For example, between 1989 and 1994 the annual number of applications by Korean firms' for Korean patents relating to semi-conductors increased about six-fold to 3,336. Almost all of these (95 per cent) were manufacturing process patents, and it was the large process-using, semiconductor producers like LG, Samsung and Hyundai that made the vast majority of these applications (Kim 1997: 163-165). Thus a massive base of process-centred user innovation appears to have underpinned the rapid and export-intensive growth of this industry's production of increasingly complex products.

Other studies have identified extensive user innovation in the development of process-based industries in Korea. In particular Enos and Park (1988) examined the early technological development of the chemical and steel industries and highlighted the ways in which Korean firms made intensive efforts to build up their innovative capabilities. In large part these capabilities were used to develop streams of user-innovation to improve the performance of the process technologies that firms had originally acquired from suppliers in advanced economies – in the petroleum, synthetic fibre and steel industries (pp. 74-86, 132-142 and 190-207 respectively).

Almost all this research was based on case studies of individual firms and industries, and these provided limited opportunities to draw insights from controlled comparative analysis. However, an important break from this tradition was made in a comparative study of the development of innovative capabilities in two steel companies in Brazil (Figueiredo 2001, 2002, 2003). This identified differences in management and strategy that underlay differences between the two firms in the intensity with which they developed these capabilities and in the intensity with which they applied them to generate streams of performance-improving innovation in the processes they used.

Important insights from this large body of work include the following.

The incidence and economic significance of user innovation

- The incidence of such user innovation is widespread. These studies indicate that manufacturing firms in developing countries commonly complement externally sourced technology with internally generated process innovation, starting at early stages in the development of manufacturing industries in those countries. Thus very many firms in developing countries do not follow common influential prescriptions about how they should introduce change in the process technologies they use - i.e. that they should rely on external sources, typically in more advanced economies, and that they consequently do not need to engage in innovation before they begin to close in on using technology at the international frontier (e.g. McArthur and Sachs, 2002).
- In general, such user innovation involves incremental change to the process technologies already in use in the firm. Such new-to-the-firm innovation is not merely about adaptation to 'fit' better with local contexts. It is also about improvement beyond the initial performance of acquired technologies.
- On their own, individual 'steps' in such paths of improvement typically yield only small advances in performance, but the cumulated economic significance of continuous streams of small steps is often considerable. For example, Dahlman and Fonseca (1987) showed that, in a number of major process units in a steel plant in Brazil, user-implemented modifications and improvements over periods of around seven years after they had reached initial design capacity more than doubled their rate of output from those initial design levels. Such findings reflected similar patterns to those found in studies in advanced economies – for instance Hollander (1965) showed how productivity gains from user-generated incremental improvements to U.S. rayon plants during their operating lifetime could be just as significant as the one-step gains from investment in new plants that embodied novel processes.

The underlying accumulation of capabilities to innovate

- The origins of such cumulative paths of incremental innovation are typically rooted in specific resources and capabilities in the user firm. For the most part these differ from the resources and capabilities for routine operations and also from those used to undertake formally organized R&D. Although they may overlap in part with both, they typically consist of specialized technical, process engineering and managerial competences organized within maintenance departments, engineering sections, quality enhancement groups, process improvement teams and the like. Thus, although sometimes described as resulting from 'learning-by-doing', these paths of cumulating incremental process improvement do not arise merely as a more or less automatic consequence of repetitive 'doing' of routine production (Wamae 2009). They are the consequence of purposeful innovative acts undertaken by specific capabilities in the firm (for a critique of common perspectives on 'learning-by-doing', see Scott-Kemmis and Bell (2010)).

- Consequently, a key activity underpinning such paths of user innovation is the prior process of building up those capabilities. In particular, their effective acquisition and accumulation depends on explicit expenditure and strategic managerial effort to implement suitable ‘learning mechanisms’ – involving for example: specialized training; special arrangements (e.g. with suppliers) to acquire particular kinds of skill; know-how and experience; and, intensively managed internal processes for embedding such competence in the user firm.
- The explicit learning mechanisms by which process-using firms acquire and develop their innovation capabilities are typically embedded in a cumulative process by which successively ‘deeper’ levels of capability are developed in the user firm. These levels have been described in several studies as running from: (i) capabilities for executing simple and minor improvements to existing facilities and production procedures, through (ii) those needed for much more complex design, engineering and management roles in collaborating with suppliers to set up new, more advanced and innovative process facilities or procedures; to (iii) R&D-type capabilities required to generate new knowledge as an input to the design and engineering of novel processes. As a result the time paths for building such progressively deeper level of capability for undertaking user roles in innovation can take decades not years (Bell 2006).

