Digital Skills *Insights* 2019

International Telecommunication Union
Place des Nations
CH-1211 Geneva, Switzerland

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2019

Acknowledgements

The 2019 issue of "Digital Skills *Insights*" (previously called "Capacity Building in a Changing ICT Environment") was prepared by the Human Capacity Building Division (HCB) within the Projects and Knowledge Management Department of the Telecommunication Development Bureau of ITU. The work was carried out under the overall direction of Cosmas Zavazava, Chief of Department, with a team comprised of Susan Teltscher, Mike Nxele, Halima Letamo and Elena Stankovska-Castilla.

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ISBN:

978-92-61-29321-5 (Paper version)
978-92-61-29331-4 (Electronic version)
978-92-61-29341-3 (ePub version)
978-92-61-29351-2 (Mobi version)

Foreword

I am pleased to present to you the 2019 edition of **Digital Skills *Insights*** (previously called "Capacity Building in a Changing ICT Environment"). Now in its third year, this online publication focuses on pertinent topics related to capacity and skills development arising from the current and future digital technology environment. The objective of the publication is to provide new insights and enhance knowledge among the ITU stakeholder community in the growing field of learning and skills development in the digital era.

This third issue of the publication features eight articles from international experts in this field, which take a critical and analytical approach towards the subject of capacity and skills development. The first set of articles provides a broad overview of the discussion on digital literacy frameworks, new methods of teaching and learning in view of digital developments, as well as new capacity building concepts and initiatives in the digital age. This is followed by a set of articles which showcases concrete examples of the impact of new technologies on skills gaps and skills developments in selected developing countries.

The articles illustrate how developments in automation and artificial intelligence (AI) have caused the education sector to re-evaluate the importance of ethics and how people can shape, govern and regulate technology to better serve human existence. They also stress the need for academic qualifications in new emerging technologies such as Internet of Things (IoT) and propose practical solutions for the design of such curricula.

The discussions raise key questions on how human capacity can be matched, or augmented, with machine capability for social impact, how emerging technologies can be combined to create meaningful training programmes, as well as how the demand for different types of skills will be affected by automation and digital transformation. The articles draw some thought provoking conclusions, such as the need to think critically about the human context of current technological challenges and the opportunities presented by ICT savviness of young people in societies that could be used to drive the agenda for development of digital skills.

I trust that this publication will contribute to the on-going discussions among the ITU membership, including policy-makers, academics and other stakeholders involved in the digital skills ecosystem, on how to address the future demand for digitally skilled citizens.

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About this publication

"Digital Skills *Insights*" (previously called "Capacity Building in a Changing ICT Environment") is an online publication which puts together scholarly articles with a focus on the impact of digital transformation on capacity and skills development. It covers a wide range of topics that may affect people and their skills development, such as artificial intelligence (AI), the Internet of Things (IoT), big data, telecommunication regulatory issues, smart cities/societies, digital competencies, open source learning and intellectual property rights, etc.

The publication seeks to provide a body of knowledge that will facilitate academic research and innovation exploring the linkages between emerging technologies and capacity development. It features current and new thinking that will contribute to informed policy debates and decisions among policymakers and regulators, as well as help the private sector to anticipate and plan for human capital requirements and skills development in order to remain competitive in a rapidly changing ICT environment.

The publication, which is released annually, feature contributions from academic scholars and other researchers from all over the world. The purpose of the articles is to share views and scholarly opinions that will stimulate debate among its readers. Articles published are subjected to a quality assurance process by well acclaimed experts through a peer review exercise.

This publication is available on the ITU Academy platform. The published articles will also be subject to discussion at forums organized from time to time for Academia members of ITU.

Those interested in submitting an article for consideration in future editions of "Digital Skills *Insights*" should contact the ITU Human Capacity Building Division at hcbmail@itu.int.

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The use of reference frameworks to support digitally competent citizens – the case of DigComp

By Riina Vuorikari and Yves Punie

Introduction

Reference frameworks for digital competence create an agreed vision of what is needed in terms of competences to overcome the challenges that arise from digitization in almost all aspects of our lives. Examples at the global level are the Digital Competence Framework for Citizens[1] by the European Commission and the United Nations Educational, Scientific and Cultural Organization's (UNESCO's) work through the Media and Information Literacy framework (MIL)[2]. Both were developed around the same time and both have a common goal to enable people to develop digital competence to support their life chances and employability. Reference frameworks such as these two create a common understanding through agreed definitions and set vocabulary that can be consistently applied in all tasks from policy formulation and target setting to instructional planning, and assessment and monitoring.

In the following, we first provide examples of recent reviews of digital competence frameworks in general and focus on the debate as to why such frameworks are necessary and important. The DigComp framework is introduced as an example. In order to illustrate the whole scope of DigComp, two other global initiatives are introduced, namely UNESCO's work through MIL and the Organization for Economic Co-operation and Development's (OECD's) Programme for the International Assessment of Adult Competencies (PIAAC) study, which, rather than being a reference framework, is a measurement instrument of adults' problem-solving skills in digitally-rich environments[3].

The overall objective of this article is to assist policy-makers and stakeholders to understand various uses of reference frameworks. For that reason, a number of examples are provided to demonstrate European Union Member States' use of the DigComp framework in support of creating and implementing digital skills plans. Finally, we highlight several other reference frameworks that the European Commission has created for teachers[4], for educational organizations such as schools[5], and for citizens to cope with digital marketplaces[6].

