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HARNESSING TECHNOLOGY FOR THE ENHANCED PRODUCTIVITY AND COMPETITIVENESS OF SMALL AND MEDIUM SIZED ENTERPRISES IN THE ESCWA REGION

BACKGROUND PAPER

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Executive Summary

Small and medium sized enterprises (SMEs) in ESCWA Member States face numerous challenges. Improved literacy rates, growing population levels and informed consumers in an increasingly sophisticated marketplace are fueling demand for new and innovative goods and services and creating new opportunities in business and manufacturing. Meanwhile, small and medium enterprise owners and entrepreneurs aware of market potentials are unable to secure the local human resource and financing needed to help their firms compete in an increasingly dynamic and international marketplace. Youth unemployment rates thus remain high, while brain drain continues to plague the region, despite the increasing investments that ESCWA Member States are directing towards education and training. Cultural, legal and financial constraints further complicate matters as incentives for discovery and modernization are marginalized in family-owned SMEs in favor of traditional business practices carried over from generation to generation. Investments in research and development and risk-taking are also viewed as a luxury, rather than a necessity, in an environment where financing is scarce and intellectual property is sometimes perceived as a communal resource. Uncertainty and insecurity, which are unfortunate conditions commonly experienced in the ESCWA region, also hamper the ability of SMEs to engage in strategic business planning and pursue investments for improving their productivity and competitiveness. This is despite the emergence of new and unique financial instruments that are being deployed throughout the region to support entrepreneurship and investment, and the adoption of public policies increasingly cognizant of the role that SMEs play in enhancing socio-economic welfare.

This paper focuses on the institutional aspects influencing the ability of SMEs in ESCWA Member States to harness technology. It also examines the various mechanisms through which SMEs adopt or adapt technologies into their production processes. In doing so, the paper examines technology deployment at the various stages of production with a view towards enhancing efficiency and improving environmental performance. The paper also discusses four models that illustrate how technology can be incorporated into the operations of SMEs engaged in manufacturing. These focus on the purchasing of turnkey production systems, the fostering of innovation, the creation of customized products, and the opportunities presented by outsourcing and sub-contracting.

While it is well accepted that technology is not a magic wand that can solve all the problems facing SMEs, the appropriate development and deployment of technologies make it an enabling tool central to efforts seeking to enhance the ability of SMEs to survive and thrive in an increasingly competitive marketplace. Governments, the private sector and universities all play a role in enhancing the ability of small and medium producers to benefit from technology. The paper thus closes with recommendations for discussion on how these actors can help SMEs to access, incorporate, harness and develop new technologies to improve their productivity and competitiveness.

Arabic Summary

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I. INTRODUCTION

The increasing liberalization of trade and globalization of markets in a new knowledge economy has dramatically changed the relationship between suppliers, producers and consumers, and altered the way business is conducted in the local and international marketplace. Automation, quality control and customization have become key components of enhancing competitiveness in an environment where productivity is measured by efficiency and savings, and competitiveness is based on innovation and adaptation. Changes in these areas are forcing small and medium sized enterprises (SMEs) to either adjust to new dynamic conditions or opt out of the market, which would have adverse implications for socio-economic welfare in the region. Governments, industry and civil society are thus looking for ways to help SMEs to harness technology as a means to overcome these competitive pressures.

SMEs tend to dominate economic activity in the manufacturing sectors of developing countries. In the ESCWA region they are the main employers of educated human resources and are recognized to contribute effectively to elevating the standard of living of the middle and lower classes.¹ Challenges facing SMEs are often well-known, but difficult to overcome given the diverse nature and capacity of SMEs within and between different economic sectors. National programs seeking to encourage SME development are also often positioned in a range of policy frameworks targeting different development goals, such as industrial diversification, investment promotion, employment generation, science and technology, gender empowerment and decentralized development. Enhancing the competitiveness of SMEs in the region can have positive outcomes for each of these development objectives, and assisting SMEs to harness new technologies can help to realize these goals.

The importance of SMEs for developing economies is true irrespective of their definition. In the ESCWA region, most countries use the number of employees as a criterion for classifying SMEs, while some also include capital as an indicator of firm size. For example, a small firm in Yemen ranges from 5 to 9 persons, while a medium firm would have up to 50 employees; micro-enterprises are those with less than 5 employees. Jordan recently changed its definition and now considers firms with less than 250 employees and capital worth more than JD 30,000 as SMEs, while firms with fewer than 10 employees and less than JD 30,000 of registered capital are considered crafts.² Based on this definition, 98.7% of firms in Jordan are SMEs. Saudi Arabia considers firms with 10 to 25 employees to be small firms, while a medium-sized firm has between 25 and 100 employees. Firms with 9 or less employees in Saudi Arabia are considered micro-enterprises. Oman does not maintain a separate classification for micro-enterprises, but considers firms with over 100 employees to be large in size. In Egypt, firms with less than 100 workers are defined as SMEs. These firms represent 98% of all registered enterprises and produce 80% of Egypt's GDP.

The SME sector in non-oil exporting ESCWA countries is largely comprised of family-owned businesses that focus on a cluster of products and services for which the firm has established a solid reputation, often drawing on knowledge and experience passed on from generation to generation. Innovation and investment tend to coincide with generational cycles, but improved access to information on technological developments is helping to facilitate the introduction of new ideas into the family-owned firm. An increasing number of new SMEs are also being launched thanks to the transfer of technologies between economic sectors and investments being pursued by expatriates that have learned new approaches to production and management during work or study abroad. This is creating opportunities for start-ups, spin-offs and product diversification in firms that are able to be innovative, flexible and responsive to new ways of doing business.

SMEs in countries of the Gulf Cooperation Council (GCC) constitute an increasingly dynamic sector that is promoted as a means to encourage economic diversification. SMEs in these economies are mostly recent start-ups linked to entrepreneurs and investors that have been able to take advantage of increased liquidity in the region, new financial instruments and increasing demand for consumables over the last few decades. These and other Arab economies that depend on oil and mineral resources often promote

¹ National Council for Scientific Research (NCSR), "National Science – Technology – Innovation Policy (STIP)," Lebanon, 2006.

² Letter from the Ministry of Industry and Trade of Jordan to the Prime Ministry, Reference 23/1/7/23002 dated 12 January 2005, when JD 30,000 equaled US\$ 42,625.

investment in associated large-scale industries. However, policies are being adopted to support SMEs as a means to encourage dynamism in the manufacturing and services sectors and to generate employment and income opportunities for nationals in urban centers and remote areas. Numerous industrial estates, technology parks and economic cities are thus being established with specialized services catering to the needs of SMEs in order to meet these policy goals.

Technology offers the tools with which SMEs can endure changing business conditions and cultivate new business ideas in the global knowledge economy. Productivity gains can be generated from lower production cost, due to less expensive inputs such as raw materials and labor, or by improved management systems and production efficiencies, which generate more output from the same amount of input with less waste. Technology can boost productivity under both these scenarios by reducing the cost of inputs, increasing the rate of output and reducing the generation of unintended by-products. Technology also contributes to enhanced competitiveness by creating avenues through which product design, production, compliance, quality control and marketing can be energized by innovative approaches for achieving targets more effectively. The harnessing of technology at the firm level also becomes the springboard from which an SME can pursue higher value added product development that can facilitate integration into global supply chains and quickly respond to changing consumer preferences.

There are many models for harnessing technology in SMEs. The purchase of turnkey systems can facilitate access to new technologies under different modes that may result in the transfer of capital, manufacturing systems or knowledge. SMEs might then proceed from becoming skilled users of imported production technologies to eventually customizing these technologies to the needs of their firms or clients. SMEs can also become the source of innovation and technological solutions that respond to regional specificities and opportunities presented by new research. They can also be outsourced to manufacture specific products for clients within a value chain through the use of technology tools related to product design, production, packaging and quality control. Sub-contracting arrangements can further enhance the transfer of technology and know-how along a value chain. As such, there is a spectrum of models that SMEs can consider for harnessing technologies, and various ways that governments, business support services and education providers can assist SMEs to make the most from these opportunities.

II. THE ENABLING ENVIRONMENT

Revitalizing industrial manufacturing and build a stronger professional service sector are essential aspects of sustaining a productive economy. One proven scheme is based on the creation of an environment that stimulates people, firms and institutions to make the most of domestic and foreign technologies in creative and entrepreneurial ways.