Interconnections and longer term evolution

- These studies demonstrate that process-centred user innovation is often intimately interconnected with product innovation. It is often the main source of ‘product quality’ that shapes product competitiveness, especially in international markets. At the same time, the introduction of new or improved products typically requires at least some degree of change in the production process used.
- Also ‘pure’ forms of user-implemented innovation (whether product- or process-centred) are only one end of a spectrum that involves varying degrees and forms of collaboration and interaction between the internal innovation activities of users and complementary contributions from external suppliers. Thus although relatively ‘pure’ forms of user-responsibility for process innovation in developing country firms seem to be concentrated in more incremental (new-to-the-firm) innovation, user-roles do not simply vanish in more substantial innovation steps involving external suppliers. In such situations user firms’ innovative capabilities and activities commonly interact with those of external suppliers in a wide variety of complementary arrangements. This again reflects common patterns in advanced countries that is perhaps especially the case in large-scale process-type industries (e.g. cement, steel and other metals, chemicals, paper, and mining) - see e.g. Laestadius (1998) and Pisano (1997) for experience in the paper and pharmaceutical industries respectively.
- Consequently, it is not surprising that many of these studies indicate that capabilities to generate relatively incremental forms of process innovation constitute an initial nucleus in the longer term development of more diverse capabilities for engaging in more novel forms of innovation in a widening array of interactions with other actors in local innovation systems.

- Similarly, the benefits of investment in cumulatively deepening innovation capabilities over long periods are likely to be much greater than those that accrue simply to the initial process-using and incrementally innovating firm. Individual engineers and managers embodying such valuable capabilities may migrate to other firms or to set up their own firms to supply services, process equipment or specialized process software – thus contributing to the diversification of production in the domestic economy. Indeed, the specialized innovation-generating departments and sections of user innovators may spin off as complete entities to set up new firms. For example, the highly successful Korean steel company, Posco, built up strong internal innovation capabilities and consolidated these into a distinct subsidiary company, Posec. This was later spun off and became a successful competitor in the global market for steel engineering services and specialized steel engineering software.

Cutting across these observations, a body of evidence now exists to demonstrate both considerable differences in the rate at which firms have accumulated successive levels of innovation capability and substantial variation in the intensity of user innovation actually implemented - including cases where firms generated no improvement in process performance at all over many years (Bell et al. 1982). Questions therefore arise about the factors that affect such inter-firm differences.

Here the literature has been much less successful in systematically illuminating the key issues on a generalizable basis. This reflects the heavy reliance on case studies of individual firms and industries within individual developing countries. Nevertheless three points seem important. First, the characteristics and strategic behaviour of individual firms have a strong influence on their development of strong user innovation capabilities. But second, the prevailing economic contexts in which firms operate have a very strong influence on those firm-level characteristics and behaviours, and hence government policies shaping those contexts matter (Lall 1992). Third however, the most common instruments of ‘technology and innovation policy’ in developing countries seem to have limited importance, especially in the early stages of developing user innovation capabilities in industrial firms. These policy instruments focus very heavily on increasing R&D activities, and primarily located in public organizations like universities and research institutes. Consequently, apart from sometimes providing a small flow of technologically informed human capital between such organizations and manufacturing firms, they appear to have little influence on fostering the development of *non-R&D capabilities within industrial enterprises* – the core base for large proportions of the user innovation that have been examined in the literature reviewed above.

However, the development of CIS-type innovation surveys in a growing number of countries opens the possibility of going beyond the limits of firm and industry case studies as a basis for illuminating policy issues about user innovation in industry in developing and emerging economies. The opportunity they provide for much more systematic comparative analysis of inter-firm, inter-industry and inter-country differences opens up much greater possibilities for illuminating those policy issues. One such study is a recent analysis of user innovation in Korean firms that makes use of CIS-like data (Kim and Kim, 2011). Another is the study reported in this paper – an initial exploration of user innovation in Mozambique based on a CIS-type innovation survey.

3. Methodology

3.1 Innovation and official statistics

While there is widespread appearance of user innovation in developed countries, little of it appears in official statistics. Official statistics as those presented by statistical offices, central banks, regulators or other official bodies to describe the state of a particular activity. They need not be gathered by government organizations and in some countries they are produced by research institutes under government contract. For innovation the most widely used example of a survey gathering official statistics is the European Union Community Innovation Survey (CIS) which was the model for the questionnaire used in the Mozambican National Innovation Survey 2009. Both CIS and the Mozambican Innovation Survey use guidelines given in the Oslo Manual (OECD/Eurostat 2005).

One of the objectives of this study was to explore the possibility of including firm-based user innovation in Mozambican official statistics on innovation in the future. Process innovation in firms was chosen as the focus of the study as firms use processes, they do not sell them. If the firm improves its production process for its own benefit, it is a user innovator.

To probe firm-based user innovation, the question of interest was that on process innovation, and the follow up question.

Who developed these process innovations?

1. Mainly your enterprise or enterprise group
2. Your enterprise together with other enterprises or institutions
3. Mainly other enterprises or institutions

The results of the follow up question in the survey are given in Table 1. For Maputo Province, the fifteen enterprises that reported process innovation, and responded to the follow up question, were included in the case study.