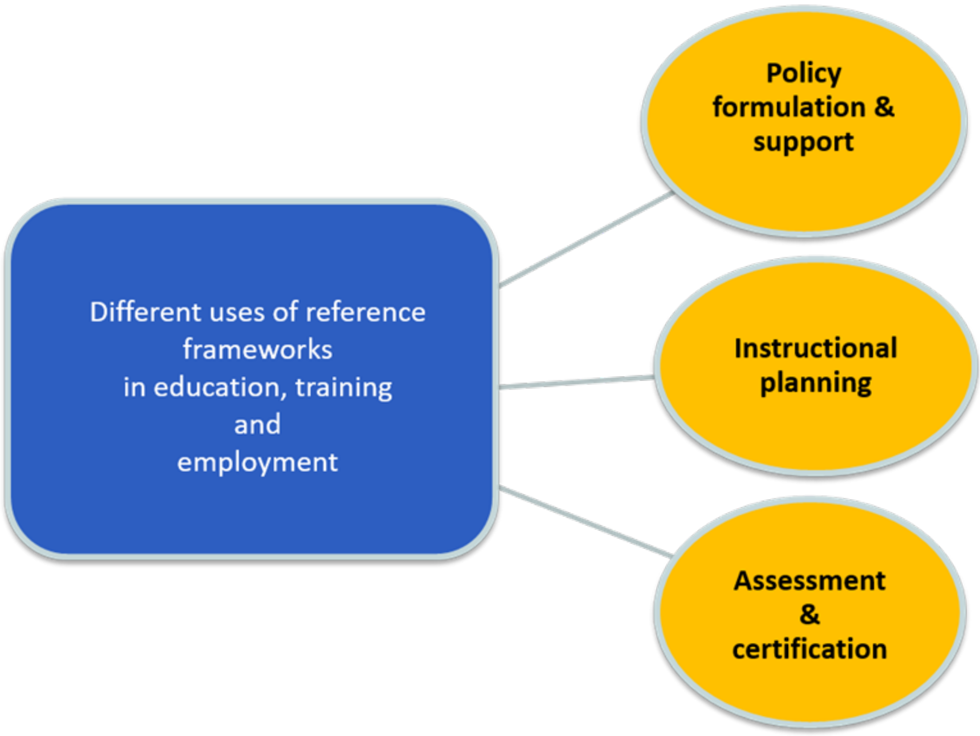
Digital competence reference frameworks

In a recent publication by UNESCO (2018), a review of existing regional, national and sub-national frameworks dealing with information and communication technology (ICT) skills was conducted. The focus was the global context and the report identified 47 countries in which specific digital literacy frameworks were adopted. The overall number of such frameworks is likely to be higher as new policies are continuously being developed. Furthermore, the search was limited to frameworks available in English whereas in many countries only original language versions exist.

Another global review of "Digital Skills for Life and Work" was published in 2017 focusing, among other things, on an overview and examples of commonalities between existing digital skills initiatives through common terms used, e.g. basic functional digital skills, generic digital skills, 'higher level' skills (Broadband Commission for Sustainable Development, 2017). A third recent publication with a global outlook is called "Digital Skills Toolkit" which provides policy-makers with detailed guidance on developing a digital skills strategy at the country level as well as for implementation (ITU, 2018).

In general, reference frameworks for digital competence are important in order to create a common understanding and agreed definitions (e.g. a set of vocabularies), that can be consistently applied in all tasks including: policy formulation, target setting and monitoring; instructional planning including curriculum reforms and teacher

Figure 1.1. Main purposes for use of a digital reference framework in education, training and employment



Source: EC, 2016

education; and assessment and certification (Figure 1.1). More specifically, they provide a common language identifying the key areas and specific competences that should be addressed. They describe the competences in detail, and sometimes also foresee learning outcomes and proficiency levels (e.g. basic, intermediate, advanced). Apart from using reference frameworks as a tool to further the above goals, they can also be used to create valid and reliable measurement and/or assessment instruments. In such cases, the conceptual framework is operationalized in terms of a battery of questions or tasks that can be applied, for instance, to measure the level of an individual's digital competence. In the following discussion, we focus on reference frameworks and their use, rather than valid and reliable instruments for measurement and assessment.

DigComp: The European Digital Competence Framework for Citizens

The Digital Competence Framework for Citizens, also known by its acronym DigComp, was first published in 2013 by the European Commission (European Commission, 2013). From the outset, it aimed to become a tool to improve citizens' digital competence, to assist policy-makers to formulate policies that support digital competence building, and to plan education and training initiatives to improve digital competence of specific target groups. In 2018, a user guide called "DigComp into action: Get inspired, make it happen!" was published presenting 38 examples of DigComp use from all over Europe (European Commission, 2018a). The guide was published with the aim of sharing practices with the community of users, thus emphasizing the importance of learning from one another, but also inspiring a community of potential new users.

At the heart of DigComp are the common concepts that support definition of the remits and limits of digital competence. Within the European Union, the first political level agreement was reached in 2006 with "A European Reference Framework on the Key Competences for Lifelong Learning". One of the key competences identified was digital competence. The document further defined the essential knowledge, skills and attitudes related to this competence. After an update of the policy recommendation in 2018, the definition reads as follows: *"Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and*

Table 1.1. Mapping between DigComp and MIL

Competences in DigComp (European Commission, 2016)	Elements of media literacy (ML) and information literacy (IL) (UNESCO, 2013)
1.1 Browsing, searching and filtering data, information and digital content 1.2 Evaluating data, information and digital content 1.3 Managing data, information and digital content	IL: Define and articulate information needs IL: Locate and access information IL: Assess information ML: Critically evaluate media content (…in the light of media functions) IL: Organize information IL: Use ICT skills for information processing
2.1 Interacting through digital technologies 2.2 Sharing through digital technologies 2.3 Engaging in citizenship through digital technologies 2.4 Collaborating through digital technologies 2.5 Netiquette 2.6 Managing digital identity	IL: Communicate information ML: Engage with media for self-expression, intercultural dialogue and democratic participation IL: Make ethical use of information
3.1 Developing digital content 3.2 Integrating and re-elaborating digital content 3.3 Copyright and licences 3.4 Programming	ML: Acquire and use skills (including ICTs) needed to produce user-generated content
4.1 Protecting devices 4.2 Protecting personal data and privacy 4.3 Protecting health and well-being 4.4 Protecting the environment	
5.1 Solving technical problems 5.2 Identifying needs & technological responses 5.3 Creatively using digital technologies 5.4 Identifying digital competence gaps	
Note: Two ML competences with no direct mapping to DigComp (ML: Understand the role and functions of media in democratic societies; ML: Understand the conditions under which media can fulfil their functions)	

Source: European Commission, 2016

for participation in society." (The Council of the European Union, 2018).

The work on operationalizing the policy-led definition of digital competence commenced in 2010 and resulted in the publication of the first DigComp reference framework in 2013 (European Commission, 2018b). It defined digital competence as a combination of 21 competences that can be grouped in five main areas:

- information and data literacy;
- communication and collaboration;
- digital content creation;
- safety;
- problem solving.