With fierce global competition and emerging technological opportunities, small and medium manufacturers may face closure if they do not improve the agility, reliability and profitability of their plant operations. The need to optimize on input costs and procurement processes, as well as reach markets quickly with certified products that comply with conformity assessment procedures is possible with the deployment of appropriate production and quality assurance technologies. SMEs in the ESCWA region must also seek to remain informed about changes in the global marketplace and maintain a global presence given the advent of the increasingly sophisticated and informed consumer of the 21st century.

Despite the number of innovative ideas being generated by companies, entrepreneurs, researchers and students throughout the region, the successful incorporation of technology into SME business development in the region has been hampered by several constraints. Specifically, these involve the need to strengthen human resources, improve the targeting of research and development, redress financial challenges, and overcome legal obstacles.

A. SKILLED HUMAN RESOURCES

Technology deployment and harnessing towards improved SME productivity requires a continuously educated and trained workforce. A positive relationship between education and economic development has been established and could be described as follows:³

- An educated workforce stimulates higher rates of innovation;
- Innovation yields the ability to develop and sell increasingly complex goods and services;
- Services mostly arise in conjunction with the dissemination of new products; and
- As new products are developed, services are provided, productivity is enhanced and wealth is generated.

While education and literacy numbers have been improving in the ESCWA Member States, the region still does not have a sufficient number of skilled professional workers that can introduce, deploy and adequately manage state of the art technologies in the workplace. In 2004, literacy among youth between 15 and 24 years was over 90% in many ESCWA Member States, and as high as 85% in the highly-populated country of Egypt.⁴ The Arab region spends 5.4% of GDP per year on public universities and colleges, compared with 5.0% in industrialized countries and 3.8% in developing countries.⁵ These investments can help the region's younger generations to access the education needed for them to secure stable and productive jobs if training is targeted to meet the needs of local firms and if financial instruments are provided to help young people to establish new businesses.

At the university level, enrolment stands at 23% in developing countries and 69% in rich countries (i.e., tertiary school enrolment as a share of the corresponding age group).⁶ In the ESCWA region, the number of national university graduates from scientific and engineering fields between the years 1997 and 2004 varied from Yemen, where they represented 4.6% of total university graduates, to Syria where they comprised 26% of all graduates.⁷ On the other hand, in the fields of natural sciences, Arab university graduates specializing in these fields, as represented by their share of total university graduates, was at par

³ Stacy Lindsay, *Culture, Mental Models, and National Prosperity*. Monitor Group, Boston USA, 2000.

⁴ UNDP, *Human Development Report*, 2004.

⁵ UNESCO, 2005 *op. cit.*

⁶ UNCTAD, *The Least Developed Countries Report 2007: Knowledge, Technological Learning and Innovation for Development*.

⁷ ESCWA, *Regional and Country Science and Technology Indicators of Sustainable Development in ESCWA region*, New York, 2005 ملامح قطرية وإقليمية لمؤشرات التنمية المستدامة لقطاعات مختارة في منطقة الإسكوا (٦) قطاع العلم والتكنولوجيا (جيا). E/ESCWA/SDPD/2005/Booklet.6).

with their peers in Australia and Germany (e.g., 15.8% of graduates in Lebanon and 13.2% in the occupied Palestinian territories).⁸

It is also important to consider that the seeds of innovation and the introduction of technology tools into local SMEs often begin in educational institutions that are forming the employees of the future. This is where students learn about new developments and can engage in creative thinking about solutions to technical problems. Linkages between universities and SMEs can create jobs for young graduates able to understand, adopt, apply and support the maintenance of technologies in a modern enterprise. While automation and the integration of new technologies may replace jobs in some instances, higher value jobs are alternatively created allowing for higher income and more rewarding employment opportunities for skilled graduates.

Despite the significant resources being directed to support higher education in the region, universities and other educational institutions should direct greater energy towards identifying, targeting and responding to the needs of local firms. By doing so, universities can specialize in certain areas and develop competencies in the institution and among young graduates to meet the needs of the local market. This would in turn help SMEs to access new knowledge, reduce costs related to importing foreign experts and labor, and enhance firm competitiveness, while creating new employment opportunities at home.

B. RELEVANT RESEARCH AND DEVELOPMENT

Technological innovation has been increasingly the outcome of scientific research. On average, across various sectors, more than 30% of annual revenues in the manufacturing business derive from new or improved products.⁹ Investing in research and development (R&D) has been strongly correlated to improved economic indicators. Historically, steady GDP growth occurred for more than a century in those countries that account for most of the world's R&D investments. Governments in developing countries devote on average only 0.8% of GDP to R&D, compared to 2.4% of GDP in rich countries.¹⁰

It is interesting to note that R&D spending in the ESCWA Member States varied between 0.02% and 0.9% of GDP during the period 1996 to 2003.¹¹ While these figures are significantly less than those of industrialized nations, it is important to also compare expenditures with a country like India that spent 0.5% of its GDP on R&D in 2000 and then increased it to 2% in 2007. Furthermore, while the Arab region spent US\$ 6 per capita on R&D in 2002, Latin America spent US\$ 42 per capita while China invested US\$ 40 per capita during the same year.¹² The total amount spent in the Arab world on R&D, education and health combined also amounted to less than expenditures on imported military equipment, and has remained characteristic of public spending in the region in view of ongoing conflicts and uncertainty.

Nevertheless, some progress is underway. New technology zones are being established in several ESCWA countries as a means to provide the infrastructure and foster the environment needed to conduct R&D in specialized areas, such as the healthcare sector in Saudi Arabia and the multimedia industry in the United Arab Emirates. Egypt also recently issued a new policy objective to increase spending on science and technology to 1% of GDP in the coming years.¹³ These initiatives, however, would need greater elaboration in order to target SME development.

In terms of the type of research being undertaken, most scientific institutions in the Arab region still focus R&D resources on the agriculture and health sectors, which suggests that research priorities remain tied to national policies seeking to meet basic needs, such as food security and public health. Research related to industry, engineering, and related fields such as computer science and microelectronics is being conducted by only 20.2% of the total number of R&D units in the region. Interestingly, research on energy-

⁸ UNCTAD, *op. cit.*

⁹ NCSR, STIP 2006 *op. cit.*

¹⁰ UNCTAD press cit.

¹¹ ESCWA, 2005 *op. cit.*

¹² UNESCO, *Global Investment in R&D Today*, 2003.

¹³ "Egyptian science faces reform," *Science*, 6 July 2007.

related activities is reportedly being undertaken by only 8.7% of R&D units in the region, which may indicate some degree of under-reporting.

Another indicator signaling that a limited amount of research is taking place in the region is the number of scientific researchers per million people. In Jordan there were 1,927 researchers per million people in 2004, while in Syria there were only 29 despite the high number of graduates in science and engineer fields. As a point of comparison, there were an average of 3,728 researcher per million people engaged in research-related activities in the high-income countries of the Organization for Economic Cooperation and Development (OECD) during the same year.¹⁴

In order improve the enabling environment for research, development and technological innovation, more resources should be allocated towards targeted R&D spending and fostering employment opportunities in the public and private sectors. Creativity and academic freedom should be encouraged in research-oriented institutions, as well as coordination and complementary among the research programs. Selecting priorities for channeling R&D budgets is not an easy task. Effort should thus be made to stimulate public debates in this area and to consult with local enterprise owners and entrepreneurs regarding their needs. This can be facilitated by strengthening the relationship between government, the private sector and universities to:

- Improve access to information on industrial developments, trends and technical services;
- Create legal and organizational frameworks triggering incentives for industrial R&D;
- Engage in applied research associated with the development of new higher value added products;
- Find solutions for problems through collaboration among regional and national institutions.

The formulation and adoption of national science and technology policies can also assist in orienting resources into priority areas, although such strategies do not necessarily need to identify specific projects to target. As mentioned in the science, technology and innovation policy document developed by the National Council for Scientific Research of Lebanon in 2006, “neither firms nor governments can afford to rely exclusively on accessing or buying knowledge produced elsewhere since much knowledge is embodied in persons, procedures, and organizations. In other words, neither companies nor countries can ‘free-ride’ on science elsewhere.”¹⁵ Increasing the quality and quantity of R&D in key areas of importance to ESCWA countries is thus not only important for enhancing the competitiveness of SMEs, but also that of the region as a whole.

C. PARTNERING FINANCE WITH DEVELOPMENT OBJECTIVES

Very few SMEs in the ESCWA region are engaged in investments to produce new technologies. Limited headway has also been made in terms of investments in new manufacturing and process technologies associated with automation, quality assurance and the integration of information and communication technologies in production systems. Apart from uncertainty and instability associated with the regional situation and business environment, the cost of financing is consistently cited as an obstacle to investing in new technologies.