Table 1: Answers for Innovation Process Question in Mozambique

| Province | Quantity | Who did the innovation | Quantity |
|---|----------|------------------------|-----------|
| Maputo | 15 | Your enterprise | 10 |
| | | Together with others | 3 |
| | | Others | 2 |
| Gaza | 3 | Your enterprise | 3 |
| | | Together with others | 0 |
| | | Others | 0 |
| Inhambane | . | Your enterprise | . |
| | | Together with others | . |
| | | Others | . |
| Sofala | 4 | Your enterprise | 2 |
| | | Together with others | 2 |
| | | Others | 0 |
| Manica | 3 | Your enterprise | 2 |
| | | Together with others | 0 |
| | | Others | 1 |
| Tete | 4 | Your enterprise | 2 |
| | | Together with others | 2 |
| | | Others | 0 |
| Zambezia | 1 | Your enterprise | 0 |
| | | Together with others | 1 |
| | | Others | 0 |
| Nampula | 3 | Your enterprise | 2 |
| | | Together with others | 1 |
| | | Others | 0 |
| Niassa | 1 | Your enterprise | 1 |
| | | Together with others | 0 |
| | | Others | 0 |
| Cabo-Delgado | 0 | Your enterprise | 0 |
| | | Together with others | 0 |
| | | Others | 0 |
| Total | | Your enterprise | 22 |
| | | Together with others | 9 |
| | | Others | 3 |
| Total enterprises engaged in process innovation* | | | 34 |

Source: Mozambican National Innovation Survey 2009

. No Answer

* Based on available responses

3.2 Samples

The Mozambican National Innovation Survey 2009 sampled manufacturing firms with 25 or more employees in the list given by Mozambican National Enterprises Register. Although the Oslo Manual recommends 10 employees or more, 25 employees or more was used to reduce the population and save on survey costs.

The size of the total population was 903 enterprises and the questionnaire was administered to all. In total, 140 firms responded and the response rate was 16%. Among these, fifteen enterprises were selected in Maputo Province which had reported process innovations in the reference period, 2008-2009.

For the case study, all fifteen process innovators in Maputo province were contacted and responses were received from all fifteen enterprises. Respondents were willing to discuss their process innovation activities.

3.3 Questionnaire design and data collection

Based on the studies carried out in this field by other countries, a questionnaire fitting to the Mozambican situation was prepared and pilot tested. Note was taken of a 2007 questionnaire used by Statistics Canada (Schaan and Uhrbach 2008, Statistics Canada 2008).

A personal interview approach to capture information was adopted as the most effective for information gathering and for guaranteeing a high response rate. The questionnaire was first tested in 5 enterprises and two questions that created problems were revised before the full data collection took place. An English translation of the questionnaire is provided in the Appendix.

4. Findings

4.1 Results from the survey

The first observation follows from the Mozambican Nation Innovation Survey 2009 (Table 1) and it is that 65% of firms that were process innovators managed the innovation themselves, 26% did it with others and, for 9%, the process innovation as done by others. This pattern is evident in Maputo Province where the results from the 15 firms were 67% (10), 20% (3) and 13% (2) respectively. While not a statistical sample, Maputo Province shows the same behaviour as Mozambique and, as a consequence, findings from this case study could have wider applicability. The results that follow are classified according to their response to the follow-up question in Section 2.

Mainly your enterprise or enterprise group

For the ten enterprises that responded that the innovation was done by “Mainly your enterprise or enterprise group”, there were seven in services, two in manufacturing and one in construction. The distribution was the following.

Services (7)

- 1 Software consultancy (software development and modification)
- 2 Auditing and consultancy (software development and modification)
- 2 Cleaning services (modification of equipment related to cleaning)
- 1 Engineering consultancy (no information on its user innovation)
- 1 Services offers (modification of procedures in services offers)

Manufacturing (2)

- 1 Metal mechanics (modification of equipment and procedures for metal mechanics)
- 1 Cement packing (modification of equipment and procedures for cement packing)

Construction (1)

- 1 Construction (modification of equipment and procedures for construction)

Nine of the enterprises modified equipment, software or practices and one firm provided no information. None adopted new equipment, software or practices by developing it on their own.

The important finding is that all enterprises that were process innovators and reported that the innovation was done “Mainly your enterprise or enterprise group” in the case study were user innovators. If this is the case for all process innovators in the Mozambican innovation survey, there is a significant population of user innovators in Mozambique. If the statistics were more plentiful, there could be problems caused by firms having more than one process innovation, but reporting only for one.¹

Your enterprise together with other enterprises or institutions

There are three enterprises in this category, all in service industries

- 1 Graphic services (modification of graphic printing procedures)
- 1 Cleaning services (modification of practices for cleaning services)
- 1 Telecommunications services (modification of telecommunication services)

While all three were modifiers of services, there are outstanding questions about the role of the other enterprises or institutions. This is needed to determine whether this is user innovation on the part of the enterprise, in which case the enterprise is in the lead. If the collaborator is leading it is not user innovation, but it is process innovation.

Mainly other enterprises or institutions

¹ We are thankful to Professor Youngbae Kim for this observation.

There are two enterprises in this category, one is a service enterprise and one is a manufacturer.

1 Cleaning services (new to the firm innovation in cleaning practices)

1 Manufacturing of hygiene and cleaning products (new to the firm innovation in practices related to manufacturing)

These enterprises were process innovators, but they were not user innovators as the new practices came from outside the enterprise.

