Chapter 6

Biomedical Engineering and Entrepreneurship

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Introduction

Innovation refers to the process of translating an idea into a product, process or service that creates value, or the transformation of an existing product, process or service with the addition of new features. Innovation may be brought about by incremental or radical advances. All innovation begins with creative ideas.

Innovation as it relates to medical devices usually involves the invention of new devices and modification of existing devices. It could also involve appropriation, which means taking an existing device and applying it to a different situation. Biomedical engineering innovation of medical devices may be based on the application of new knowledge from scientific research, or on engineering problem solving; in the latter case, existing knowledge or techniques are applied to newly defined problems.

Innovation requires attention to needs. The well-supported presumption is that when a potential innovator focuses on needs and is attentive to the market of prospective users, he or she can acquire insight into the problems that require solutions and the products that might present suitable solutions.

The identification of a need and the subsequent development of a solution to the need is not the end of the innovation journey. Ensuring that the solution or product reaches the intended beneficiaries and is in fact implemented to address the need, requires a set of activities that may be considered entrepreneurship.

This chapter explores the concept of entrepreneurship, considers the entrepreneurial environment in Africa, and discusses the implications of the latter on the field of biomedical engineering on the continent.

The concept of entrepreneurship

The word entrepreneur is derived from the French verb “entreprendre”, which means to undertake, to attempt, or to try. The term was first introduced by the early 18th century French economist, Richard Cantillion, who defined the entrepreneur as the agent “who buys means of production at certain prices in order to combine them” into a new product and acts as a rational decision maker who assumes risk and manages the firm (Schumpeter, 1951; Kilby, 1971b).

Throughout the history of entrepreneurship, the concept has evolved as scholars from multiple disciplines have grappled with a diverse set of definitions. According to Stokes, Wilson and

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Mador (2010), the variety of definitions of entrepreneurship could be categorized into three main dimensions of behaviours, processes and outcomes, while others see the concept from the perspective of coordination of productive resources, introduction of innovation and the provision of capital (Hoselitz, 1952). However, the most substantial research into entrepreneurial research was achieved in the 20th century by Joseph Schumpeter who asserted that entrepreneurship and entrepreneurs produce a "creative destruction" which continuously replaces existing components of an economy (Schumpeter, 1934). The definitions range across showing entrepreneurship as a personal characteristic at the micro level of the individual and as an on-going process of transformation at the macro level of the society.

In general, entrepreneurship refers to the ability or the process of creating or adding value by organizing resources to take advantage of an identified opportunity. While it is the individual who takes the necessary steps to become an entrepreneur, a society can transform itself into an enabling environment that encourages entrepreneurship among its members.

Entrepreneurship is today recognized as a socio-economic phenomenon and considered the global panacea to unemployment as well as an essential ingredient for economic development (Bogoro, 2015). There is convincing evidence of a link between entrepreneurship and national development, especially in developed countries in America, Europe and Asia (Kilby, 1971a). For this reason, developing countries are vigorously embracing entrepreneurship, because beyond the realms of business and economy, the concept has become a positive way of life: a way of thinking, reasoning, behaving and acting (Timmons & Spinelli, 2004).

The entrepreneurial environment in Africa

Africa has received global attention in the 21st century as the continent for new growth and opportunities. There has been considerable debate on how African governments can create significant numbers of jobs and develop home-grown business leaders able to access global markets and propel growth in a sustainable and inclusive manner. Sustained growth and development depend crucially on, among other things, the capacity and willingness of African countries to create on a sustained basis an enabling environment conducive to the emergence of entrepreneurship in the public and private sectors.

One set of factors determining the entrepreneurial environment includes the overall economic, socio-cultural and political situation that influences people's willingness and ability towards entrepreneurship, while another addresses the availability of support services that promote the creation of new enterprises.

Entrepreneurship and local private enterprises are critical components of African economic development (McDade, 2002) and are central to Africa's future prosperity. Fostering entrepreneurship is, therefore, vital for African countries if they are to develop and transform their economies. The biggest business opportunities in the coming decade will require Africans who are able to start businesses, create jobs and generate wealth, and recognise and take

advantage of growth opportunities. However, African entrepreneurship can only thrive under a favourable entrepreneurship environment.

The 2017 *African Economic Outlook* report (AFDB, OECD & UNDP, 2017) reveals some interesting statistics about entrepreneurship on the continent. Africa is the region with the highest proportion (22%) of adults starting or running new businesses in the world, although there is considerable variation across African countries. Thirty-eight percent of African entrepreneurs are in the 25–34 age group, reflecting the continent's demographics and its young population. Firms that are younger than five years old and have fewer than twenty employees provide most of the new jobs in Africa's formal sector, with most African entrepreneurs (55%) focusing on lower skill sectors such as retail trade, hotels and restaurants; manufacturing accounts for only 8%. Africa also has a high rate of female entrepreneurs, with African women being twice as likely to start a business than women elsewhere.