Banks in the region are generally reticent to finance new equipment investments in the absence of collateral, such as real estate, and prefer alternative investment opportunities that are relatively more lucrative and less risky, such as those involved in construction, real estate and natural resource development projects. This trend is not unique to the ESCWA region, rather it is global reality. R&D and technology-related projects are also not among the priorities for funding identified by international lending institutions. For instance, over the last 25 years only 3.9% of total World Bank lending to developing countries has gone to science and technology projects.¹⁶ Contrarily, bilateral donor agencies and assistance programs have sought to support industrial modernization programs in various forms by providing technical assistance and diagnostics assessments for facilitating technological upgrading among firms, particularly SMEs. However,

¹⁴ All figures in paragraph from UNDP 2004 cit.

¹⁵ NCSR, STIP 2006 cit.

¹⁶ UNCTAD/press cit.

the experts recruited to perform these diagnostics are often sourced from the donor country, while the financing of investments at the firm-level remains largely the responsibility of the local business owner. Hence, competing for and accessing finance remains an important constraint facing small and medium firms in the region with limited capital resources. This provides an area where government intervention may be necessary to support investments in the SME sector, including business support services.

In the ESCWA region, SMEs can also uniquely benefit from Islamic banking principles in seeking investments for technology in both existing enterprises and start-up ventures. The financing institution in these instances effectively becomes a partner in the enterprise, with all the risks and rewards that a partnership entails. This form of banking is based on the Islamic principle of refusing secured interest made on loans and deposits as typically is the case in conventional banking systems. Islamic banks cannot assure a fixed return in advance of an investment, but rather participate in the yield resulting from the use of the funds. The depositors share in the profits according to a predetermined ratio, and are rewarded with profit returns for assuming risk. Furthermore, when working with an entrepreneur, the bank cannot require a guarantee such as security and collateral from the industrialist in order to insure its capital against the possibility of an eventual loss. Despite the spread of this form of banking in the ESCWA region, especially in the Gulf countries, it is unfortunate that this form of banking has been largely biased against agricultural and industrial ventures, and especially reticent to providing capital to would-be entrepreneurs.¹⁷

Nevertheless, a few venture capital institutions have surfaced and started operation in the region. For instance, since 2005, a Venture Capital Bank in Bahrain targets “fundamentally sound and well managed small and medium-sized enterprises (SMEs) across multiple industry sectors with strong growth potential.”¹⁸ In 2006, the Injazat Technology Fund was launched in the United Arab Emirates and functions within Islamic banking principles to invest in promising technology start-up companies in the Middle East and North Africa.¹⁹ The emergence of these investment houses may indicate increased willingness to invest in technology-based start-ups in the region.

It also is important to keep in mind that finance is needed to sustain and modernize existing SMEs as much as it is needed to launch new start-ups. However, in the last five years, many of the investment banks that have initiated operations in the region have targeted start-up companies more than existing enterprises. This has left SME business owners at a comparative disadvantage when seeking financing from private banks that are not linked to publicly-subsidized financial schemes associated with industrial modernization programs. This is despite the fact that investing in technology retrofitting packages for existing, family-owned production facilities may entail less risk than investing in start-ups seeking to market new, yet untested technological products and solutions.

D. STRENGTHENED LEGAL SYSTEM

A common problem facing SMEs in the ESCWA region relates to their registration and legal status. Family-owned businesses seeking to access financing and invest in new technologies must often overcome challenges associated with shared decision-making, personal liability, licensing, registering property, and the costs of remaining compliant with legal requirements associated with establishing companies and joint ventures. These challenges become particularly problematic for smaller firms seeking to secure investments and forge partnerships that can help them to expand their capacity and competitiveness.

Time and resources expended to complete legal and bureaucratic procedures also tend to be higher for SMEs as compared to larger firms. However, the situation has been improving in several countries in the region, particularly in Egypt which was identified as the top reformer in terms of improving the business environment, as assessed by the World Bank in its *Doing Business 2008* report.²⁰ Many other initiatives have

¹⁷ Islamic Banks and Investment Financing, Rajesh K. Aggarwal, Tarik Yousef, *Journal of Money, Credit and Banking*, Vol. 32, No. 1 (February 2000).

¹⁸ Venture Capital Bank, Bahrain, www.vc-bank.com

¹⁹ Injazat Technology Fund, UAE, www.injazatfund.com

²⁰ World Bank, “Top Reformers in 2006/07,” *The Doing Business Project*, <http://www.doingbusiness.org/features/Reform2007.aspx>

also been taking place for legalizing e-business and e-government transactions, which should also assist SME to more easily satisfy legal requirements and access technologies for enhancing their competitiveness. Improving the business environment and the transparency of legal procedures also facilitates the entry of women into the SME sector.

SMEs should also consider intellectual property (IP) as an asset and a source of wealth. This is especially true for innovative enterprises whose business is based on unique or customized products and services, or which have developed products of interest to niche markets. In the international marketplace, IP protection is often critical to securing capitalization and financial reward from the commercialization of innovative products, as it can protect exclusivity rights associated with the exploitation of an invention.²¹

During the last decade, ESCWA Member States have made important advancements in terms of legislating intellectual property rights (IPR). Nevertheless, and despite improved legislation, very few patents have been reported, protected, or registered in the region and the number of refereed scientific journals published in the region remains very small. Between 2000 and 2004, while all developing countries filed on average 172,000 patents on an annual basis, rich countries filed more than one million patents annually.²² Not a single ESCWA or Arab country was included among the top twenty sites where patents are registered by residents, as per the 2007 patent report of the World Intellectual Property Organization (WIPO).²³ Residents in ESCWA countries thus remain reticent or uninterested in registering intellectual property in the region. Furthermore, in the rare case of IPR enforcement in the region, penalties have been relatively small compared to the alleged gains obtained from ignoring IPR protections. As such, there is insufficient deterrence to stimulate compliance with IP laws in the future. Accordingly, while new ideas and innovations are being produced in the region, these developments are not widely disseminated or publicized and remain unregistered due to lack of confidence in IP registration, protection and enforcement in much of the region.

²¹ Patents: Tapping the Potential of Innovative New Products, www.wipo.int/sme/en/documents/wipo_magazine/06_2002

²² UNCTAD press cit.

²³ WIPO, *The WIPO Patent Report*, 2007 Edition.

III. HARNESSING TECHNOLOGY IN SMES TODAY

Prior to discussing the role of technology in SME development, it is useful to define technology in general terms. According to the Encarta Dictionary, “technology” is defined as the:

- Application of tools and methods; the study, development, and application of devices, machines, and techniques for manufacturing and productive processes; or the
- Method of applying technical knowledge; a method or methodology that applies technical knowledge or tools; or the
- Sum of a society’s or culture’s knowledge.

Hence, the role of technology in improving SME productivity is embodied in its definition and is largely tied to managing knowledge and investing in improved manufacturing and production systems. New developments in industry are intensifying the interdependency between production process technologies and information technologies, and are increasingly evident in small and large enterprises alike. These developments are generating direct and indirect benefits in production, management and service through.²⁴

- Increased savings in total costs of operations;
- Improved decision-making and better business continuity;
- Improved coordination with supply chain trading partners and customers;
- Consistent and efficient production of goods based on desired specifications;
- Appropriate management of plant-floor based on collected data;
- Deeper understanding of the revenue-generation operations;
- New career opportunities in more creative and value added activities; and
- Better information flows for aligning activities at every level.

It is thus useful to review how technology has been integrated into the operations of SMEs during various stages of their development and production process.

A. HISTORICAL PERSPECTIVE

Historically, developments in industrial production and manufacturing have been marked by revolutionary innovative technologies that have changed the history of nations. Civilizations and historical periods have been named after industrial processing associated with natural materials such as stones, iron and metals. More recently, groups of nations have been labeled “industrial,” “developed” or “rich” based on the sophistication and diversification of their industrial output and technological base. Technology components and systems have revolutionized production and contributed strongly to the creation of major world powers. This correlation between production technologies and economic power is often rooted in the exchange of knowledge and technologies between military, aerospace and civilian manufacturing industries.

Stages of industrial development and production were often introduced and in some cases eliminated based on adopted and applied technologies used during processing and assembly. Figure 1 illustrates the various phases of production development coupled with associated technological applications and systems.