The leftmost column of Table 1.1 lists all competences, and their numbering refers to the competence areas. The division of areas and competences was based on research and analysis of existing frameworks, and consensus building with experts and educational stakeholders.
It resulted in a framework that is regarded as comprehensive and relatively easy to understand. Although differences between areas and competences are identified, it is worth mentioning that in reality, various overlapping points and cross-references exist. An update to version 2.0 was published in 2016 (European Commission, 2016), and following that the eight levels of learning outcomes were developed (European Commission, 2017).

Regarding the agreed terminology, for instance, DigComp has adopted a device-agnostic wording of "digital technologies" so that it is not necessary to name a specific technology, software or application when further discussing the knowledge, skills and attitudes associated with each of the competences. The term "digital technologies" encompasses not only the use of personal computers (e.g. a desktop, laptop, netbook or tablet computer) but also other hand-held devices (e.g. smart phones, wearable devices with mobile networking facilities), games consoles, media players or e-book readers which, more often than not, are also networked and/or connected to the Internet. Such vocabulary allows for "future proofing" the framework against the fast speed of change in the field of technologies, while at the same time remaining device and application neutral, and only focusing on high-level competences that are deemed important (rather than being device- or application-specific).

It is also important to highlight that the way the descriptors of DigComp competences are formulated is descriptive rather than prescriptive. Further elaboration of the content and the level of the competences should be undertaken by users taking into account national and local context. For instance, ethical aspects are included in terms of competences rather than prescribing the desired behaviour, as it is up to those implementing the initiatives to define such behaviour in more prescriptive terms, if they wish to do so. This ensures the DigComp framework is flexible and adaptable, but at the same time, it requires effort to adapt it to specific circumstances. This is, however, an important factor under the principle of subsidiarity within the European Union: In the broad area of education and training, the European Union does not have exclusive competence. It is up to Member States to take (legislative) decisions and actions. In this context, reference frameworks such as DigComp facilitate peer learning and exchange between Member States.

Reference frameworks: Highlighting commonalities and differences

One of the powerful features of reference frameworks is that they can be used to highlight commonalities and differences between separate initiatives by comparing which areas, competences or competence levels are embodied in a currently existing framework, a certification scheme or a syllabus. A mapping exercise and a gap analysis are useful methods for this purpose. In the following, to exemplify how digital competence reference frameworks can be used for a mapping exercise, DigComp is compared with UNESCO's work on MIL. In general, a mapping exercise seeks to associate each element (i.e. competence) of the given set (e.g. DigComp) with one or more elements of a second set (e.g. MIL). This is illustrated in Table 1.1 which maps competences of both frameworks.

At first sight, Table 1.1 shows that there many commonalities between the two frameworks, but also differences, as not all of the competences can be associated with each other. Regarding similarities, many are found, particularly in the first competences that pertain to the DigComp area of "information and data literacy" (1.1-1.3). This is not surprising as MIL aims to bring together the fields of Information and Media literacy as "a combined set of competencies necessary for life and work today" (UNESCO, 2011). Similarly, both DigComp and MIL have commonalities in terms of competences using digital technologies for "communication and collaboration" (2.1, 2.2, 2.3, 2.5).

However, differences are also identified: Two of the media literacy (ML) competences are not addressed in DigComp at all ("ML: Understand the role and functions of media in democratic societies" and "ML: Understand the conditions under which media can fulfil their functions"). This highlights the first notable difference between the reference frameworks: DigComp does not have such deep roots in media education as MIL; however, the European Commission does also undertake other activities in this area (European Commission, 2019a).

On the other hand, the second difference in scope is that DigComp focuses more on the safety and security of activities in the digital sphere as well as on "problem solving using digital technologies". These two competence areas are not included in MIL. Regarding the DigComp area of "problem solving using digital technologies", this is a transversal area that can be found in all other competence areas. For example, finding information on the Internet requires setting a task and solving a number of steps to reach the goal. Such cognitive strategies are needed when a person solves a problem, either with or without digital competences.

The emphasis in DigComp is on the use of digital technologies for learning, work and for participation in society, which is very similar to the focus of the PIAAC on problem solving in technology-rich environments. The latter is described as "the intersection of what are sometimes described as "computer literacy" skills (i.e. the capacity to use ICT tools and applications) and the cognitive skills required to solve problems" (OECD, 2013).

Whereas PIAAC provides details describing and operationalizing a number of content and cognitive strategies into a measurement instrument developed as a task-based assessment environment, DigComp describes four competences on a conceptual level. These extend from troubleshooting technical issues (5.1) to assessing needs and/or existing problems to finding a solution using digital tools and technologies (5.2). Competence 5.3 focuses on "problem solving using digital technologies creatively": In other words, the competence to use digital technologies to create new knowledge and to innovate with processes and products that did not exist previously. The final competence (5.4) focuses on identifying one's own competence gap in terms of digital competence and training needs.

Finally, to make the link between DigComp and a number of other existing frameworks more visible and explicit, the DigComp 2.0 update clarified some definitions. For example, the term "problem solving" was aligned with the one used by the OECD's Programme for International Student Assessment (PISA)[7] and the term "well-being" follows the definition of World Health Organization (for more examples, see European Commission, 2016)[8].

Use cases for digital reference frameworks: practices from DigComp

Reference frameworks, such as those focusing on digital competence, can have various uses to help and support policy-makers and decision-takers in their work. In Figure 1, three different use cases are identified in the context of education, training and employment: "policy formulation and support", "instructional planning" and "assessment and certification". Below, some examples from countries and regions in the European Union are provided in each of the areas. These illustrate the deployment of the DigComp framework in different contexts for different purposes. The stakeholders in question range from educational and employment authorities at national and regional levels to public and private training institutions and the third sector organizations that provide education and training opportunities (e.g. non-governmental and non-profit organizations, public-private partnerships). The user guide, "DigComp into action: Get inspired, make it happen", illustrates such cases with the aim of sharing practices with a further community of potential users (European Commission, 2018a).