4.2 Indicators

What is clear from the case study results is that indicators of user innovation could be produced from innovation surveys, easily, if the assumption is made, based on this case study, that all enterprises that do the process innovation on their own are user innovators. Of course, this is a strong assumption and more data are required to show to what extent it holds. However, the estimate following from this assumption is only an under bound for user innovation as some of the enterprises that collaborate will be user innovators and some not. The distinction is whether the enterprise with the process innovation is in control of the collaboration or not. If it is, it is a user innovator. If it is not, it will be a process innovator, but not a user innovator. The source of the innovation would then be the partner in the collaboration. Finally, for process innovators where the innovation is done mainly by others, there is no user innovation.

Focusing on process innovators where the innovation was done mainly by the enterprise or the enterprise group

The ten process innovators in this category were described in the previous section. These enterprises took the modification of technologies seriously, as most (8) engaged in the activity continuously, as opposed to occasionally (2), they did it as part of a formal programme (7), and it was funded internally in eight cases, by customers in one and from other sources in one case. There was a dedicated budget in five cases, in four cases it came out of the maintenance budget, and in one case from another source. In most cases, then, adoption by modification was an on-going and formal activity, budgeted from within the enterprise and with a dedicated budget.

A significant point is that none of the ten enterprises had their own R&D unit. All of the knowledge needed to modify the technologies was coming from learning by doing, using and interacting. This is not an exceptional result as firms in many OECD countries exhibit a higher propensity to innovate than to do R&D (Gault 2010: 60). This observation is important as it means that such firms in Mozambique cannot benefit from R&D support programmes.

Looking outside of the business unit, four knew of other firms doing similar modifications and six co-operated with other business units. However, four did not co-operate and did the work internally, of the six that did co-operate, three worked with other business units in the firm, one worked with a supplier and one with another external firm. This is consistent with the self-contained approach of these firms that fund the work mainly from within, do the

modification continuously and either do not co-operate or do so only with other business units in the firm.

It is not then surprising to find that nine out of ten did not share the technologies that resulted from their work on modification. The one firm that did share, gave the technology away in order to gain feedback and more expertise, an act that is not uncommon in developed countries for a variety of reasons (von Hippel 2005), but, based on the data available, it is not common in Mozambique and it is also quite low in Korea (Kim and Kim 2011). The free revealing of knowledge in recently industrialized countries and in developing countries is a topic for further research.

Of the ten firms, half protected their intellectual property and half did not. Of the half that did there was no preferred approach. They used secrecy, trademarks, confidentiality agreements, copyrights, and combinations of these.

Finally, six of the firms reported that the technology modifications done by them had been adopted by other firms, in two cases by suppliers of the original technology and in four cases by other firms that used the original technology. The assumption is that these knowledge transfers took place for a fee, as only one firm shared such knowledge.

5. Implications for policy

There are several reasons why user innovation in firms is important to innovation policy. The first is that, as indicated in extensive previous research on the subject, process-centred user innovation in developing countries potentially has considerable developmental significance. In its own right it can yield substantial productivity gains while also contributing to competitiveness in product-related ways – e.g. through increased product quality or in supporting other kinds of product-centred innovation. But also, over the longer run, it seems to act often as an initial nucleus of innovation capability that lays a basis for the evolution of wider and ‘deeper’ firm-level capabilities to innovate; and those evolving capabilities within firms commonly constitute a basis for innovation-related interactions with other actors in the local innovation system, so constituting an important forces for the closer articulation of system structures.

The second reason for addressing issues about process-centred user innovation is that it appears to be more intensive, perhaps with greater developmental significance in process-based industries producing relatively standardized (or commodity-type) products – e.g. (i) primary industries like petroleum and mining, (ii) materials-intensive industries like cement, steel or aluminium, and (iii) natural resource-based industries like pulp and paper or other bulk agro-processing. These kinds of industry are particularly important in Mozambique and other African countries, and that importance is likely to increase over the next decade and beyond. So at least in principle, they are likely to focus fairly centrally in policies for technology and innovation in such countries.

But third, this calls for a significant shift in emphasis within the portfolio of technology and innovation policies in many of these countries. Currently the emphasis is often heavily concentrated on supporting R&D - principally undertaken in organizations like universities and research institutes, rather than in firms. In this respect, the implications of the finding of this case study mirror those of prior research. In firms that do not do R&D, all but one of the fifteen firms in the case study, and all of the firms that did the process innovation on their own, the problem solving that creates value by improving the production process requires policies that are quite different from those that usually support R&D, even in the business sector. That is why it is important to establish the presence of this phenomenon in Mozambican firms as an input to the policy debate as part of implementing the Science, Technology and Innovation Strategy of 2006. There are policy initiatives in place, of which the Scientific Innovator Program is an example, for which the Ministry of Science and Technology is responsible. However, this initiative is directed at individuals and not at enterprises. The needs emerging from this study are for initiatives directed at enterprises.