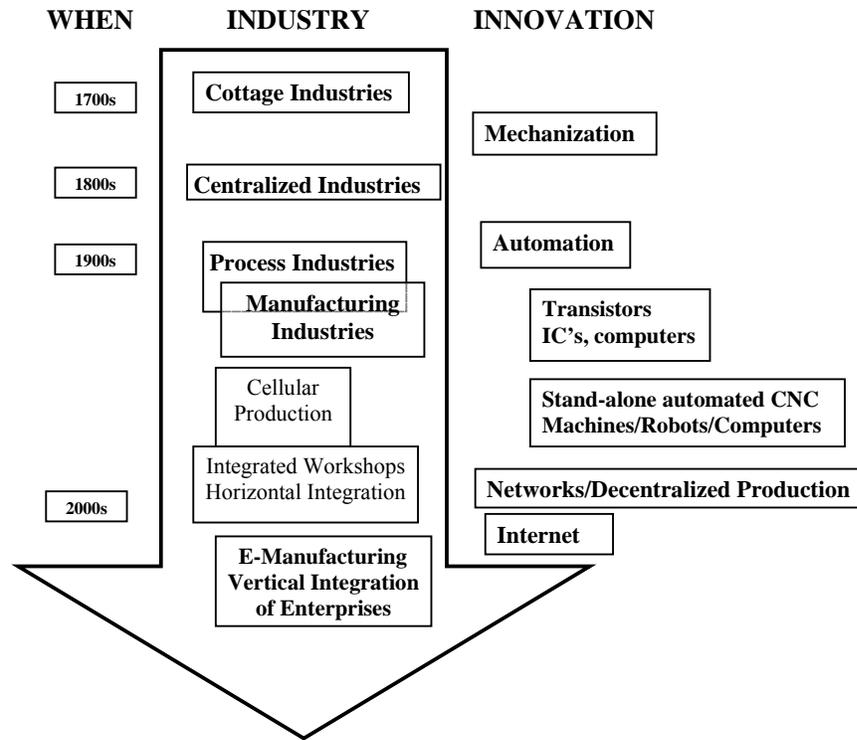
Tooling mechanization required the centralization of expensive industrial processes. Assembly lines and automation of the mechanized process using various technology components, including smart mechanical parts, clever designs and switching transistors, increased productivity and led to the establishment of manufacturing plants.

Later on, the digital computer effectively and efficiently replaced the electro-mechanical controllers and sequencers. These computer-based controllers formed the brains of major production tools and islands of automation like robots, computer numerical control (CNC) machining, programmable logic controllers, and others. The information generated in these automated production zones was stored in databases and provided

²⁴ Ray Zimmermann, Julie Fraser, “Converge For Competitiveness,” Rockwell Automation Inc. White Paper, June 2007.

to be very useful in integrating production floors to minimize waste, and manage work in progress while maximizing just-in-time production of components and final goods.

Figure 1: History of industrial development land-marked by innovative technologies²⁵



More recently, horizontal networking of various suppliers and workshops was made possible by creating local area networks and accessing the internet. The establishment of decentralized and synchronized production zones, which can be remotely monitored and located across the world, facilitated outsourcing and sub-contracting. Decentralized sub-plants generated an abundance of manufacturing data during the various phases of production including design, warehousing, processing, assembly, testing, and quality assurance. The need to store and share these large amounts of data at an affordable cost across networks triggered the development of large storage and fast communication devices.

Hence, several business trends emerged, such as the need for more efficient maintenance based on prediction rather than prevention, customization rather than mass production, just-in-time rather than stock inventory strategies, and other trends that required overall production to be lean, optimized and efficient.

It is important to highlight that the dynamic and flexible nature of SMEs affords them the opportunity to leapfrog directly into the e-manufacturing era. That transformation becomes feasible with the adoption of new manufacturing technologies, particularly those with integrated modules supported by information and communication technologies (ICT).

B. PRODUCTION COMPETITIVENESS TODAY

Market requirements are becoming increasingly global and affect all sectors and societies. Local, regional, and international export markets are open to multinational companies that can respond to their

²⁵ Fouad Mrad, "Technology Productivity Tools for Industry," Presentation to Syrian Computer Society, Assad Library, Damascus, Syrian Arab Republic, March 2002.

demands and achieve optimized production, typically through the integration of best value components and sub-systems from international sources. Global purchasing markets are demanding and increasingly insist on:

- Low prices;
- More features;
- Better performance;
- Short delivery time;
- Higher reliability/support;
- Known standards and quality seals;
- Wide product lines;
- Custom-made products; and
- Variable order sizes.

Working towards meeting these market demands is challenging in all business sectors and can be facilitated by the deployment of intelligent and effective production and management tools. SMEs, which are dynamic and flexible in nature and size, are well-positioned to face these challenges and favorably survive in this new environment which rewards:

- Innovation;
- Customization;
- Waste reduction;
- Product proliferation;
- Efficiency;
- Informed decision making;
- Flexibility; and
- Quality deployment and assurance.

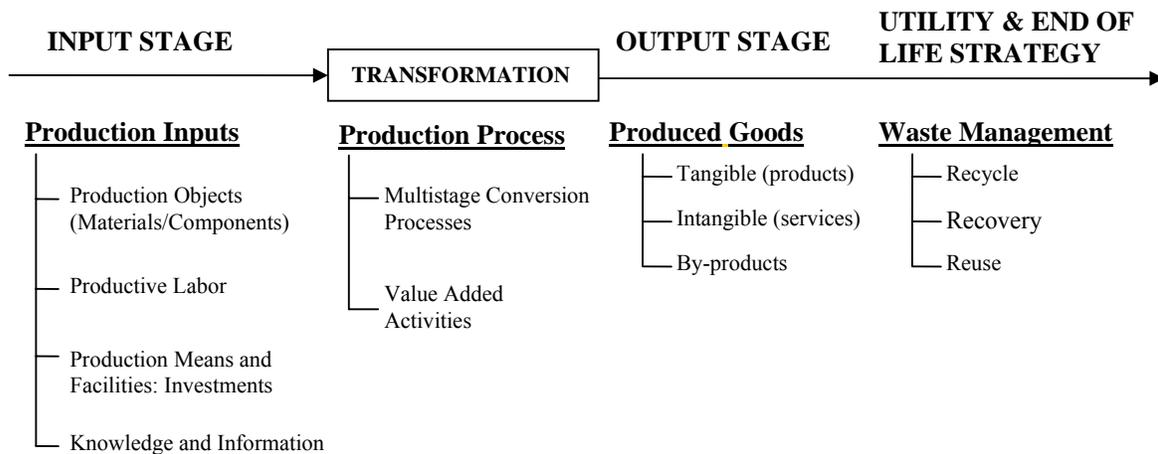
In order to achieve these measurable and controllable characteristics, it is useful to learn from best practices that have succeeded in other countries and regions and selectively apply tested industrial productivity technology tools and solutions, so as to leap frog into the competitive markets. The following section highlights main technology productivity tools that help enterprises of all sizes survive and grow by answering market needs.

C. TECHNOLOGY PRODUCTIVITY TOOLS

A pre-requisite for improving the business attributes is a general understanding of the production process, being manufacturing or service oriented. The general production model presented in Figure 2 offers a diagram to facilitate the targeting of various technology tools with a clear purpose in mind. It should be noted, however, that some of these tools offer improvements across the various stages of the model through integration and data sharing functions.

Based on this simplified and universal production model, enterprises can aim to incorporate technology tools at different stages of production to improve the overall productivity and competitiveness of the enterprise. ICT tools and databases are now commonly used throughout the transformation cycle and are essential for managing daily operations, such as word processing, e-mail, text messaging and simple accounting programs. However, industrial technologies are different in nature and tend to target specific phases in the production process. However, ICT and automation tools significantly helped to integrate different stages of product transformation. These technologies are abundantly available in the ESCWA region, with some versions developed or customized with an Arabic language human-machine interface.

Figure 2: Typical production model²⁶



1. *Production inputs*

At the input stage of the production model illustrated in Figure 2, four factors are critical: input materials, labor, capital and knowledge.

Information and knowledge have lately become recognized as being as important as the other traditional factors of production. SMEs can thus harness technology to capture and deploy knowledge throughout the transformation process. In addition, managing and protecting knowledge as an asset requires a strategy as sophisticated as that of product development, material sourcing, and marketing. Knowledge mining and management is a gradual, but essential process that allows for the accumulation of understanding and lessons learned from experiences in a manner conducive to fostering improvements within the firm.