Policy formulation and support

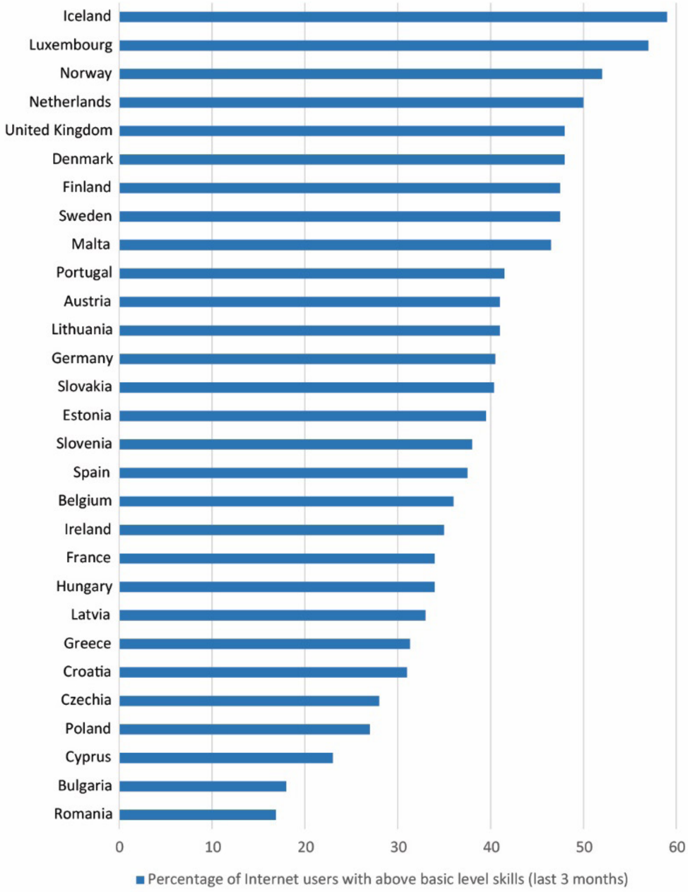
DigComp is used extensively for the development of national digital education strategies for formal education. In the case of Germany for instance, in 2016, a new strategy called "Education in the Digital World" was presented for schools and vocational education, and for institutions of higher education by the Standing Conference of the State Ministers of Education and Cultural Affairs (Kultusminister Konferenz, n.d.). After its adoption, a long-term process ensued of embedding digital competence in the curricula of each German state.

In this context, DigComp was first used along with other two frameworks to develop the conceptual model of "Competences in the Digital World". DigComp served as a reference tool to compare the two frameworks already used for media literacy in Germany with DigComp competences, revealing a need for new competences to be created (e.g. problem solving and "algorithmic thinking") (Kultusminister Konferenz, 2016). DigComp also supported work to agree upon digital competence development targets for students and their teachers in all levels and types of schools.

Furthermore, to help policymakers to obtain a macro-level view of citizens' digital competence, the European Commission developed a "Digital Skills Indicator" which is part of a larger composite index called the Digital Economy and Society Index (European Commission, 2018c).

The Digital Skills Indicator is based on DigComp's four competence areas (information and data literacy, communication and collaboration, content creation and problem solving). As a datasource, data from the Eurostat survey is used (Internet Usage in Households and by Individuals) which covers a representative sample of the European Union population between the ages of 16 and 74. In this conceptualization, individuals' Internet activities in the last three months are used as

Figure 1.2. Digital Skills Indicator (Internet users): above basic level



Source: European Commission (n.d.)

a proxy for digital skills (European Commission, 2015). Four levels for citizens' digital competence are used (no-low-basic–above basic). Figure 1.2 provides a bar chart of individuals with "above basic" digital skills for each European Union country, plus Norway and Iceland.

The Digital Skills Indicator can be viewed using an interactive tool which also allows the further analysis of the data (European Commission, n.d.). The indicator can be, for example, broken down by various background variables, so it is possible to assess the digital skills of the individuals, but also of the European Union workforce. The guide: "DigComp into action" also has a number of other examples of practices to support policy and strategy formulation in the domains of "lifelong learning and inclusion" and "employment".

Instructional planning for education, training and employment

Supporting the creation of instructional material in non-formal adult education is another use case of DigComp. In Flanders for instance, a region in Belgium where close to 400 000 people annually attend adult education centres, a decision was taken in 2014 to shift to a new competence-oriented perspective. This included modernizing the training content to include new ICT developments such as social media, tablets and smartphones. In this case, DigComp was adopted as a reference framework for citizens, which set in course a cross-sectoral working group in charge of defining learning outcomes and training modules. In August 2016, the Flemish government approved the proposal, including implementation of a website[9] that aims to facilitate the implementation of the nine new ICT programmes based on DigComp. Further details about the implementation are available in the user guide "DigComp into action: Get inspired, make it happen" in addition to a number of smaller scale examples of instructional practices in the domains of "lifelong learning and inclusion" and "employment" (European Commission, 2018a).

Assessment and certification

Creating an instrument to measure and certify citizens' digital competence is illustrated by a large-scale project initiated by the French Ministry of Education. A digital platform called PIX[10] was developed from 2016 and today, any French speaker can use it to evaluate one's level of digital competence. The competence framework is based on the DigComp competences with slight modifications and the learning outcomes are developed in eight proficiency levels[11]. The assessment approach taken by the PIX platform is task-based, which results in authentic online activities that users take at their own pace and time, solving one practical problem using digital tools in an online environment at a time. This offers individuals an opportunity to practice and revise their digital competence in a rather playful manner.

The PIX platform will also be used for the purpose of certifying one's digital competence, both by employers and educational establishments. For secondary school students in France, for example, by the school year of 2019 to 2020, the PIX certificate will replace the current Internet certificate (called D2i). The idea is that all secondary students can access PIX through their school's digital learning platform, and at a given point in time, starting from June 2019, schools will be able to organize a testing session which will lead to a certification. Similarly, employee organizations are given an option to use the PIX platform, for the purpose of digital competence acquisition by employees, and also to assess and further certify workers' digital competence. The PIX certificate is recognized by the National Committee for Professional Certification (CNCP)[12].

Creating professional digital profiles in different sectors of industry is yet another use case of the DigComp framework. In the Basque country of Spain, such work is carried out in collaboration with the Basque Government (Directorate of Entrepreneurship, Innovation and Information society), local university, manufacturing companies and other stakeholders with a long-term goal of digital transformation of the local economy. Currently, 15 professional digital profiles exist, many of which focus on the new industry 4.0 jobs (e.g. 3D designer). Since 2012, the Basque country government has implemented various activities using DigComp for the digital competence needs of citizens, enterprises, civil servants and others. For example, a digital competence assessment tool, which is based on DigComp, has been taken up by over 50 000 citizens already. The results of the assessment are linked to career and training guidance in order to improve the personal skills and employability of unemployed people. A case study is available on page 80 of the guide.