Two broad approaches to policy could support user innovation in firms that do no R&D. One is the provision of expert advice on management, financing, network connections, and human resource development. This is more than a venture capital activity, it requires the engagement of entrepreneurs who have succeeded and are willing to share their knowledge with the firms that are user innovators. The second is to develop policy mechanisms for supporting firms in acquiring and accumulating their own innovative capabilities in the form of various kinds of non-R&D competence – i.e. primarily the various kinds of engineering and related managerial competence that plays the key role in user innovation.

There is then a fourth reason to understand user innovation. Work by von Hippel (1988 and 2005), de Jong and von Hippel (2009) and Gault and von Hippel (2009) in industrialized countries suggests that firms that are user innovators have a higher propensity to give away, or freely reveal, the intellectual property that results from the problem solving in the firm. This has implications for intellectual property policy. In the case where free revealing was common, consideration could be given to creating a patent-like instrument, with a review process similar to that for a standard patent application, giving recognition to the originator of the knowledge, but also making the knowledge freely available. On the other hand, the results of this study, and the work of Kim and Kim (2011), suggest that there is not a high propensity to give knowledge away in Mozambique or Korea and that the existing intellectual property regime is functioning.

Kim and Kim (2011) contrasted the 3.2% of firms in Korea that give knowledge away with Canada and the Netherlands where the figure is over 20%. Their explanation was that there is a lack of trust in Korea and there is also the close buyer-supplier relationship dominated by the chaebols. This is an important insight and it suggests additional work in Mozambique to see if there is an issue of trust that prevents sharing of knowledge or if other factors are important – such as differences between innovative behaviour in different types of industry, or the limited intensity of innovation across industrial firms and hence limited opportunities for the *reciprocal exchange* of knowledge that underpins much of the reported ‘sharing’ of technology in user innovation. Understanding this would lead to a third set of policy questions.

6. Conclusion

This is a report of a case study that followed the first innovation survey of Mozambique. Both the case study and the survey were new initiatives and there is still much to learn. The case study has clearly identified the presence of user innovation in Mozambique and these findings suggest the development of statistical indicators in this area to support consideration of related policy initiatives.

Finally, much has been learned about developing, testing, and administering a questionnaire, analysing the data and managing a case study. This forms a basis for future work. But also, as illustrated in both this study and in previous research in this area, parallel and hopefully interacting case study work is also critically important in developing important areas of understanding that cannot, realistically, be expected to be generated by innovation surveys alone. Again a basis for such future work has been explored in this study.

Acknowledgements

The authors thank the UNU-MERIT project team, Martin Bell, Fred Gault, Michael Kahn, Mammo Muchie and Watu Wamae for their support and comments, Youngbae Kim for sharing his work on Korea, participants in the 2011 Open and User Innovation Conference in Vienna and at the 2011 Globelics Conference in Buenos Aires for comments. They also wish to thank the Ministry of Science and Technology of the Republic of Mozambique for its support for this work.

References

- Bell, M. (2006), 'How long does it take? How fast is it moving (if at all)? Time and technological learning in industrialising countries'. *International Journal of Technology Management*, 36 (1-3): 25-39.
- Bell, M., D. Scott-Kemmis and W. Satyarakwit (1982), 'Limited learning in infant industry: a case study', in F. Stewart and J. James (eds), *The Economics of New Technology in Developing Countries*. Frances Pinter: London.
- Dahlman, C. and F. V. Fonseca (1987), 'From Technological Dependence to Technological Development: the Case of the USIMINAS Steel Plant in Brazil', in J. Katz (ed.), *Technology Generation in Latin American Manufacturing Industries*, Macmillan, London.
- De Jong, J.P.J. and E. von Hippel (2009). 'Transfers of user process innovations to process equipment producers: a study of Dutch high-tech firms', *Research Policy*, 38, 1181-1191.

Enos, J, and W. H. Park (1988), *The Adaption and Diffusion of Imported Technology: The Case of Korea*, Croom Helm: London.

Figueiredo, P. N. (2001), *Technological Learning and Competitive Performance*, Edward Elgar, Cheltenham, UK.

Figueiredo, P. N. (2002), 'Does technological learning pay off? Inter-firm differences in technological capability accumulation paths and operational performance improvement', *Research Policy*, 31, 73-94.

Figueiredo, P. N. (2003), '*Learning, capability accumulation and firms differences: evidence from latecomer steel*', *Industrial and Corporate Change*, 12 (3): 607-643.

Gault, Fred and Eric von Hippel (2009). *The prevalence of user innovation and free innovation transfers: Implications for statistical indicators and innovation policy*. MIT Sloan School of Management Working Paper 4722-09. Cambridge, MA: MIT.

Gault, Fred (2010), *Innovation Strategies for a Global Economy, Development, Implementation, Measurement and Management*, Cheltenham: Edward Elgar and Ottawa: IDRC.

Gault, Fred (2011), *User Innovation and the Market*, UNU-MERIT Working Paper 2011-009, Maastricht: UNU-MERIT, pp. 18.

Hollander, S. (1965), *The Sources of Increased Efficiency: a Study of Du Pont Rayon Plants*, Cambridge, MA: MIT Press.