The success of SMEs is largely based on their human resources. Increasingly productivity is largely based in increasing the capacity of an employee to produce more thanks to increased input, capital and/or knowledge. Enhancing the competence of employees can only be achieved through training and continuous learning. SME owners are responsible for managing the career development and growth plans of their staff members for the same reason that they are responsible for protecting the intellectual assets of the enterprise. Therefore, opportunities and environments for staff development should be instituted in order to help employees remain informed about new knowledge and know-how generated in the marketplace.

Procurement has been a pioneer in harnessing information technology and the internet to support production functions, specifically through e-business transactions. Global benchmarking and purchasing has helped to optimize and list reliable and competitive suppliers of raw materials, which can be accessed and approached through on-line systems that allow for the efficient and cost-effective procurement of components and materials needed for production.

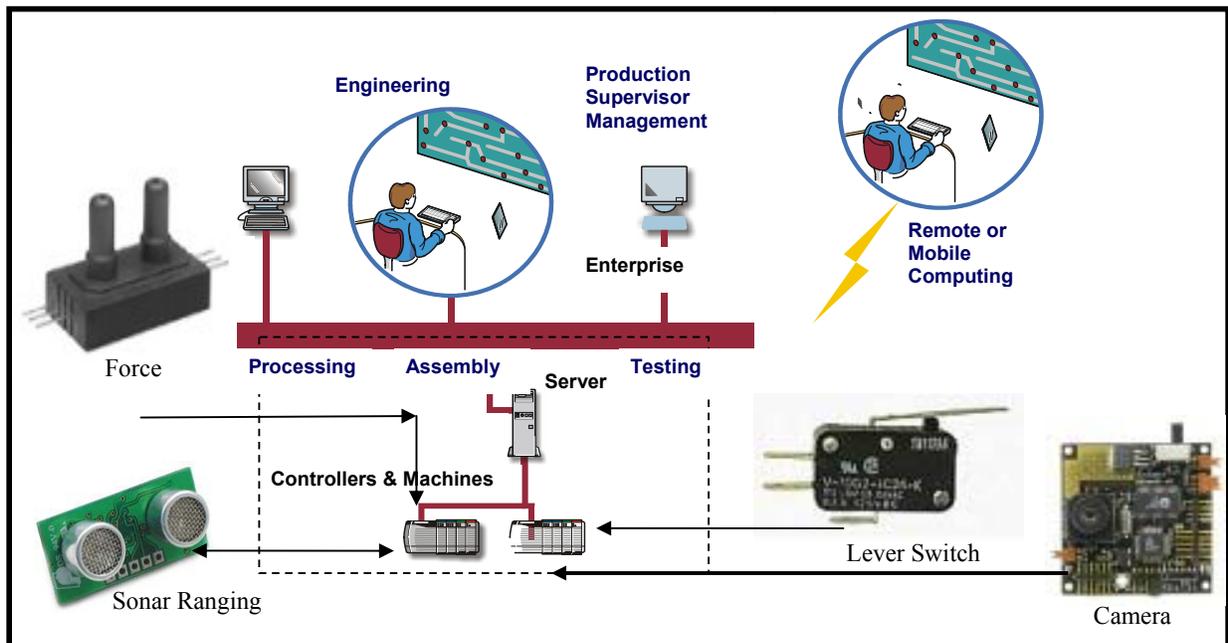
As for capital investment, technology allows top management to analyze information from the production floor. Hence, decision-making is conducted based on collected data and educated analysis, including detailed performance monitoring reports of the various phases of the production process. This allows for real-time detection of problems and identification of areas where failures may occur. As a result, capital investments can be made with less risk, since decisions are based on information and identified gaps in production processes, and not on perception or speculation.

²⁶ Adapted from "Justifying Investment in Industrial Automation," Zaki Demachkieh, Thesis in Engineering Management Program, American University of Beirut, Supervised by N. Abboud and F. Mrad, 1997.

2. Production process

The skillful transformation of raw materials into the final product requires the deployment of modern industrial technologies at nearly every step of the production process: material handling and inventory warehousing, design and planning, material processing and assembly, testing and packaging, facilities management/supervision and control. The integration of various technologies utilized in during production allows the enterprise to efficiently deliver competitive products and services, as illustrated in Figure 3.

Figure 3: SME production process; possible scenario of technology-based knowledge flow²⁷



Microprocessor-based equipments and standalone controllers consistently execute the tasks based on the performance specifications of the design. These controllers generate a wealth of information about productivity, product quality, and delivery, which can be used to improve the efficiency and productivity of the firm. The following are typical production technologies that are becoming increasingly used in manufacturing SMEs in the ESCWA region:

- Automated material handling and storage: inventory control, parts, raw material;
- Computer integrated processes: design, plan, process control, assembly, and packaging; and
- Automated inspection and quality assurance.

These production technologies communicate together for “just in time” execution of scheduled functions. Tracking materials, products, and transformation logs also constitute the quality assurance backbone of the firm. Since most SMEs can not afford and adopt all these technological components, a diagnostic assessment that identifies investment priorities is suggested. However, it is safe to assume that the global quality assurance concern and export focus have resulted in widespread adoption of inspection and testing systems and technologies across SMEs. Popular technologies for quality assurance and testing are based on instrumentation for measuring and computers for acquiring and storing relevant data. These inspection and testing technology tools are based on affordable microelectronics and computers that are usually portable with compact packaging. Sample tools include digital cameras, bar code readers and printers, various sensors of temperature, force, and other measurements necessary to monitoring processes, as previously shown in Figure 3.

²⁷ Adapted from Rockwell Automation RSVIEW technology, www.ra.com

In the ESCWA region, successful applications of process and supervisory control systems have been harnessed for decades. While a few of these technology tools have been produced in the region, some have been imported and locally adapted to the needs of the SMEs in the region to create new products and industries centered around quality control and instrumentation. SMEs are also increasingly pursuing design innovations by diversifying product lines and packaging options to create higher quality and more competitive outputs.

3. *Production output*

Technology tools for the delivery, marketing, service and maintenance of products are abundant, and include the following:

- Marketing through e-commerce, web-based solutions, and client-based information systems;
- Global delivery order using internet-based shipping;
- Consumer service inquiry and feedback systems;
- Product history log and performance tags;
- Internet-based service reminders and maintenance scheduling;
- Practical spare parts allocation and dispensing.

SMEs can draw upon internet and computer-based marketing and knowledge management tools and consumer service strategies as a way to draw and maintain new clients. Opportunities are multiplied when reliable, rapid and cost-effective internet connectivity is available in-country.

4. *End of life strategy*

SMEs produce products and associated utilities for consumer markets. However, in view of the increasing production and consumption trends being experienced in the ESCWA region, it is becoming increasingly important to adopt environmentally friendly strategies for sustainably managing waste associated with production outputs and by-products. SMEs have a role to play in reducing waste and can use their environmental performance as an asset for improving their marketability and bottom line.

Like every sound business plan requiring an exit strategy, product design must have a corresponding end of life strategy for outputs and by-products. Efficiently designed systems minimize waste generation throughout the production process by identifying stages where heat, water and pressure can be redirected into the production chain, thus reducing the volume of new inputs needed to run the system. Liquid and solid waste can also be recycled and reused in certain industries, or their volume reduced, which generates savings associated with smaller waste disposal costs. New packaging technologies and improvements in packaging design can also reduce the amount of waste generated after products are transported and consumed.

Integrated thinking about production systems and product design allows system designers and producers to select materials and processing methods that are compatible with the efficient management and disposal of waste. Furthermore, advancements in technology are offering affordable ways to make the recycling and reutilization of components and materials a lucrative business opportunity. As such, an “end of life” strategy does not only focus on “end of pipe” pollutants, but should constitute an integrated approach to mitigating and preventing the production of unwanted by-products throughout the production system, as well as reducing the volume of waste generated after consumption of the final product. In doing so, protecting the environment and properly managing natural resources can become economically viable and lucrative, in addition to being beneficial for sustainable development.

D. COST OF INTRODUCING TECHNOLOGY TO SMES

The introduction or upgrading of technology into the enterprise carries direct and indirect costs. Hence there is a need to carefully identify and select the technology tools that are adequate and can be fully utilized.