Other frameworks for digital competence by the European Commission

DigComp is aimed at ensuring digital competence for citizens in general, including individuals, learners, workers and those seeking employment, so as to enable individuals' participation in society and economy. The European Commission is undertaking further work to tackle specific challenges related to capacity building for the digital transformation of education and training, and for the changing requirements for lifelong learning competences in general. Notably, as a derivative work from DigComp, a Digital Competence Framework for Consumers (DigCompConsumers) was developed to support and improve consumers' digital competence. It is defined as "the competence consumers need to function actively, safely and assertively in the digital marketplace". DigCompConsumers introduces the conceptual reference model which outlines 14 competences and gives examples of each competence in terms of knowledge, skills and attitudes (European Commission, 2019b).

Moving from individuals to professionals in the area of lifelong learning, a digital competence framework for educators has also been developed. DigCompEdu is directed towards educators at all levels of education & training. It describes what it means for educators to be digitally competent and provides a general reference frame to support the development of educator-specific digital competences in Europe. DigCompEdu details 22 educator-specific competences for teaching in a digital society along 6 competence areas. Current work is focused on a self-assessment instrument.

Last but not least, shifting from education professionals to the institutional level, a European framework for digitally competent educational organizations (DigCompOrg) was published to promote effective digital age learning (European Commission, 2019c). DigCompOrg is now turned into SELFIE, a tool for schools' self-reflection of their digital capacity.[13] It was launched in October 2018 and is currently available in the 24 official languages of the European Union, with more languages to be added over time. Other work supporting institutions include a framework for opening-up higher education institutions (OpenEdu) which was also published in 2016, supporting higher education institutions dealing with the challenges and opportunities related to open education (e.g. Open Educational Resources, open science).

Conclusion

Reference frameworks create a common understanding through agreed definitions and set vocabulary. They can be consistently applied in all tasks from policy formulation and target setting to instructional planning, and assessment and monitoring. They can mobilize stakeholders to take initiatives and learn from each other to address digital skills challenges. They can serve different purposes in the overall process of developing a strategy for digital skills as well as for their implementation and monitoring in a national or regional context. Their overall aim is to ensure that all individuals can acquire the necessary competences for full participation in society and economy. For that, educational organizations and educators must also develop their own digital competences.

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Liberal arts in the context of automation and artificial intelligence

By Catharina Maracke

Introduction

Understanding digital technologies is of crucial social, political and economic importance in the twenty-first century. Digital technologies, such as automation and artificial intelligence (AI) in particular, are the driving force for economic and social development – they shape our societies, practices and institutions. At the same time, they raise important questions with regards to the skills required to best utilize them.

One example is the question about ethical concepts that build the framework for human life and coexistence. In order to make accurate and appropriate political and policy decisions regarding new technologies, we must reflect on the ethical aspects of their development, the moral questions of their applications, and the general impact of their exploitation. Understanding morality, history and civilization is an essential component of reflection. Skills such as critical thinking, complex reasoning, and logic are becoming more important.

However, our traditional understanding of academic disciplines differentiating between liberal and business arts does not accurately reflect the new challenges of digital transformation. We still distinguish between liberal and professional education, whereby the meaning of liberal arts is restricted to the humanities – history, language, literature and so on. We tend to ignore the fact that liberal arts are disciplines that commemorate and foster inventive action, both through their subject matter and teaching method (Gordon, 2012). They should become mandatory components of engineering and business, as they are needed to teach and learn decision-making activities.

The following sections provide an overview of the history and development of our current academic system in the Western European world and the role of liberal arts education in the traditional context of higher education. The challenges presented by the digital transformation are explored with a particular emphasis on the role of liberal arts education to prepare for the skill set needed in the age of digitization. What do we need to know to successfully tackle the issues introduced by rapid developments such as the digital transformation? What is needed to become a leader in the twenty-first century?

From the Academy to the academic disciplines

Today's concept of a university as a designated place to learn and teach goes back to Ancient Greece. The Greek philosopher Plato is said to be credited with the idea of an "Academy", a place where students from different backgrounds come together to attend lectures.[1] Prior to the Academy, it was common for young people to have a mentor, but the relationship between the student and the mentor and the learning and teaching only happened on a one-on-one basis (McElreavy *et al.*, 2016). Mentoring and lecturing a group of students was a new paradigm and has since been widely accepted as a concept for teaching and education in our modern world.

After Plato's death, the Academy continued for nearly three centuries with Aristotle being its most famous student. Even though the Academy focused on dialectics and did not have a formal curriculum, scholars generally agree that subjects taught and discussed included philosophy, physics and mathematics (Schofield, 2002). The idea of teaching and discussing different subjects is therefore not new, but the concept of the modern disciplinary system reflected in today's university departments and faculties only developed during the thirteenth century. In 1231, the University of Paris consisted of four faculties: theology, medicine, canon law and arts (Adler, 1977).[2]

Disciplines differ from one another in at least three primary ways: the area of their investigations (also referred to as their context), their research methods and their epistemologies (Schommer-Aikins, Duell & Barker, 2014). The contexts of disciplines are often classified using a system that differentiates between "pure" and "applied" as well as "hard" and "soft" categories (Biglan, 1973). According to this classification, and in simplified terms, "pure" disciplines are primarily theoretical, e.g. mathematics, as opposed to the "applied" disciplines like engineering. "Hard" disciplines refer to the more paradigmatic disciplines whereas "soft" disciplines refer to the pre-paradigmatic disciplines, which also points to the differentiation between natural sciences and social sciences, the so-called humanities (Krishnan, 2009). However, the development and possible classification of the academic disciplines we know today is the result of an ongoing process which can be traced back to the early days of the universities in the Western world (McElreavy *et al.*, 2016). New disciplines have been added, mostly reflecting current social or technological trends, e.g. gender studies or media studies.

Today, the term "academic discipline" includes many elements of the various meaning of discipline but is mostly used as a technical term to describe the organization of learning and the systematic production of new knowledge (Krishnan, 2009).

Liberal arts and liberal education

The "liberal arts" refer to those subjects or skills that in Ancient Greece were considered essential for a free person. The term *liberalis* can be translated as "worthy of a free person" (Trask, 1973).[3] Originally designed for the education of privileged young people, liberal arts were considered to be the basic knowledge required of a free person in order to actively participate in civic life, e.g. participating in public debates, defending oneself in court or serving on juries or in military service.