Katz, J. (1987), *Technology Generation in Latin American Manufacturing Industries*, London: Macmillan Press.

Kim, L. (1997), *Imitation to Innovation. The Dynamics of Korea's Technological Learning*, Boston, MA: Harvard Business School Press

Kim, Youngbae and Hyunho Kim (2011), *User innovation in Korean Manufacturing Firms: Incidence and Protection*, KAIST Business School Working Paper Series KCB-WP-2011-01, Seoul: KAIST Business School.

Laestadius, S. (1998), 'The relevance of science and technology indicators: the case of pulp and paper', *Research Policy*, Vol. 27, 385-395.

Lall, S. (1987), *Learning to Industrialise: The Acquisition of Technological Capability by India*, London: Macmillan.

Lall, S. (1992), 'Technological capabilities and industrialisation', *World Development*, 20 (2): 165- 86.

McArthur, J. W. and Sachs, J. D. (2002), 'The Growth Competitiveness Index: Measuring Technological Advancement and the Stages of Development', in *World Economic Forum, The Global Competitiveness Report 2001-2002*, New York and Oxford: Oxford University Press.

Ministry of Science and Technology (2006), *Mozambique Science, technology and Innovation Strategy (MOSTIS)*, Maputo: Ministry of Science and Technology.

OECD/Eurostat (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, Paris: OECD.

Pisano, G. P. (1997), *The development factory: Unlocking the potential of process innovation*, Boston, MA: Harvard Business School Press.

Schaan, S. and M. Uhrbach (2009), *Measuring User Innovation in Canadian Manufacturing, 2007*, Catalogue 88F0006X, no. 3, Ottawa: Statistics Canada.

Scott-Kemmis, D. and Bell, M, (2010), 'The mythology of learning-by-doing in World War II airframe and ship production', *International Journal of Technological Learning, Innovation and Development*, Vol. 3 (1), 1-35.

Statistics Canada (2008), *Follow-Up to the Survey of Advanced Technology 2007*, The Daily, October 27, Ottawa: Statistics Canada.

von Hippel, E. (1988), *The Sources of Innovation*, Oxford University Press.

von Hippel, Eric (2005), *Democratizing Innovation*, Cambridge, MA: MIT Press.

Wamae, W. (2009), 'Enhancing the role of knowledge and innovation for development', *International Journal of Technology Management and Sustainable Development*, Vol. 8(3), 199-220.

Appendix: Questionnaire for the case study in an English translation



Republic of Mozambique

Ministry of Science and Technology

**INNOVATION QUESTIONNAIRE: CASE
STUDY OF MAPUTO PROVINCE**

PROTOCOL OF THE QUESTIONNAIRE

This survey comes as a continuation of the previous investigation, in order to evaluate the innovative processes of firms carrying out such activities.

First, let us thank you and your colleagues for responding to the Mozambique Nation Innovation Survey 2008. This survey helps the Minister of Science and Technology to develop policy to help firms like yours.

Second, let us reassure you that we are here from the Ministry of Science and Technology and that anything said today will be kept confidential and used only for analysis. Under no circumstances will MCT release or disclose any information pertaining to your firm.

Section A: Process innovation Mainly by your Enterprise or Enterprise Group

In your response to the survey, you answered question B6 (provide a blank questionnaire at this point) about process innovation and then your response to B7 indicated that the new or significantly improved methods, logistics or supporting activity [you should know which from the response] was done: Mainly by your enterprise or enterprise group.

A-1. Can you tell us if this involved developing a wholly new process or modifying an existing process?

A-2. Why did you do it?

- To make the process do better what it was doing
- To expand the capabilities of the process
- Other
- If 'Other' please describe the reason

Section B: Process innovation Mainly By your Enterprise Together with Other Enterprises or Institutions

In your response to the survey, you answered question B6 (provide a blank questionnaire at this point) about process innovation and then your response to B7 indicated that the new or significantly improved methods, logistics or supporting activity [you should know which from the response] was done: By your enterprise together with other enterprises or institutions.

B-1. Can you tell us if this involved developing a wholly new process or modifying an existing process?

B-2. Why did you do it?

- To make the process do better what it was doing
- To expand the capabilities of the process

Other
If 'Other' please describe the reason

B-3. What was the relationship with the other enterprise or institution?

Client
Supplier of the process technology
Competitor
Public sector organization
Other (please specify)

B-4. What was the reason for the collaboration?

They had useful knowledge
They used our firm as an experiment
We lacked the resources to do the work ourselves
Other (please specify)

Section C: Process innovation Mainly By Other Enterprises or Institutions

In your response to the survey, you answered question B6 (provide a blank questionnaire at this point) about process innovation and then your response to B7 indicated that the new or significantly improved methods, logistics or supporting activity [you should know which from the response] was done: Mainly by other enterprises or institutions.

C-1. Can you tell us if this involved developing a wholly new process or modifying an existing process?

C-2. Why did you do it?

To make the process do better what it was doing
To expand the capabilities of the process
Other
If 'Other' please describe the reason

C-3. What was the reason for using an outside enterprise or institution?