When pursuing new technology investments, it is useful to consult with the various internal stakeholders that will be involved with the management, operation and monitoring of the new system prior to

decision-making. This helps to generate a feeling of ownership and accountability relative to the project and improves the value and impact of the investment on the business. This is important since technology-induced improvements can be captured by an organization only if there is awareness and acceptance of new ways of thinking about achieving operations excellence. For SMEs it is also advisable to use modular, scalable applications that can be separated into technology blocks and introduced into operations at the rate appropriate to the firm, based on downtime planning and cost. The use of commercially available tools that install and integrate easily with existing systems can also facilitate and reduce the cost of integrating new technologies into existing production processes.

The amount of spending on technology that an enterprise should invest is relative and firm-specific. Variables to consider when making investment decisions include the level and type of competition being experienced in traditional markets, as well as opportunities that are being missed in new markets by not engaging in higher quality or more efficient production. Investing in technological change, however, will not reap benefits if new systems are not appropriately integrated into the firm. Table 1 highlights some of the direct and indirect costs associated with the introduction of technology into small and medium firms.

TABLE 1: DIRECT AND INDIRECT COSTS OF TECHNOLOGY INTRODUCTION IN SMES

Direct	Indirect
<ul style="list-style-type: none"> • Purchase of equipment (and associated financing) • Installation and interfacing with existing systems • Hiring/sub-contracting skilled workers • Changes in cost of associated utilities 	<ul style="list-style-type: none"> • Plant layout modification (if needed) • Maintenance and monitoring • Retraining of workers • Forecasted upgrading of system over time

SMEs cannot often afford to maintain specialized R&D programs that can identify, adapt and introduce modern industrial technologies into existing systems. As such, regional universities, research centers and government-sponsored industrial modernization programs provide a pool of resources for technology diagnostics, investment and training in R&D related fields. These institutions offer specialized and skilled personnel that can assist SMEs in areas that are not part of their core functions or for which they do not yet have trained staff.

SMEs are also encouraged to concentrate on critical technologies that constitute the backbone of their product lines (e.g., investing in Computer Numerical Control (CNC) for parts production, injection molding for plastic production, washing machines for textile finishing, etc.) and avoid diverting scarce resources into tangential technology tools that are needed for enhanced business productivity (e.g., webpage design, computer maintenance, e-commerce system), but which can also be outsourced from service providers. This can allow SMEs to easily turn to their service providers as deployment partners for identifying and incorporating new efficient applications and services. This in turn reduces operating costs and frees personnel for value added development of core business activities. Outsourcing non-core services can also free-up management to engage in more productive networking and business development work.

IV. MODELS FOR HARNESSING TECHNOLOGY IN SMES

SMEs can pursue different avenues for harnessing technology into their production systems, and can even become technology providers themselves. Harnessing technology to achieve SME growth can be achieved following many business models. The most practical of these for SMEs include the following:

- Turnkey solutions imported from technology suppliers;
- Home grown technology products and innovations;
- Customization and adaptation of existing off-the-shelf products and tools; and
- Outsourcing and securing sub-contracts for technology-based services and supplies.

These models illustrate how technology is incorporated into firms based on the experiences of a sample of firms in the ESCWA region. Other ways of harnessing technology exist, but can often be viewed as hybrid approaches that combine two or more of these generalized models.

Each of these models can also be viewed as a way to help SMEs to enter value added chains, either as an intermediate supplier or producer of final goods for the market. This is because while the incorporation of technology-based tools into SMEs first targets improved productivity within the firm, investing in technology also creates direct and indirect benefits associated with accessing new networks of specialized service and equipment providers and expanding the firm's knowledge base. This in turn allows the firm to better assess what is available in the market and identify opportunities for business development through upstream and downstream linkages to other firms.

A. TURNKEY TECHNOLOGIES

Turnkey systems are technology packages that represent the purchase of the complete solution from design to end-use. While there are different degrees involved in the purchase or contracting of turnkey systems, arrangements generally assure the installation, testing, corresponding maintenance and some limited training on the utilization of the system and/or equipment. The level of technology transfer that results depends on the sophistication of the system and the degree of integration into a firm's production chain.

During the past three decades, the Arab world has spent US\$ 1,000 billion on technology-based turnkey projects, which is more than 20 times the amount spent within the Marshall Plan that rebuilt Europe after the Second World War.²⁸ It is thus evident that turnkey systems have secured an important place in the minds of local business and government as solutions to the region's development needs. However, despite the preference for these types of arrangements, turnkey contracts – including those that are leased, licensed or serviced by the supplier – can still be designed to ensure that knowledge and know-how is transferred along with the system or equipment put into place. For instance, interfacing various turnkey sub-systems offers opportunities for in-house capacity building and systems integration, which can best be pursued by involving those that are involved in the operation, maintenance and management.

In ESCWA countries, SMEs linked to natural resource-based industries or regional specificities can benefit from learning from turnkey systems than in turn can be the springboard for creating complementary industries. For example, turnkey technologies associated with the petrochemical production, plastic industry, software development, agro-food processing and water desalination have been important in fueling growth in those sectors. However, transferred technologies have also fostered the creation of new goods and services, such as those seeking to promote Arabic digital content and consumables based on local tastes and preferences. The case study detailed in the box below illustrates how firms can successfully transfer technologies from abroad to establish new companies in ESCWA countries thanks to knowledge, technical skills and resources that are available in the region.

²⁸ UNESCO, 2005 cit.

Box 1.

Case Study: Purchase and transfer of a turnkey production facility to the ESCWA region

A pioneer in the manufacture of diamond working tools started a successful business in the 1960s in Italy. The tools produced use diamond circular and linear saw blades, diamond wire, and diamond wheels to produce precision equipment for the stone and construction industry. After 40 years of un-interrupted work, modernization, growth and an established network of around 100 international sales outlets and representatives, the business was purchased by investors based in the ESCWA region and relocated to Lebanon in 2004. The SME continues to be fully operational and has generated quality sustainable jobs for educated technicians, scientists, managers, and salespeople. Furthermore, a chain of parts suppliers and knowledge support in local labs and universities had developed, which as generated secondary benefits and opportunities associated with the transfer of these turnkey technologies to the region.

Many lessons can be drawn from this experience:

- Regional investments in technology production is lucrative and can be linked to successful European or Western experiences and networks;
- There are competitive advantages in relocating the production of technological tools and equipment to the region;
- Relocated advanced production turnkey facilities has knowledge multiplier effects that cover supplier chains and generate new knowledge;
- The branding and marketing of successful products produced based on consistently reliable quality standards can be legally acquired and can be a determining factor influencing the success of a firm.

B. HOME GROWN INNOVATION

When an educated workforce and technical personnel identify gaps in supply chains and consumer markets, these gaps can be filled by home grown innovation. Innovation results in a different way of doing business, as embodied in a new process, product or technology. Innovative ideas can emerge from within the firm, research center or through individual initiative to respond to new market opportunities.

Home grown technologies can influence SME development in several ways. First, innovation fostered within the firm can improve the productivity and competitiveness of an SME's existing operations, particularly in firms that allow for creativity and open lines of communication with management decision-makers. Alternatively, innovators working within SMEs can create new goods and services that are nurtured in the firm and then spun-off as independent SME ventures that maintain links to their parent company. In the third instance, innovators with an entrepreneurial spirit within a firm that is not sufficiently responsive to new ideas often end up leaving the firm to establish their own enterprises. While this results in a loss for the SME who invested in the employee and fostered the environment where the innovative idea emerged, this also creates new enterprises headed by new business leaders that can create additional income and employment benefits for the local economy. In the fourth case, independent innovators or inventors associated with research institutes or universities can launch their own businesses. In most cases, however, the idea for an innovation is an outgrowth of familiarity with a sector through professional or academic experience and an enabling environment where R&D is fostered by public, private or non-governmental actors.

While a traditionally weak enabling environment for R&D remains a challenge constraining innovation and entrepreneurship in the region, this has not stopped the creation of new products and technology-based enterprises. Additionally, an increasing number of initiatives are being introduced to strengthen R&D infrastructures and networks in the region to foster home grown innovation responsive to regional development needs. For instance, new technology parks and incubators are being launched and linked to universities as a way to capture knowledge and creating an environment for innovation to support

local industries. Research grants and programs are being funded by governments, regional organizations and international donors, which provide resources and recognition for research focused on areas of interest to the region.