Today's understanding of the liberal arts goes hand in hand with the development and the changing role of the universities, particularly in the Western world. In the European context, the history and development of universities has been influenced and characterized by distinct periods. Medieval concepts were followed by renaissance humanism and enlightenment with evolving emphases on what knowledge means and how it should be pursued and studied (van der Wende, 2011). In particular during the nineteenth century, the role of higher education was debated along with the critical question of whether universities should focus on training responsible citizens whose intellectual and emotional background would contribute to the smooth evolution of society as a whole or whether they should focus on professional training to produce skillful lawyers, physicians, or engineers.[4] After the Second World War, economic demands pushed students to pursue university education not, as had been the case in the past, in order to become "wise citizens", but in order to pursue a career. Education for the sake of education was no longer wanted or even particularly respected (Haberberger, 2017). Similarly, profession and vocation have also gained in importance at American universities, although more explicitly at the graduate level and in professional schools rather than at the undergraduate level as was the case at European universities.[5]

In order to understand the role and potential opportunity of the liberal arts, it is important to formulate a definition. While the terms liberal arts, liberal education and general education have been conflated and contested over the past centuries, there seems to be consensus that liberal arts and liberal education can be characterized and perhaps best defined by their learning outcomes (Haberberger, 2017; Godwin, 2015):

- critical thinking and broad analytical skills;
- learning how to learn;
- independence of thought;
- empathy – seeing all sides of an issue;
- self-control for broader loyalty;
- self-assurance in leadership ability;
- mature social-emotional judgement and personal integration;
- equalitarian, liberal values;
- participation in and enjoyment of cultural experience.[6]

Students are not only expected to gain knowledge of the subjects which they take, but to approach knowledge critically, to evaluate and to synthesize knowledge from many different sources, and to respect the grey between the black and white (Haberberger, 2017). The common objective goes back to the idea of educating "wise citizens" and to cultivate a sense of collective responsibility that will prepare students for a wise and ethical stewardship of their world (Haberberger, 2017).

This definition, based on results rather than topics and content, is not to be confused with the meaning of a "general education". In fact, the discussion is not about generalists (liberal arts) vs specialists (professions). It is about learning outcomes and what knowledge and skills are required to shape society. Whereas most academic programmes and corresponding degrees can be characterized and defined according to their subjects, the learning outcomes that account for a liberal arts programme are independent of the subject matter. The key to liberal arts and liberal education can therefore be linked to the method of teaching and to the question of "how" it is taught instead of the subject itself and "what" is taught (Haberberger, 2017).

Digital technologies and automation

Digital technologies and especially the current developments in automation and AI have caused many scholars to re-discover the importance of ethics (Floridi *et al.,* 2018; Kokuryo & Kaya, 2017). Self-driving cars and the related trolley problem or autonomous weapons and the potentially lowered threshold for going to battle provide only two examples of the current debate about ethics and technology. It seems obvious to argue that ethical questions and especially the question of governance are becoming increasingly important. Many scholars have explored risks and opportunities of automation and especially AI for society and raised the question of an appropriate ethical framework (Floridi *et al.,* 2018).

However, in addition to the question of how humans can best shape, govern and eventually regulate the future of technology so that it serves to better human existence, there is another important issue and that is the skill set needed to deal with and further develop emerging technologies. When considering skill sets for the future of our society, we can differentiate between two slightly different perspectives. The first aspect to be examined is the coming shift in demand for workforce skills: What skills are needed to successfully participate in the digital economy, or, more bluntly, what should people learn today so that they have a job in the future?

Another perspective goes beyond the job market and reflects upon the future of mankind: What skills are needed to ensure and further develop humanity? Put differently and looking back at the evolution of mankind, what skills do we need in order to guarantee human existence and to further develop humanity?

The future of the workforce

Young people are growing up in an age of technological change. Recent developments in the context of AI point to the total automation of our lives and leave young people anxious about their ability to compete in the job market. A critical question is whether AI and the latest automation technologies will continue to favour high-skill workers over low-skill ones or perhaps affect all skill levels.[7]

Technological progress has always had an impact on the job market and the skills required in different professions. During the industrial revolution in Europe and the United States in the early nineteenth century, the steam engine and other technologies raised the productivity of workers with primarily basic manual skills, enabling them to do work that had previously been done by higher skilled and higher paid workers (McKinsey Global Institute, 2018). Instead of a complete collapse of the labour market, we saw a shift in the demand for skills.

In today's world of automation and robots, the shift in required workforce skills will further accelerate. A recent study has revealed that the strongest growth in demand will be for technological skills whereas the demand for basic cognitive skills, including data input and processing, as well as the demand for physical and manual skills, including general equipment operation, will decline (McKinsey Global Institute, 2018). At first glance, the answer to the new demand for specific advanced technological skills seems quite easy: Encourage young people to focus on advanced IT, and especially programming skills, and prepare the educational system to focus on most desired areas such as engineering, data analysis, mathematics, technology design, etc. Prominent voices have already proclaimed that studying anything besides the field of science, technology, engineering or mathematics (STEM) is a mistake when preparing for a job in the digital economy[8].

However, while advanced technological skills are essential for running a highly automated and digitized economy, there will also be growing demand for people with advanced social and emotional skills (McKinsey Global Institute, 2018). A refined analysis suggests that the demand for leadership, entrepreneurship and initiative taking, creativity, critical thinking, complex problem solving, decision-making and communication, or people management and negotiation will grow across all industries and continents (World Economic Forum, 2018; McKinsey Global Institute, 2018). Some even see the growing demand for these “high-cognitive” skills as part of an ongoing trend, arguing that non-routine interpersonal and analytical tasks in occupations have been constantly rising over the past years (Autor & Price, 2013). The real question to be answered is therefore not about the skills required to compete in the digital economy but how to enable humans to create value in an increasingly automated world (World Economic Forum, 2018).

The future of humanity

Emerging technologies will not only have an impact on the future of the workforce, but also on society at large and the future of humanity. One of the most critical questions to be elaborated in this context is how technology affects learning and human behaviour.

