THE TRANSFORMATIVE ROLE OF INFORMATION COMMUNICATION TECHNOLOGY WITHIN A SOUTHERN AFRICA CONTEXT

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Abstract

The potential for Information Technology (IT) to transform and sustain any social sector has been remarked upon widely. The role of IT in enhancing sustainable development was recognized at worldwide forums like World Summit of Information Society (WSIS), 2007). The objective of the paper is to discuss sustained engagement by institutions and individuals in Nordic and Southern African Universities that could benefit from a stronger emphasis on IT and opportunities and challenges associated with such innovations. A welfare development methodology serves as underpinning construct to contextualize and operationalize the vision towards a progressive multilateral cooperation between developed and Southern African countries. As technology advancement continues to drive economic growth, in some cases, it unleashes disruptive change. Policy makers as well as business leaders therefore need to identify potentially disruptive technologies, and carefully consider their potential, before they exert their disruptive powers in the economy and society. Economic policies pursued by colonial governments were rather more concerned with the protection and promotion of economic interests of home country rather than the development of local economy. Such policies transformed indigenous economy and country into mere suppliers of raw materials and consumer of finished industrial products for colonial master, and did not focus on the welfare and development of indigenous communities. The paper concludes that IT integration requires careful application taking into consideration infrastructural differences between regions that could complicate or challenge the process. The paper recommends selected technologies, techniques and practices that would help organizations understand, anticipate, fulfil, and exceed the needs and expectations of their stakeholders, and thus producing lasting prosperity while preserving the natural resources for future generations.

Introduction

Information and communications technologies (ICTs) are transforming societies and fueling the growth of the global economy. Despite the broad potential of ICTs, their benefits have not been spread evenly as yet. Indeed, using ICTs effectively to foster social inclusion and economic growth is among the key challenges facing policymakers world-wide today. ICTs tend to hold tremendous promise as an enabler of social and economic development and can help underserved populations obtain, manage and disseminate knowledge and tap into global networks of information and services. The rapid innovations in technology; the fruits of intensive Research and Development (R&D) efforts by practitioners in the field are making ICTs less expensive and easier to use, bringing the power of ICTs within the reach of more people including those living in developing countries. ICTs promote development across many dimensions, and at their most fundamental level, they enable organizations to be more productive, thereby spurring economic growth and helping firms to be more competitive. ICTs can also expand the reach and effectiveness of social development projects and have already yielded important benefits in such areas such as healthcare, education, and environmental preservation. Public-sector uptake of ICTs is also making governments more efficient and their decision-making more transparent. Finally, many developing countries have achieved important economic gains in nurturing the development of domestic ICT industries. It is not enough, however, to place ICTs onto the development agenda without

also addressing other critical elements of the development equation. A nation's regulatory environment in particular can have a profound impact on ICT utilization and ICT industry growth. Engagement with policymakers on a range of ICT policy issues that affect users and the industry, including such issues as property rights, international trade and investment, competition, publicly funded research, online security and privacy, technology standards, e-Government, education and digital literacy, ICT skills development, affordable financing, incentives for private-sector ICT investment, and telecommunications infrastructure and access (Microsift, 2013).

However, there is need for public-sector leadership to be combined with private-sector - Public Private Partnerships (PPPs) investment and commitment. The proposition for promoting social inclusion and economic growth is essential in development initiatives, to be placed as a major goal for companies and institutions to provide products and services that help people to be more productive and to unlock their full potential. This paper describes some influential technologies and some proposition for development them through universities collaboration, and it is hoped that this paper will help readers obtain some greater appreciation for the potential that ICTs hold for social and economic development, and of the important benefits that can accrue to developing nations that could fully exploit these benefits. It is also hoped that ICT coalitions between developed and developing countries could influence policy makers, and business leaders through respective collaborating institutions to forge ideas on how their governments, industry, and users can work most effectively to unlock the full potential of ICTs for a sustainable developing world.