However, despite the positive developments and encouraging trends shown on the continent in recent years, the troubling reality is that African entrepreneurship has been driven largely by necessity rather than by opportunity seeking. Necessity entrepreneurs start a firm because of a lack of employment opportunities. They generally use existing technologies and processes, and lack high growth prospects, while opportunity entrepreneurs pursue independence and profit; they have strong motivations towards innovation and growth, and look beyond local markets and existing products and services (Austin, Stevenson & Wei-Skillern, 2006). African entrepreneurs tend to enter sectors that require lower skill levels, have fewer barriers to entry, have quick turnover, and do not require long-term investment (AFDB, OECD & UNDP, 2017). This contrasts with the situation in high-income countries, where technology and service industries are where nearly half of entrepreneurs start new businesses (Herrington & Kew, 2017).

Implications for biomedical engineering in Africa

Biomedical engineering practice in Africa offers tremendous opportunities for designing and providing appropriate medical devices for hospitals and other medical facilities through entrepreneurship development and practice. Below are some examples of biomedical engineering-related entrepreneurship in Africa.

The Cardio-Pad[1] was developed by Cameroonian Arthur Zang. It is used to detect cardiovascular disease in patients who live in remote areas and are unable to access health services offered in the city. The device is used to determine whether the heart is functioning normally by collecting data from four electrodes attached to the chest of the patient; the data are transmitted wirelessly to a cardiologist who is then able to provide a diagnosis. The device has been sold in India, Nepal, Gabon and Cameroon.

[1] https://himore-medical.com/products/hardwares/cardiopad

Deaftronics[2], a company in Botswana, built a prototype solar charger for solar power hearing aid batteries that would last for three years and could be used with many hearing aids available on the market. It was developed for the hearing impaired in developing countries who are unable to access electricity to charge their hearing aids. The batteries are recharged via sunlight, household lights or even cellphone chargers. The company brought the device to market and receives revenue through the sales and manufacturing of hearing aids, solar chargers and batteries.

In South Africa, Power Free Education Technology (PET)[3], a Non-Profit Organisation, developed a wind-up Doppler ultrasound fetal heart rate monitor to detect fetal distress. It is used in the rural areas of developing countries to monitor fetal heart rate while the mother is in labour. The organisation entered into a partnership with the Phillips Africa Innovation Hub to develop, test and commercialise the device.

These are only a few examples of medical device innovation and entrepreneurship on the African continent. Many innovators from Africa apply for venture capital or make use of funding mechanisms like that provided by the Lemelson Foundation[4] which provides funds and support to entrepreneurs. Saving Lives at Birth[5] has also funded a number of biomedical engineering entrepreneurs from Africa. The Grand Challenges Explorations programme[6], which supports innovation in global health, is another relevant funding mechanism.

Challenges for African biomedical engineering entrepreneurship

The challenge in developing an African entrepreneurial biomedical engineering environment is not only the lack of infrastructure but also the lack of innovative capacity and ecosystems that support innovation, as well as a fragile healthcare system on the continent.

As evident from the examples above, local production of medical devices on the continent could offer a cost-effective route to improving access to appropriate healthcare; however, the absence of an innovation-supportive setting for the production of economically viable medical devices, may serve to hinder local innovation and development and in turn limit the ability to meet local health care needs. Thus, improved access to medical devices in Africa will require a competent, innovative and well trained cadre of biomedical engineers operating in a supportive business environment to produce needs-appropriate and economically viable devices, with appropriate financing mechanisms to connect producers, payers and consumers; and regulations and policies to support equitable access to and quality of devices.

The innovative capacity of the African biomedical engineer to meet the current health care needs of the continent will, in part, depend on the robustness of the higher education system in general and the training and development of biomedical engineers in particular in various

[2] https://scalingpathways.globalinnovationexchange.org/organizations/deaftronics-pty-ltd
[3] https://pet.org.za
[4] https://www.lemelson.org/our-programs/developing-country-programs/incubation
[5] https://savinglivesatbirth.net
[6] https://gcgh.grandchallenges.org

universities and colleges of engineering across the continent. It will also depend on the sharing of limited academic resources. There is therefore an urgent need to create a robust and integrated biomedical engineering training system on the continent; this will contribute to the creation of a culture of cross-country sharing of ideas and an ecosystem of collaboration for biomedical engineering innovation to support entrepreneurship.

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