As such, internationally adopted indicators of R&D achievements might not be fully indicative of the actual amount of innovation taking place in ESCWA countries. For example, registering patents is not a common practice for family-owned businesses despite the diversity of new products that have emerged from such businesses in recent years. Counting the number of published papers in internationally refereed journals may also not be appropriate if monitored journals are those focused on specialized industries not of priority for the region (e.g., cars, aerospace, integrated micro-chips, etc.). Accordingly, despite indicators that find that R&D in the region remains weak, home grown innovation does occur and can support the SME sector in the region.

Box 2.

Case Study: Home grown innovative technology products in the ESCWA region

University research on materials testing in the ESCWA region led to the establishment of a business that designs and manufactures specialized equipment and automated machines for testing materials. While the SME proved successful in local, regional and international markets, the SME's business growth strategy prompted it to establish a small representational office in Europe that provides packaging and sales support for the marketing its high-tech products. The SME thus conducts design, prototyping, programming and debugging in the region, and then finalizes assembly and packaging abroad in order to access foreign markets and overcome negative perceptions that innovation does not take place in the Arab region. According to the company's website, its core strength derives from its commitment to forging an "alliance with client teams for the development of special purpose products and systems." The design and development of these products happens in the ESCWA region.

Many lessons can be learned from this experience:

- Innovation has no nationality and the ESCWA region is a supplier of high-tech solutions;
- Existing market perceptions regarding production in much of the Arab region is a serious challenge that entrepreneurs and enterprises must overcome;
- Image building based on regional commitments to professionalism, quality assurance, excellence and innovation enhanced by an effective marketing strategy can help change these perceptions; without improvements in this area local innovators and entrepreneurs will continue to seek out other countries to market their products thus perpetuating mistaken perceptions about innovation in the Arab region.

C. CUSTOMIZATION

Customization is the integration and interfacing of different off-the-shelf technology components and sub-systems in an innovative and purposeful manner to create new goods and services. Customization often responds to everyday problems in an innovative way. In the ESCWA region, customization helps local industries take advantage of business opportunities and improve their productivity by identifying ways to incorporate technology solutions into existing business practices. If these problems were common to the industry worldwide, the needed solutions would most probably have been developed abroad and imported as turnkey systems by the ESCWA Member States. However, niche products and specialized production methods that render local SMEs competitive often need to customize technologies to meet their specialized needs. As such, the customization of existing technologies through moderate transformation or adaptation has become an increasingly effective and appropriate way to assist SMEs to harness technologies.

Box 3.

Case Study: Customized technology solutions in the ESCWA region

In many ESCWA countries, the supply of electricity is regularly interrupted, unreliable and suffers from power fluctuations. Generators and power regulators designed in developed countries have proven unfit to respond to the problem since the equipment manufactured for consumers in those countries is not designed to withstand extreme environments and heavy demands for power over long durations of time.

Community leaders and SMEs in the ESCWA region have long sought to overcome power shortages and blackouts through piecemeal solutions. This has resulted in the fabrication of rugged products that are oftentimes unsafe, unreliable and unable to accommodate the power needs of home appliances and consumer electronics. A local engineer thus established a firm drawing upon local university research that was able to customize a new line of power stabilizers and power supplies suited to the needs of the local market. The range of products subsequently expanded and includes products such as power stabilizers, uninterruptible power supplies (UPS) of various sizes and battery chargers. After 15 years of operation, this electronic producer has 30 employees and has become a reputable supplier of power-related products in many regional markets, especially countries in crisis.

Many lessons can be learned from this experience:

- Crafting customized products for niche markets makes sense for SMEs that can combine turnkey solutions and home grown innovation to satisfy special market needs;
- SMEs can generate profits from customized product and be competitive relative to larger firms that derive their competitiveness from economies of scale associated with standardized product ranges;
- Knowledge of local problems, their source and their characteristics, coupled with an educated workforce, can spark innovation and entrepreneurship;
- SMEs can develop their client base by identifying consumers that face similar problems and challenges as those being experienced in local markets.

D. OUTSOURCING AND SUB-CONTRACTING

Opportunities presented by outsourcing services and sub-contracting suppliers should be a regular part of business planning for small and large firms alike. Such business arrangements are bi-directional and create mutual benefits. SMEs can outsource their non-essential technology-based functions to service providers in order to focus on core business development and production. Smaller firms have traditionally outsourced services related to accounting, waste management and marketing. However, the introduction of new technology tools to support manufacturing have also prompted SMEs to turn to external suppliers of services related to product design. These include architects, skilled technicians and printing services specialized in the use of computer-assisted design tools (e.g., CAD/CAM, Autocad) to lay out patterns or specify measurements needed to most efficiently fabricate garments, furniture or customized metalwork. In some cases these skills are then developed in-house so that the SME can harness these technologies as part of its core business functions following improved familiarity with utility and use of the technology tools.

At the same time, SMEs should continuously survey the market for opportunities to regularly supply other enterprises and larger supply chains with standardized components or outputs. This allows firms to expand their network of clients, strengthen their reputation as a trusted member of a supply chain and create opportunities for backwards and forward technology linkages between companies. While some sub-contracting relationships remain limited to specific components, knowledge can oftentimes be gained in the process regarding new market developments and more sophisticated technological tools that are used along the supply chain. As such, outsource and sub-contracting are two sides of the same coin that both provide opportunities for SMEs to harness new knowledge and technologies.

Box 4.

Case Study: Outsourcing technology production in the ESCWA region

A manufacturing firm of 20 employees in an ESCWA country started machining parts using advanced CNC production technologies for a multinational corporation based in France in 2002. The business relationship started by producing certain components based on pre-specified requirements and quantities on an exclusive basis.

Confidence was quickly built between the small and large firms and orders began to range from the design and manufacture of single customized parts to the supply of 50,000 pieces of the same component. The development of the business relationship allowed the SME to justify investments in more sophisticated CNC technologies and led it to forge sub-contracting arrangements with smaller local suppliers in order to continue to quickly respond to orders that were increasing in size. Satisfying these larger orders required close collaboration between the SMEs and its network of smaller CNC shops to ensure consistent quality among final outputs. The local shops that became part of the network underwent a rigorous qualifying process and are subject to continuous auditing by the SME, which provides them with design, knowledge and know-how needed to manufacture the components requested by the foreign client. These outsourcing and sub-contracting arrangements have allowed the SME to produce around 20,000 parts annually and expand its client base. Interestingly, while the SME was able to maintain product quality in the network, the inability to control intellectual property associated with their design of specialized components has become a difficult problem to manage as some sub-contractors have sought to now produce on their own.

After five years, the SME now manufactures parts for various sectors throughout the region, e.g., pharmaceuticals, cement, construction, lighting fixtures and accessories. The management of a dual-layer sub-contracting supply chain remains central to the firm business strategy, which is demand-driven, but also largely design-based. The firm's commitment to designing and manufacturing customized components through a network of sub-contractors has allowed it to keep design and production functions based in the region, and has allowed smaller firms to also develop their skills and be a part of supply chains that the SME has entered.

Many lessons can be learned from this experience:

- Outsourcing and sub-contracting can benefit firms of all sizes;
- Harnessing technology includes the transfer of knowledge and know-how; machinists that have passed through vocational education systems may be familiar with the use of technological equipment, but may still require training and supervision for the manufacture of customized parts;
- SMEs can maintain a competitive advantages in technology-based sectors where customization, design, innovative management schemes and quick delivery times can give them a competitive edge;
- SMEs as well as large firms suffer from lack of protection regarding intellectual property rights.

E. COMPARISON

It is important to realize that in global competitive markets no single business model is suitable for all firms and sectors of production. Many factors influence the set-up and structure of an SME and the ways it seeks to take advantage of advancements in technology. This includes the strategic direction of the firm, available skills, access to financing, market opportunities, cost of raw material, and acquired knowledge and experience. In general, however, SMEs in the ESCWA region can facilitate their entry into supply chains through adopting new technologies that are off-the-shelf, home grown, customized or fostered through outsourcing and sub-contracting arrangements. Some of the advantages and disadvantages of each of these models are detailed in Table 2. However, each approach provides SMEs with an opportunity to expand its technological breadth and enhance its competitiveness relative to other firms in the marketplace.