The level of demand for mobile Internet access in developing economies will depend largely on how well device makers and mobile Internet services tailor their offerings to the needs of people who are just entering the global consumer class. While Internet use has been growing by twenty five percent (25%) a year in developing economies (compared with five percent (5%) in advanced economies sometimes referred to as Northern/Western/More industrialized country (NoWeMic), sixty four percent (64%) of the population in developing economies are not yet connected. During the year 2016, developing economy markets are expected to be the largest source of smartphone market growth. India's share of global smartphone sales is expected to grow from two percent (2%) in 2012, to nine percent (9%) in 2016, and Brazil's share is expected to rise from two percent (2%) to five percent (5%). Continued reductions in the prices of smartphones and data plans should help sustain rapid adoption rates. Anticipated DE component costs are expected to continue to decline, which could reduce producer costs for midrange smartphones by about 30 percent by 2016.

ICTS for development: welfare development approach

ICT for Development (ICT4D) is an initiative aimed at bridging the digital divide, (the disparity between technological "have" and "have not" geographic locations or demographic groups), and aiding economic development by ensuring equitable access to up-to-date communications technologies. Information and Communication Technologies (ICTs) include any communication device encompassing radio, television, cellular phones, computer and network hardware and software, satellite systems etc., as well as the various services and

applications associated with them, such as videoconferencing, computer conferencing and distance learning. The United Nations, through its UN Development Program, actively promotes ICT4D as a powerful tool for economic and social development around the world. The term *'digital divide*' on the other hand, describes the fact that the world can be divided into people who do and people who do not have access to, and the capability to use modern information technology, such as the telephone, television, or the Internet. The digital divide exists between those in cities and those in rural areas. A 1999 study showed that eighty six (86%) of Internet delivery was only to the twenty (20) largest cities. The digital divide also exists between the educated and the uneducated, between economic classes, and, globally, between the more and less industrially developed nations (Rouse, 2011).

Sustainable development is viewed as an organizing principle for human life on a finite planet. It posits a desirable future state for human societies in which living conditions and resource-use meet human needs without undermining the sustainability of natural systems and the environment, so that future generations may also have their needs met. Sustainable development ties together concern for the carrying capacity of natural systems with the social and economic challenges faced by humanity economy "in equilibrium with basic ecological support systems" (Roman and Blattman, 2001). Scientists in many fields have highlighted The Limits to Growth, and economists have presented alternatives, for example a 'steady state economy',[3] to address concerns over the impacts of expanding human development on the planet (Wakelin and B. Shadrach, 2001 and WSIS, 2007).

The term 'sustainable development' rose to significance after being used by the Brundtland Commission in its 1987 report '*Our Common Future*'. In the report, the commission coined what has become the most often-quoted definition of sustainable development: "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*." Whyte, 2000 and Colle & Roman, 2001).

The concept of sustainable development has in the past most often been broken out into three constituent domains: environmental sustainability, economic sustainability and social sustainability. However, many other possible ways to delineate the concept have been suggested. For example, the Circles of Sustainability approach distinguishes the four domains of economic, ecological, political and cultural sustainability. This accords with the United Cities and local governments specifying of culture as the fourth domain of sustainability.[6] Other important sources refer to the fourth domain as 'institutional' or as 'good governance.' (Hunt, 2001 and Latchem & Walker, 2001). Some have criticized the term "*sustainable development*", stating that the term is too vague. The term is considered more charming than meaningful. Sustainable development has become obscured by conflicting world views, the expansionist and the ecological, and risks being co-opted by individuals and institutions that perpetuate many aspects of the expansionist model.

Welfare Development Method

The "Declaration of Principles" agreed upon at The World Summit on the Information Society in 2003 defined an "information society…[as one] where everyone can create, access, utilize, and share information and knowledge, enabling individuals, communities and people to achieve their full potential in promoting their sustainable development and improving their quality of life" (WSIS, 2007). Much of the focus was on rural tele-centres, the last mile of

connectivity. It was felt that access to information (be it health, agriculture, education or government schemes) would at some level lead to individuals being able to act on that information and empower themselves (Colle & Roman, 2001 & Whyte, 2000). Positive expectations of tele-centres were portrayed by many (Hudson, 2001, Latchem & Walker, 2001, Roman & Colle, 2002).