Originally introduced to support and improve human life, emerging technologies such as automation and AI can also have unexpected and potentially unintentional consequences. What was designed to increase efficiency and convenience can easily control our physical environment in unprecedented ways. Automation and AI can and will be used to automate authority and to prevent wrongdoing and human mistakes. Thousands of years of discussing and reflecting on the core question for society – what is the right thing to do – will be programmed into the car once we allow AI to drive on behalf of ourselves. While it might be helpful to automate choices and anticipate the “right” decision, increased automation of our lives can also affect us as moral actors with unforeseeable consequences (Kerr, 2010).

Looking back at the early days of education as practised in Plato’s Academy, it can be argued that group discussions and discourse, be it political, academic or scientific, are critical for the development of society. The important aspect of the first developments of ethics as a framework for people living together in a society is an active engagement in discourse, discussion and dispute. The pure observation of choices and decision-making is not sufficient to form a functioning society.[9] Virtue is action according to the laws of nature (McKeon, 1998). In other words, the development of moral dispositions requires both knowing and *doing*. Human existence consists in the exercise of decision making, using what can be observed and learned. There is a practical element involved, which requires ongoing practice in real life situations over the course of a lifetime. When approaching a difficult situation, humans will use all relevant knowledge collected over lifetime and particular circumstances of the relevant case as a guide in making an ethical decision.

For humans to observe and learn, there needs to be a “playground” for moral development, a place where decision making and considering the right and wrong thing to do can be practised. If technology prevents us from making mistakes, from exploring different consequences and negotiating these consequences with ourselves and others, these technologies will eventually eliminate our ability to cultivate and practise wisdom and to achieve moral excellence. In other words, moral reflection, be it Kantian, consequentialist, existentialist, nihilistic, or influenced by any other perspective, will become impossible if technology is set to systematically deny the ability to act upon those deliberations.[10]

What will be the consequences for humanity? What will happen to our society if we deliberately automate decisions and thereby eliminate context and negotiation? How can future generations cultivate a moral compass, a sense of right and wrong, good and bad, if they are locked on a course that leads them only from here to there with no opportunity for moral journey, deliberation and error?

Ethical decision-making cannot be uploaded or downloaded. It requires a broad variety of experiences, consideration and mistakes. Future generations need to defend and exercise a considerable degree of autonomy to maintain the ability to access the world of moral decision-making and to make use of it. It is therefore critical for them to be equipped with skills that enable them to constantly reflect, question and improve technology so that they do not become locked in.

New skill set?

Looking at the future of the workforce and the future of humanity reveals that future generations need to be prepared to compete in a rapidly changing job market and to approach large-scale human challenges posed by new technologies, particularly the increasing trend towards automation. What matters most is not the content to be learned but the way people think about it and adapt to changing circumstances. Will they be able to think independently and ask the right questions? Will they be able to identify the problems to be solved and facilitate the activities needed to address those problems? To face future challenges, the next generation of students must be trained to be both resilient and adaptable to competition and changing circumstances (Sun, 2018).

Since liberal arts teach students to think critically and evaluate knowledge from different sources, strong arguments can be made that they create an opportunity for students to develop adaptive skills required for the age of technological change. More than any other discipline, liberal arts are based on the principle that knowledge is manifest for the transformation, not merely the description, of our nature. In that sense, liberal education is not a one-way process in which we look at static subject matter, the human species. It is a reflexive process in which the nature of humanity is formed by the study of humanity (McKeon, 1998), and therefore the most effective, if not the only way to teach future generations personal enrichment and resourcefulness for a rapidly changing world.

Interestingly, similar concepts can be found when considering leadership research and theories. While there are many different studies and perspectives on the concept of leadership[11] there seems to be a basic understanding among different schools of leadership that it is more useful to define leadership as an activity rather than trying to find a definition grounded in authority and personal characteristics (Heifetz, 1994). Focusing on activity, the concept of leadership can be further classified as being effective (with regards to implementing business goals), and/or as being able to facilitate change and work on adaptive problems (Heifetz, 1994). Either way, it is essential to foster and nurture creativity and critical thinking, along with empathy and active engagement.

In summary, skills such as critical thinking and active engagement to approach unforeseeable events, including critical reflection and the ability to facilitate change, will be essential for future generations to tackle opportunities and risks presented by emerging technologies. The primary objective of liberal arts to educate “wise citizens” and to cultivate a sense of collective responsibility, offers the best way to prepare future generations for a wise and ethical stewardship of their world.

Conclusion

It is important to realize that in order to effectively tackle today’s biggest social and technological challenges we must think critically about their human context, which is something the liberal arts can help future generations to pursue. However, the solution is not that liberal education should replace any other field of study nor should the liberal arts prevail over any other discipline. We need to re-think and re-build our current higher education system in a way that it better reflects the challenges and opportunities posed by emerging technologies and better prepares young people for the job market and the world ahead of them.

Even today, most academic disciplines are designed to prepare students for careers and professions.[12] A law faculty prepares young people for the legal profession, a business school prepares them for management positions, and most universities are reserved for the professional and advanced work specializing in building professional careers. Correspondingly, most students opt for a vocational major, prioritizing financial prosperity over the more traditional ideals of university education, such as developing a meaningful philosophy of life (Haberberger, 2017; Gordon, 2012).

However, as outlined above, there is a compelling case for the liberal arts, which is supported by real-life examples: Michael Dell, founder and CEO of Dell, Steward Butterfield, CEO of Slack, and Jack Ma Yun, cofounder and Executive Chairman of Alibaba Group, majored in liberal arts. Even if this list of prominent CEOs can be criticized as cherry picking, it seems not only legitimate but also critical to ask whether the role of liberal arts has been significantly underestimated. Of course, we need technical experts to tackle emerging technologies, but we also need people who understand the reasons for and manner of human behaviour. Since liberal arts can create an opportunity for students to develop new skills and cultivate the pursuit of lifelong learning, we should place a higher priority on them and identify ways to implement and combine them with other disciplines and learning endeavours.

Liberal arts should not be seen as an alternative to professional education. If the goal is to prepare future generations for the social and technical challenges ahead of us, the most important skills include independent thinking and critical reflection as best conveyed by liberal arts. Their subjects and teaching methods should be integrated in today's higher education system, be it at the undergraduate or graduate level and across all disciplines. However, it is important to realize that liberal education as outlined in this article does not only relate to specific topics. Adding ethics to programming courses seems beside the point. While philosophy and especially ethics play an important role in the context of liberal education, the significance of liberal arts can only be understood by considering the historical background. Referring to the subjects and skills required to become a free person, and as further developed over the past centuries to reflect the growing importance of universities in the social context, liberal arts can only be defined by their results. Active engagement was necessary to participate in Plato's Academy and only active engagement based on critical reflection will prepare future generations to tackle the challenges posed by digital technologies. If and to what extent this perspective of liberal arts can be included in other disciplines or whether we need to re-think our current system of academic disciplines and possibly re-build our universities would go beyond the scope of this article and should be addressed in a more detailed analysis.