They sold the product we required
They used our firm as an experiment
We lacked the resources to do the work ourselves
Other (please specify)

Section D: General

D-1. How frequently is the modification (development) of technologies carried out in your business unit?

Continuously

Occasionally

D-2. How is the modification (development) of technologies carried out in your business unit?

Formal Program

Informal Program

D-3. How is the modification (development) of technologies funded in your business unit?

Internally

By customers

From other funding sources

By suppliers

D-4. Which budgets are used for technology modification (development) in your business unit?

Part of the maintenance budget

Dedicated budget for each project

Part of the R&D budget

Other budget

Part of the innovation budget

D-5. Does your enterprise has separate R&D unit / R&D budget?

Yes

No

D-6. Do you know of other firms that have carried out (developments) similar to yours?

Yes

No

D-7. Does your business cooperate with other business units, firms or institutions to modify(develop) technologies?

Yes

No

D-8. Who did your business cooperate with for the modification (development) of technologies?

Suppliers

Other business units in firm

Consultants

Clients

- Industrial associations
- Universities
- Commercial labs
- Competitors
- Federal government labs
- Colleges
- Provincial labs
- Private non-profit
- Other type

D-9. Does your business unit share the technologies that it has modified (developed) with other firms or institutions?

- Yes
- No

D-10. How does your business unit share the technologies it has modified (developed)?

- At no charge
- In exchange for something of value
- (i.e., free equipment)
- Other method
- For a fee

D-11. Why did your business unit choose to share the technologies that it modified (developed)?

- To allow a supplier to build a more suitable final product
- Gain feedback and expertise
- Nothing to lose (no direct competition)
- Enhance reputation
- Other
- Contractual obligation

D-12. Does your business unit use any method to protect your process Intellectual Property (IP)?

- Yes
- No

D-13. If yes, how do you protect your IP?

- Confidentiality agreements
- Patents
- Secrecy
- Trademarks
- Copyrights

Other

D-14. To the best of your knowledge, have any of the technology modifications (developments) in your business unit been adopted by the following:

Supplier of the original technology

Other firms that use the original technology

That completes our formal interview. Is there anything you would like to tell us about how the Ministry could help support your activities like those you have just described?

Thank you very much for your time.

The UNU-MERIT WORKING Paper Series

- 2011-01 *Mitigating 'anticommons' harms to research in science and technology* by Paul A. David
- 2011-02 *Telemedicine and primary health: the virtual doctor project Zambia* by Evans Mupela, Paul Mustard and Huw Jones
- 2011-03 *Russia's emerging multinational companies amidst the global economic crisis* by Sergey Filippov
- 2011-04 *Assessment of Gender Gap in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-05 *Assessment of Effectiveness of China Aid in Financing Development in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-06 *Assessment of the Impacts of Oil: Opportunities and Challenges for Economic Development in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-07 *Labour Market and Unemployment in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-08 *Social impacts of the development of science, technology and innovation indicators* by Fred Gault
- 2011-09 *User innovation and the market* by Fred Gault
- 2011-10 *Absorptive capacity in technological learning in clean development mechanism projects* by Asel Doranova, Ionara Costa and Geert Duysters
- 2011-11 *Microeconomic analysis of rural nonfarm activities in the Kyrgyz Republic: What determines participation and returns?* By Aziz Atamanov and Marrit van den Berg
- 2011-12 *Immigration and growth in an ageing economy* by Joan Muysken and Thomas Ziesemer
- 2011-13 *State-led technological development: A case of China's nanotechnology development* by Can Huang and Yilin Wu
- 2011-14 *A historical perspective on immigration and social protection in the Netherlands* by Melissa Siegel and Chris de Neubourg
- 2011-15 *Promoting return and circular migration of the highly skilled* by Metka Hercog and Melissa Siegel
- 2011-16 *Voluntary agreements and community development as CSR in innovation strategies* by Vivekananda Mukherjee and Shyama V. Ramani
- 2011-17 *Strengthening the roles of political parties in Public Accountability - A case study of a new approach in political party assistance* by Renée Speijcken
- 2011-18 *The elusive quest for the golden standard: Concepts, policies and practices of accountability in development cooperation* by Renée Speijcken
- 2011-19 *Are health care payments in Albania catastrophic? Evidence form ALSMS 2002, 2005 and 2008* by Sonila Tomini and Truman G. Packard
- 2011-20 *On India's plunge into Nanotechnology: What are good ways to catch-up?* By Shyama V. Ramani, Nupur Chowdhury, Roger Coronini and Susan Reid
- 2011-21 *Emerging country MNEs and the role of home countries: separating fact from irrational expectations* by Rajneesh Narula and Quyen T.K. Nguyen
- 2011-22 *Beyond knowledge brokerage: An exploratory study of innovation intermediaries in an evolving smallholder agricultural system in Kenya* by Catherine W. Kilelu, Laurens Klerkx, Cees Leeuwis and Andy Hall
- 2011-23 *Dynamics of biosciences regulation and opportunities for biosciences innovation in Africa: Exploring regulatory policy brokering* by Ann Kingiri and Andy Hall