Aishwarya Lakshmi Ratan and Savita Bailur (2007) deconstruct the term "development" in "ICT for Development" (ICT4D), whether it implies welfare or agency? Using a framework of individual capability expansion and social choice theory, they illustrate how these two approaches may conflict, and present a simple model to explore how sometimes the Provider's intention in providing an ICT artefact and the User's ultimate usage differ. They analyze selected case studies against this and find that the User is likely to gain a tangible, immediate return on using agency-enhancing applications (particularly involving entertainment content), while the impact of welfare-enhancing applications is harder to achieve, given the complex contextual determinants of converting information on "potential" welfare outcomes to "actual" welfare gains. They recommended further research on the welfare-agency tension, and on assessing paternalism in "ICT for development" interventions.

The capability approach presents us with a fairly broad and comprehensive definition of overall human development, in which individuals are seen as the central agents of positive change (as opposed to the State, firm, or household). Sen (2001:512) argues that "the real challenge … is to imbue [all] individuals with freedoms of the type that will allow them to pursue that which they have cause to value". While this sounds theoretically simple, its implications for policy are complex. An insistence on agency implies that "revelation of preferences is not enough; we have to understand the social structural constraints on the decision-maker…".

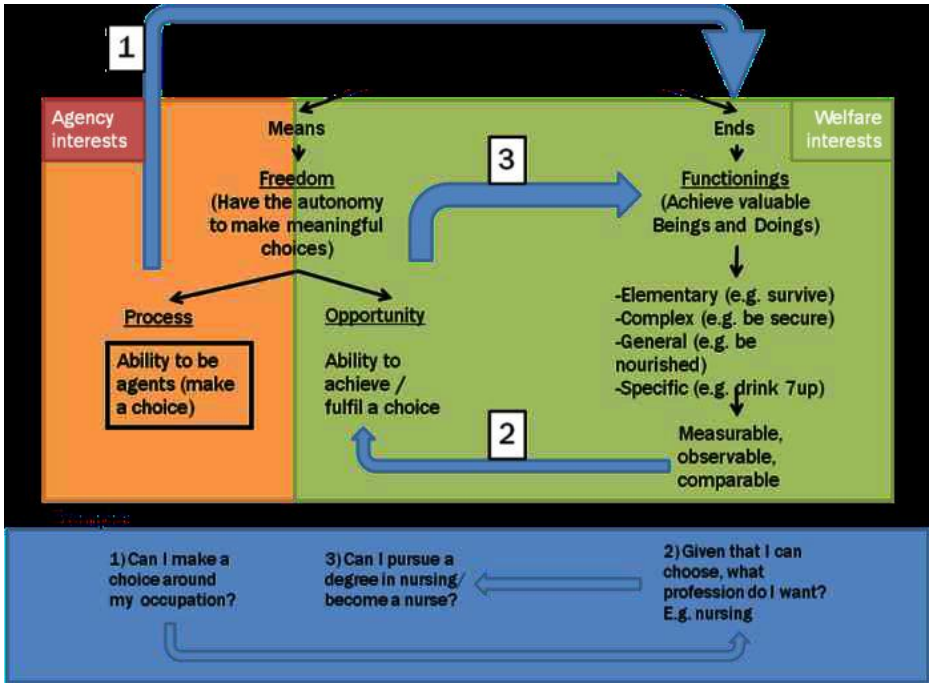


Figure 1: Development as capability enhancement (Alkire, 2004)

Sen, (1995) attempts to operationalize his formulation of social choice theory by linking it back to the capability approach. He maintains that through informational broadening and partial interpersonal comparability, the identification of those "substantive freedoms" that ensure the improvement of key capabilities for all human beings can be arrived at. Sen, (1995:44-45) argues, "in dealing with extreme poverty in developing economies, may be able to go a fairly long distance in terms of a relatively small number of centrally important functionings (and the corresponding basic capabilities, e.g. the ability to be well-nourished and well-sheltered, the capability of escaping avoidable morbidity and premature mortality, and so forth)". In summary, the model provides four key insights:

1) ICTD projects involve collective choices between Providers and Users with varying conceptions on desired capabilities, which sometimes lead to divergent not convergent social choices around the use of the ICT artefacts for "development".

2) Sub-optimal development outcomes may manifest in ICTD projects when a paternalistic provider overrides the agency capability of a User in a context whereby mandating that the User should use the ICT artefact for strictly welfare-related applications (when there is no consistent social choice).