TABLE 2: COMPARISON OF SELECTED MODELS FOR HARNESSING TECHNOLOGY IN SMES

Model	Advantages	Disadvantages
Turnkey Technologies	<ul style="list-style-type: none"> ➤ Quick installation and application ➤ Tested and reliable solutions ➤ Professional support ➤ Effective training and information 	<ul style="list-style-type: none"> ➤ Expensive ➤ Closed architecture ➤ Reliance on supplier ➤ Limited upgrading of in-house skills
Home Grown Innovation	<ul style="list-style-type: none"> ➤ Mastering of solution ➤ Accumulated knowledge ➤ Targets needed features only 	<ul style="list-style-type: none"> ➤ Slow to set-up ➤ Learning curve can slow start-up ➤ Testing and trials are needed
Customization	<ul style="list-style-type: none"> ➤ Capitalizes on experience ➤ Transfers technology and skills ➤ Allows for a mix of best practices 	<ul style="list-style-type: none"> ➤ Interfacing challenges ➤ Difficulties of integrated black boxes ➤ Some reliance on other suppliers
Outsourcing and Sub-contracting	<ul style="list-style-type: none"> ➤ Promised savings ➤ Reliable services ➤ Allows for focus on core business 	<ul style="list-style-type: none"> ➤ Increases reliance on others ➤ Intellectual property and security risks ➤ Competition from sub-contractors

V. CONCLUSION AND RECOMMENDATIONS

SMEs constitute the economic backbone of developing societies. In ESCWA countries, the development of the SME sector is central to policies seeking to alleviate the socio-economic challenges facing the region. SMEs in today's knowledge based economy characterized by open markets and liberalizing trade regimes must be globally competitive in order to survive. To successfully compete, SMEs must manage productive processes and operations with increased efficiency and with a view towards technological change and innovation. Improvements in SME productivity can be achieved by more efficient use of inputs and properly deploying technology tools. Therefore, public sector interventions, private sector initiatives and academic programs must be complementary in order to create an enabling environment that facilitates proper training and education of human resources, encourages R&D relevant to regional needs, channels sufficient financing for launching and modernizing enterprises through the use of technologies, attracts investments and protects intellectual property.

Harnessing technology for improved SME productivity can be achieved through many models and depends on the enterprise's business strategy and the demand of its clientele in the market. SMEs have dynamic and light organizational structures that allow them to have lean and flexible operations. When aiming for competitiveness, it is essential to realize that knowledge has become a valued asset, which is as important as raw materials, capital, finance, and labor. Technology tools can target independently and jointly all areas of production from input through transformation to marketing and waste management. As such, technology has a dual role in improving SME competitiveness by first improving the productivity and management of the firm, and second as a catalyst for enabling the creation of higher value added products.

Production technologies have marked the history of civilizations and industrial development throughout the centuries. Although the ESCWA region needs to reinforce environments to foster innovation, the proliferation of information and communication technologies and inter-linkages being forged between technological advances in different sectors make it feasible for SMEs in the region to leapfrog into the state of the art exploitation, application and production of new technologies. While introducing new technologies has associated direct and indirect costs for new and existing firms, educated and selective deployment of core business technology blocks can facilitate the integrating of technologies into firms and justify investment decisions. Meanwhile, harnessing technologies associated with non-core business functions can be achieved through outsourcing services and partnership alliances. The four models for harnessing technology discussed in the paper – turnkey technologies, home grown innovation, customization and outsourcing/sub-contracting – offer distinct advantage for the SMEs seeking to expand its technological base and enter new value chains. Accordingly, whether technology is being harnessed as a productivity tool or as a product in and of itself for manufacture and marketing, technology offers important opportunities for SMEs and initiatives to facilitate its entry and incorporation into SME development strategies should be supported by public, private and non-governmental actors alike.

A. RECOMMENDATIONS

Enhancing the competitiveness of SMEs in the ESCWA region depends largely on the priorities and actions taken by three key groups, specifically: government, including public research centers; the private sector, including SMEs and associated support institutions; and universities and technical institutes that provide vocational training. Complementarity and harmony in the development strategies being pursued by these three groups of players can ensure a winning scenario for enhancing SME competitiveness and productivity in the region.

1. Government

In creating an enabling environment for SMEs to harness technology and improve competitiveness, governments have a dual role. Their first responsibility is to develop legislation and create a conducive environment for business development. The second involves allocating sufficient financial and human resources to universities and technical institutes for research, education and training in targeted areas of interest to the country and region, which are identified and developed with the help of national research centers.

Recommendations for consideration by Governments thus include the following, bearing in mind that some recommendations have already been adopted by some ESCWA countries:

- Formulate and ratify laws governing intellectual property rights. If such a law exists, ensure that enforcement is practical and serves as an effective deterrent against violations;
- Offer financial incentives to encourage start-up ventures and assist SME owners modernize their production facilities through tax breaks, simplified registration and licensing procedures, subsidized equipment loans, etc.;
- Seek to allocate at least 1% of national GDP to R&D programs in universities, research institutes and centers in areas targeted in national science and technology policies over the next five years;
- Promote regional collaboration in developing and implementing national science and technology policies to encourage research and the development of technological solutions to overcome shared socio-economic problems facing the region.

2. Private sector

The entrepreneurial spirit that sparks exploration for creative solutions in product and service design must be fostered and facilitated by an enabling environment conducive to innovation, customization and creating value added products. The dynamic and flexible structure of SMEs can facilitate the entry of new technologies in production and process systems, if sufficient information, knowledge and financing are made available to encourage technological change.

SMEs worldwide, and in the ESCWA region especially, face many operational and financial limitations. Hence, despite the interest to invest in technology in the workplace, the cost might become a preventive obstacle. Therefore, selective and educated investments in technologies for production and management become essential. SMEs cannot keep up with technology training and tools that are becoming essential for productive and competitive operations. It is important that SMEs focus on acquiring core technologies for the niche businesses and outsource the other supportive utility-like technologies to specialized service providers, unless their business strategies are reformulated to incorporate these services into their core functions.

Existing enterprises, as well as new entrepreneurs, are encouraged to foster creative partnerships with firms along a value chain as a means for accessing networks of knowledge and technology that service upstream and downstream industries. Furthermore, SMEs should seek to identify and respond to needs specific to the region, which is a niche market that can offer lucrative business opportunities in areas where competition is minimal. Finally, technology producers and integrators in the ESCWA region should not remain passive about the negative perception that markets have of products made in the Arab region. Instead they should aim to apply international standards and rigorous quality assurance systems, and seek overseas presence for marketing and representation, while also seeking to enhance the image and marketability of innovation sourced from Arab countries.

Recommendations for consideration by SMEs include the following:

- Seek creative business linkages with suppliers and clients, especially those active in global value chains, in order to benefit from networks and opportunities presented by outsourcing and subcontracting arrangements;
- Remain up-to-date about the latest technologies related to the firm's core business functions and selectively adopt and adapt new technologies as needed in accordance with a clear business plan;
- Sub-contract non-essential business services to dedicated providers that are more knowledgeable about emerging technologies outside of the firm's core business function and build long-term partnerships with the providers for harnessing benefits from the latest technologies;
- Fight negative market perceptions by adopting international standards and quality assurance technologies that ensure that the design, management and manufacture goods made in the region meet consumer specifications and needs.

3. *University and technical education*

Universities and technical education systems should encourage enrolment in modern engineering and technology fields to increase the understanding and utilization of new technologies in SMEs. University-private sector partnerships can help to introduce new and emerging technologies to students in academic programs and encourage innovation among young graduates as they enter the workforce. SME managers and staff can benefit from training on new and existing technologies and ICT tools, and could seek this knowledge through universities, specialized training institutes and specialized centers of excellence focused on certain sectors or production technologies. Universities can in turn identify area for specialization based on the needs of industries based in the communities where they work. This could relate to researching improvements materials management (e.g., in plastic or agro-food production) or enhancing applied research skills (e.g. in software development and biotechnology).

Irrespective of the amount of funding dedicated to research activities and programs, impacts can only be achieved if the outcome of this research generates benefits for the region. Since most funding is public, it becomes possible to orient these efforts towards relevant R&D and to encourage complementary research roles among centers to optimize resources. In doing so, environments also need to be created where universities and SMEs can network and mutually benefit from research outcomes generated in the academic context and applied R&D initiatives being nurtured by SMEs in order to expand the knowledge base in the region while also ensuring adequate protection for intellectual property rights.

Recommendations for consideration by universities thus include the following:

- Promote enrolment in science and technology fields and vocational training programs which correspond to the needs of local industry;
- Establish partnerships for joint technology training at universities and specialized institutes with technology suppliers and trainers for the local business owners and employees;
- Identify a few niche areas for relevant research and become local centers of excellence specialized in supporting R&D in specific areas to meet the technology needs of local SMEs;
- Invite SMEs to provide input regarding the orientation of university programs so that graduates have the skills sought by local SMEs.