- 2011-24 *The when and where of research in agricultural innovation trajectories: Evidence and implications from RIU's South Asia projects* by Vamsidhar Reddy, T.S., Andy Hall and Rasheed Sulaiman V.
- 2011-25 *Innovation and Diffusion of Clean/Green Technology: Can Patent Commons Help?* By Bronwyn H. Hall and Christian Helmers
- 2011-26 *Technology alliances in emerging economies: Persistence and interrelation in European firms' alliance formation* By Rene Belderbos, Victor Gilsing, Jojo Jacob
- 2011-27 *Innovation pathways and policy challenges at the regional level: smart specialization* By René Wintjes and Hugo Hollanders
- 2011-28 *Innovation and productivity* by Bronwyn H. Hall
- 2011-29 *Mapping the interdisciplinary nature and co-evolutionary patterns in five nano-industrial sectors* by Lili Wang and Ad Notten
- 2011-30 *Assessment of industrial performance and the relationship between skill, technology and input-output indicators in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-31 *Assessment of skill and technology indicators at the macro-micro levels in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-32 *Education, training and skill development policies in Sudan: Macro-micro overview* by Samia Satti Osman Mohamed Nour
- 2011-33 *Estimating the rate of return to education in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-34 *The importance (impact) of knowledge at the macro-micro levels in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-35 *Angus Maddison and Development Economics* by Adam Szirmai
- 2011-36 *Managerial ownership and urban water utilities efficiency in Uganda* by Dorcas Mbuvi and Achraf Tarsim
- 2011-37 *Immigration and growth in an ageing economy* by Joan Muyskens and Thomas Ziesemer
- 2011-38 *The Development of Diaspora Engagement Policies in Burundi and Rwanda* by Sonja Fransen & Melissa Siegel
- 2011-39 *Understanding the changing role of the Turkish diaspora* by Özge Bilgili & Melissa Siegel
- 2011-40 *Understanding Ethiopian diaspora engagement policy* by Katie Kuschminder and Melissa Siegel
- 2011-41 *Engaging the diaspora in India* by Metka Hercog and Melissa Siegel
- 2011-42 *Protecting Vulnerable Families in Central Asia: Poverty, vulnerability and the impact of the economic crisis* by Franziska Gassmann
- 2011-43 *Innovation performance and embeddedness in networks: evidence from the Ethiopian footwear cluster* by Mulu Gebreeyesus and Pierre Mohnen
- 2011-44 *The power of the strong state: A comparative analysis of the diaspora engagement strategies of India and Ethiopia* by Katie Kuschminder and Metka Hercog
- 2011-45 *New insights on the role of location advantages in international innovation* by Rajneesh Narula and Grazia D. Santangelo
- 2011-46 *Preferences for conditioning and being conditioned - experimental & survey evidence from Zambia* by Esther Schüring
- 2011-47 *International migration and local employment: analysis of self-selection and earnings in Tajikistan* by Aziz Atamanov and Marrit van den Berg

- 2011-48 *Complementarity between in-house R&D and technology purchasing: evidence from Chinese manufacturing firms* by Jun Hou and Pierre Mohnen
- 2011-49 *The internationalization of R&D* by Bronwyn H. Hall
- 2011-50 *Missing the target: Lessons from enabling innovation in South Asia* by Sulaiman V. Rasheed , Andy Hall and T.S. Vamsidhar Reddy
- 2011-51 *Optimal public investment, growth, and consumption: Evidence from African countries* by Augustin Kwasi Fosu, Yoseph Yilma Getachew and Thomas Ziesemer
- 2011-52 *Size, competition, and innovative activities: a developing world perspective* by Abdul Waheed
- 2011-53 *What Changes Gini Coefficients of Education? On the dynamic interaction between education, its distribution and growth* by Thomas Ziesemer
- 2011-54 *Global Framework for differential pricing of pharmaceuticals* by Rutger Daems and Shyama V. Ramani
- 2011-55 *The effect of net immigration on economic growth in an ageing economy: transitory and permanent shocks* by Joan Muysken and Thomas Ziesemer
- 2011-56 *Research, higher education and innovation: redesigning multi-level governance within Europe in a period of crisis* by Jo Ritzen and Luc Soete
- 2011-57 *A renaissance for social mobility and its significance for the bridge towards postsecondary education* by Jo Ritzen
- 2011-58 *Arab Regional Systems of Innovation: Characteristics and Implications* by Samia Satti Osman Mohamed Nour
- 2011-59 *The use and economic impacts of ICT at the macro-micro levels in the Arab Gulf countries* by Samia Satti Osman Mohamed Nour
- 2011-60 *The Use and Economic Impacts of Information and Communication Technology (ICT) in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-61 *Innovation and firm-level productivity: econometric evidence from Bangladesh and Pakistan* by Abdul Waheed
- 2011-62 *User innovation in the business enterprise sector of Maputo Province in Mozambique* by Júlia Eva Baltazar Zita & Avelino Hermíneo Lopes