3) Sub-optimal development outcomes may also manifest in a non-paternalistic ICTD project, where the User chooses to use the ICT artefact for strictly entertainment-related applications thereby expanding her agency capabilities, though without affecting her welfare.

Our model points to those key "social, structural" variables that jointly determine whether an ICT artefact is used for a welfare rather than an entertainment application by a particular User, when served by a non-Paternalistic Provider. Several researchers have emphasized the importance of context and yet, the ICTD projects that incorporate context in useful and meaningful ways into project design are so few.

Disruptive technologies & development

Disruptive technology is a term coined by Harvard Business School Professor Clayton Christensen to describe a new technology that unexpectedly displaces an established technology. In his 1997 best-selling book, "The Innovator's Dilemma," Christensen separates new technology into two categories: sustaining and disruptive. Sustaining technology relies on incremental improvements to an already established technology. Disruptive technology lacks refinement, often has performance problems because it is new, appeals to a limited audience, and may not yet have a proven practical application. (Such was the case with Alexander Graham Bell's "electrical speech machine," which we now call the telephone) (Rouse, 2011).

A disruptive innovation on the other hand, is an innovation that helps create a new market and value network , and eventually disrupts an existing market and value network (over a few years or decades), displacing an earlier technology (Wikipedia, (n. d.). Technology is moving so quickly, and in so many directions, that it becomes challenging to even pay attention and have become victims of "next new thing" fatigue. Technology advancement also continues to drive economic growth and, in some cases, unleash disruptive change. Economically

disruptive technologies such as the semiconductor microchip, the Internet, or steam power in the Industrial Revolution, transform the way people live and work, enable new business models, and provide an opening for new players to upset the established order. Business leaders and policy makers need to identify potentially disruptive technologies, and carefully consider their potential, before these technologies begin to exert their disruptive powers in the economy and society.

Potential Disruptive Technologies

Through extensive research McKinsey Global Institute (2012) has sought to identify twelve (12) technology areas with the potential for massive impact on how people live and work, and on industries and economies. Furthermore, they also attempted to quantify the potential economic impact of each technology across a set of promising applications in 2025. The research is illustrative of emerging applications over the next decade or two and provides a good indication of the size and shape of the impact that these applications could have. Some of this economic potential could end up as consumer surplus; a substantial portion of this economic potential will translate into new revenue that companies will capture and that will contribute to GDP growth. The findings serve as some guide for leaders to use as they consider the reach and scope of impact, as well as the types of impacts that these disruptive technologies could have for the growth and performance of their organizations and more researchers in this field are expected to build on and enrich the current research findings.

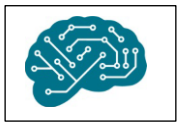
These disruptive technologies already have some significant disruptive impact. More importantly, the results of their research show that business leaders and policy makers, and society at large, will confront change on many fronts with regard the way businesses organize themselves, how jobs are defined, how we use technology to interact with the world (and with each other), and, in the case of next-generation genomics, how we understand and manipulate living things. That there will be disruptions to established norms, and there will be broad societal challenges. Nevertheless, they see considerable reason for optimism. Many technologies on the horizon offer immense opportunities. They therefore believe that leaders can seize these opportunities, if they start preparing now to integrate these promising technologies into their operations.

The McKinsey Global Institute (2012) has further identified several technologies that have the greatest potential to drive substantial economic impact and disruption by 2025 and also identify which potential impacts leaders should know about. Technologies with some potential impact can come in any field or emerge from any scientific discipline, and yet they share four characteristics (i. e. high rate of technology change, broad potential scope of impact, large economic value that could be affected, and substantial potential for disruptive economic impact). Several technologies have the potential to meet these criteria eventually, but leaders need to focus on technologies with potential impact that is near enough at hand to be meaningfully anticipated and prepared for. … have focused on the following technologies that they believe have significant potential to drive economic impact and disruption by 2025.

Mobile Internet

In just a few years, Internet-enabled portable devices have gone from a luxury for a few to a way of life for more than one billion people who own smartphones and tablets. In the United States, an estimated thirty percent (30%) of Web browsing and forty percent (40%) of social media use are done on mobile devices; and by 2015, wireless Web use is expected to exceed wired use. Ubiquitous connectivity and an explosive proliferation of apps are enabling users to go about their daily routines with new ways of knowing, perceiving, and even interacting with the physical world. The technology of the mobile Internet is evolving rapidly, with intuitive interfaces and new formats, including wearable devices. The mobile Internet also has applications across businesses and the public sector, enabling more efficient delivery of many services and creating opportunities to increase workforce productivity. In developing economies, the mobile Internet could bring billions of people into the connected world.

Automation of knowledge work



Advances in artificial intelligence, machine learning, and natural user interfaces (e.g., voice recognition) are making it possible to automate many knowledge worker tasks that have long been regarded as impossible or impractical for machines to perform. Some computers can answer "unstructured" questions (i.e., those posed in ordinary language, rather than precisely written as software queries). Employees or customers without specialized training can therefore get information on their own, and this opens up possibilities for sweeping change in how knowledge work is organized and performed. Sophisticated analytics tools can be used to augment the talents of highly skilled employees, and as more knowledge worker tasks can be done by machine, it is also possible that some types of jobs could become fully automated.

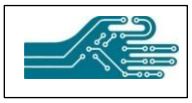
The Internet of Things

The 'Internet of Things', embedding sensors and actuators in machines and other physical objects to bring them into the connected world is spreading rapidly. From monitoring the flow of products through a factory to measuring the moisture in a field of crops to tracking the flow of water through utility pipes, the 'Internet of Things' allows businesses and public-sector organizations to manage assets, optimize performance, and create new business models. With remote monitoring, the 'Internet of Things' also has great potential to improve the health of patients with chronic illnesses and attack a major cause of rising health-care costs.

Cloud technology

With cloud technology, any computer application or service can be delivered over a network or the Internet, with minimal or no local software or processing power required. To do this, IT resources (such as computation and storage) are made available on an as-needed basis, and when extra capacity is needed, it is seamlessly added, without requiring up-front investment in new hardware or programming. The cloud is enabling the explosive growth of Internet-based services, from search to streaming media to offline storage of personal data (photos, books, music), as well as the background processing capabilities that enable mobile Internet devices to do things like respond to spoken commands to ask for directions. The cloud can also improve the economics of IT for companies and governments, as well as provide greater flexibility and responsiveness. Finally, the cloud can enable entirely new business models, including all kinds of 'pay-as-you-go' service models.

Advanced robotics



For the past several decades, industrial robots have taken on physically difficult, dangerous, or dirty jobs, such as welding and spray painting. These robots have been expensive, bulky, and inflexible, bolted to the floor and fenced off to protect workers. More advanced robots are gaining enhanced senses, dexterity, and intelligence, thanks to accelerating advancements in machine vision, artificial intelligence, machine-to-machine communication, sensors, and actuators. These robots can be easier for workers to program and interact with. They can be more compact and adaptable, making it possible to deploy them safely alongside workers. These advances could make it practical to substitute robots for human labour in more manufacturing tasks, as well as in a growing number of service jobs, such as cleaning and maintenance. This technology could also enable new types of surgical robots, robotic prosthetics, and "exoskeleton" braces that can help people with limited mobility to function more normally, helping to improve and extend lives.

Next-generation genomics

Next-generation genomics marries advances in the science of sequencing and modifying genetic material with the latest big data analytics capabilities. Today, a human genome can be sequenced in a few hours and for a few thousand dollars, a task that took 13 years and $2.7 billion to accomplish during the Human Genome Project. With rapid sequencing and advanced computing power, scientists can systematically test how genetic variations can bring about specific traits and diseases, rather than using trial and error. Relatively low-cost desktop sequencing machines could be used in routine diagnostics, potentially significantly improving treatments by matching treatments to patients. The next step is synthetic biology, the ability to precisely customize organisms by "writing" DNA. These advances in the power and availability of genetic science could have profound impact on medicine, agriculture, and even the production of high-value substances such as biofuels as well as speed up the process of drug discovery.

Autonomous and near-autonomous vehicles

It is now possible to create cars, trucks, aircraft, and boats that are completely or partly autonomous. From drone aircraft on the battlefield to Google's self-driving car, the technologies of machine vision, artificial intelligence, sensors, and actuators that make these machines possible is rapidly improving. Over the coming decade, low-cost, commercially available drones and submersibles could be used for a range of applications. Autonomous cars and trucks could enable a revolution in ground transportation regulations and public acceptance permitting. There is also substantial value in systems that assist drivers in steering, braking, and collision avoidance. The potential benefits of autonomous cars and trucks include increased safety, reduced CO_2 emissions, more leisure or work time for motorists (with hands-off driving), and increased productivity in the trucking industry.

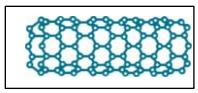
Energy storage

Energy storage technology includes batteries and other systems that store energy for later use. Lithium-ion batteries and fuel cells are already powering electric and hybrid vehicles, along with billions of portable consumer electronics devices. Li-ion batteries in particular have seen consistent increases in performance and reductions in price, with cost per unit of storage capacity declining dramatically over the past decade. Over the next decade, advances in energy storage technology could make electric vehicles (hybrids, plug-in hybrids, and all-electrics) cost competitive with vehicles based on internal-combustion engines. On the power grid, advanced battery storage systems can help with the integration of solar and wind power, improve quality by controlling frequency variations, handle peak loads, and reduce costs by enabling utilities to postpone infrastructure expansion. In developing economies, battery/solar systems have the potential to bring reliable power to places it has never reached.

3D printing

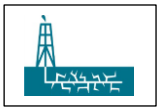
Until now, 3D printing has largely been used by product designers and hobbyists and for a few select manufacturing applications. However, the performance of additive manufacturing machinery is improving, the range of materials is expanding, and prices (for both printers and materials) are declining rapidly, bringing 3D printing to a point where it could see rapid adoption by consumers and even for more manufacturing uses. With 3D printing, an idea can go directly from a 3D design file to a finished part or product, potentially skipping many traditional manufacturing steps. Importantly, 3D printing enables on-demand production, which has interesting implications for supply chains and for stocking spare parts, a major cost for manufacturers. 3D printing can also reduce the amount of material wasted in manufacturing and create objects that are difficult or impossible to produce with traditional techniques. Scientists have even "bioprinted" organs, using an inkjet printing technique to layer human stem cells along with supporting scaffolding.

Advanced materials



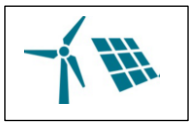
Over the past few decades, scientists have discovered ways to produce materials with incredible attributes, smart materials that are self-healing or self-cleaning; memory metals that can revert to their original shapes; piezoelectric ceramics and crystals that turn pressure into energy; and nanomaterials. Nanomaterials in particular stand out in terms of their high rate of improvement, broad potential applicability, and long-term potential to drive massive economic impact. At nanoscale (less than 100 nanometers), ordinary substances take on new properties, greater reactivity, unusual electrical properties, enormous strength per unit of weight that can enable new types of medicine, super-slick coatings, stronger composites, and other improvements. Advanced nanomaterials such as graphene and carbon nanotubes could drive particularly significant impact. For example, graphene and carbon nanotubes could help create new types of displays and super-efficient batteries and solar cells. Finally, pharmaceutical companies are already progressing in research to use nanoparticles for targeted drug treatments for diseases such as cancer.

Advanced oil and gas exploration and recovery



The ability to extract so-called unconventional oil and gas reserves from shale rock formations is a technology revolution that has been gathering force for nearly four decades. The combination of horizontal drilling and hydraulic fracturing makes it possible to reach oil and gas deposits that were known to exist in the United States and other places but that were not economically accessible by conventional drilling methods. The potential impact of this technology has received enormous attention. With continued improvements, this technology could significantly increase the availability of fossil fuels for decades and produce an immediate boon for energy-intensive industries such as petrochemicals manufacturing. Eventually, improving technology for oil and gas exploration and recovery could even unlock new types of reserves, including coal bed methane, tight sandstones, and methane clathrates (also known as methane hydrates), potentially ushering in another energy "revolution."

Renewable energy



Renewable energy sources such as solar, wind, hydro-electric, and ocean wave hold the promise of an endless source of power without stripping resources, contributing to climate change, or worrying about competition for fossil fuels. Solar cell technology is progressing particularly rapidly. In the past two decades, the cost of power produced by solar cells has dropped from nearly $8 per watt of capacity to one-tenth of that amount. Meanwhile, wind power constitutes a rapidly growing proportion of renewable electricity generation. Renewable energy sources such as solar and wind are increasingly being adopted at scale in advanced economies like the United States and the European Union. Even more importantly, China, India, and other emerging economies have aggressive plans for solar and wind adoption that could enable further rapid economic growth while mitigating growing concerns about pollution.

(McKinsey Global Institute, 2012)

These identified technologies do not represent all potentially economically disruptive technologies, as many other prevalent advancing technologies are also worth following and thinking about. However, these other technologies do not seem to have the same potential for economic impact and disruption by 2025, but cannot rule out sudden breakthroughs or other factors, such as new public policies, that might change the current situation.

CONCLUSION

The world is changing at Internet speed, and technology is continually evolving. Strategies can quickly fall behind, so the rhythm of planning has to keep pace given that time is the enemy. When technologies have disruptive potential, the stakes are even higher and the range of strategic implications wider. When necessary, leaders must be prepared to disrupt their own businesses and make the investments to effect change, as the past two decades have shown, successful companies repeatedly reinvent themselves to keep up. SANORD Research and Development (R&D) strategies should target collaborative ventures focused on selected technologies that are sustainable. In addition, creating incentives for the development and adoption of these selected technologies, governments can play an important role in facilitating the creation of networks that can speed up such an innovation by sponsoring collaborative efforts at national or international level.

Governments can help bring world-class expertise to bear and foster relationships that extend beyond the research phase to help ensure successful commercialization. The biggest challenges for policy makers could involve the effects of technologies that have potentially large effects on employment. It is noted that by 2025, technologies that raise productivity by automating jobs that are not practical to automate today, could be on their way to widespread adoption**.** The people who set policy have multiple responsibilities that are often in conflict when disruptive technologies emerge; the rising productivity that automation of knowledge work could enable could help drive productivity growth, but the potential impact on employment might create social and economic strain. At the same time, those who benefit from the established ways of doing things, imperilled by disruptive technologies, often find ways to influence policy. Given the scale of impact of the technologies we consider, the job of reconciling these conflicts and balancing the needs of today's citizens with those of future generations will place unprecedented demands on policy makers.

With the advent of disruptive technologies, policy makers should also have well-thought-out, structured methods for assessing technologies, to add rigor to their analyses. They could also look for better metrics to understand the value of emerging technologies; the value of technology often lies in its benefits to users including in consumer surplus that is not captured by GDP measures. Measures of economic activity such as GDP are important and expedient, but better efforts can be made to measure aggregate societal and economic welfare comprehensively and this aspect supports the welfare development model used as the conceptual framework of this study. Metrics can influence policy decisions, so policy makers, especially in developing countries, should select the emerging technologies carefully basing on those that will benefit the majority of citizen including those in the rural areas.

The technologies discussed in this paper could fuel a decade of rapid innovation in products, services, business processes, and even market strategies. Companies and institutions will have new ways of developing and producing products, organizing their businesses, and reaching consumers and business-to-business customers. Business leaders will need to determine when, how, and whether to take advantage of new technologies and be prepared to move quickly when others use emerging technologies to mount challenges. The development of these technologies could foster manufacturing ventures in developing countries to avoid situations where economies in the south become mere suppliers of raw materials and consumers of finished industrial products for colonial masters in the north.

In the 21st century, all policy makers and business leaders should understand technology and more than ever, develop their own well-informed views of what new developments could do for their enterprises and work to separate hype from reality. They should think carefully about how specific technologies could drive economic impact and disruption in ways that could affect their businesses cadres. Contemporary leaders should make sure to invest in their own technology knowledge; they do not have to become programmers or computer experts, but should keep abreast of technology trends and take advice from their most tech-savvy stakeholders. Business leaders, policy makers, and other stakeholders should look ahead, identify the technologies that could affect them, and determine how to shape markets and policies in ways that will serve their interests. While the appropriate response will vary by stakeholder and technology, there are some useful guiding principles that can help define responses.

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