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Endnotes

1 Plato's Academy was founded around 387 B.C. and located just outside the city of Athens. See https://www.history.com/topics/ancient-history/plato.

2 In the US, university departments were first seen around 1825. See Cohen & Lloyd, 2014), pp. 189-215.

3 The classical sources include Cicero, *De Oratore*, I.72–73, III.127, and *De re publica*, I.30.

4 See van der Wende, 2011, p. 235 for details and especially the role of Wilhelm von Humboldt in the context of European higher education.

5 For a long time, medical, engineering and law programmes in Europe started as specialized tracks upon entrance in the University system, and the division between undergraduate and graduate cycles was not very explicit or even absent in Europe. The Bologna Initiative finally re-adjusted the system to allow for comparability and moving between different European countries. See van der Wende, 2011, p. 236.

6 Haberberger, 2017, pp. 1052-1059 with reference to Winter, McClelland & Steward, 1981.

7 One of the biggest concerns is that current middle-income jobs would further decline and the inequality could intensify as non-repetitive, highly qualified jobs would pay above-average wages while pay for repetitive, lower skilled jobs would be below average. See McKinsey Global Institute, 2018.

8 https://medium.com/@vkhosla/is-majoring-in-liberal-arts-a-mistake-for-students-fd9d20c8532e

9 Aristotle stated that the proper function of human beings is activity of the soul in accordance with reason. See Broadie & Rowe, 2002, pp. 20-25 translating Aristotle.

10 Any successful and sanctioned deployment of automated decision-making will therefore impede the development of moral character by impairing peoples' ability to develop moral dispositions, thereby diminishing our well-being and ultimately undermining human flourishing. In short, automation will undermine the project of achieving moral excellence, see Kerr, 2010, p. 247.

11 For a comprehensive overview, see Day & Antonakis, 2012.

12 These developments in higher education are primarily a result of market changes in the nineteenth century and again after the Second World War, when demand increased for trained physicists, chemists, engineers and then medicines.

Transitioning from the era of capacity building to an era of capacity augmentation: how human and computing capacity can partner for social impact

By Pratik Bhatnagar and Rathan Kinhal

Introduction

An average human being can read a document at the rate of 200-230 words per minute, or about a page in two minutes. This means that in 30 minutes, a person constrained by his or her human capacity, can realistically expect to read about 15 pages, not accounting for the distractions that are all too familiar in life in the twenty-first century: WhatsApp chats, Facebook notifications, Twitter alerts, e-mails from the boss.

Now, compare that to the capabilities of Brainspace, an artificial intelligence (AI) engine. According to its founder Dave Copps, Brainspace can "ingest" – i.e. not merely read, but absorb, comprehend and analyse data and media-rich content – a million documents in 20 languages. In about the same time that it takes an average human being to read 15 pages, i.e. 30 minutes (MIT Technology Review Insights, 2016). Even human speed reading, which peaks at 700 words per minute, remains leisurely in comparison.

The purpose of this example is not to pit human capability *against* AI capability. Rather, it is to illustrate what can be possible when human intelligence is paired with artificial intelligence, working *in partnership*. Award-winning global design firm IDEO calls this "augmented intelligence" (Brown, Malmgren & Stringer, 2017), which refers to ways in which technology can be applied to extend the capacity of human beings.

This is already happening, and, indeed, in some cases has already happened without us even realizing. To take a fairly commonplace example, in just 25 years, e-mail technology and the Internet have expanded our collective human capacity exponentially, transforming how we work and interact, how we transact and bank, and how we travel, educate and enjoy leisure. In fact, it is increasingly difficult to imagine how we were able to accomplish anything at all, prior to the introduction of such technologies. Even if we do not directly use these technologies – and there are still over four billion people, or 48.8 per cent of the world's population as of end of 2018, without Internet[1]– we all live in societies that have been transformed or are fundamentally transforming as a result of the widespread mainstreaming of technological innovation around us. This mainstreaming of digital transformation across the board has, in turn, brought high-order step changes in the augmentation of human capacity itself and, by extension, the potential of overall human achievement. These innovations are "virtual exoskeletons" for our human capabilities with which we may scale heights of achievement and attain social impacts that were previously not possible.

This paper makes the assertion that the time has come to re-examine traditional capacity building programs. These are commonly understood as a more linear process of giving people the wherewithal – the knowledge, skills, and resources to shape their own development. Capacity building should now orient people towards the idea of integrating human and computing capacity to leverage technological innovations and to deliver social impact at lower costs. Through this paper, we will examine impact stories and cross-sectoral partnerships looking at how human capacity and technological innovations have been deployed and which have had the effect of leapfrogging towards long term social impacts.

Impact story: Data-driven governance in Andhra Pradesh, India

The stated mission of the real-time governance (RTG) institutional framework devised by the Government of Andhra Pradesh in India is "to bring in positive ‘disruptive’ changes in governance, public administration and management leveraging the tools of e-governance, technology and electronic communication”[2].

Although the RTG is designed to address public grievances more efficiently, its more subtle aim is to leverage technology, data and information infrastructure to augment the capacity of bureaucrats. From village to state levels, across the ranks, across departments, and across sectors, technology has been deployed to process, diagnose, analyse, and make decisions at a pace, volume and level of efficiency that was previously unimaginable.

The workflows of various state-level departments, including the office of the Chief Minister, are integrated with a call centre employing 1 750 staff working in three shifts. These workflows are aided by an information infrastructure that enables real-time assessment of the situation by analysing grievances which are collected from the general public. The call centre has a capacity of 1.5 million outbound calls per day and in eight months, over 13.9 million grievances from 14.9 million received have been addressed, representing a 93 per cent redressal rate.

In addition, the RTG’s framework, with its command and communication centre utilizes data input from closed-circuit cameras, drones, biometric-augmented technology, virtual reality, machine learning technology and Internet of Things (IoT), to model and predict disasters, assess crop yields in advance and develop sea and weather forecasts.

In volume and in outcome, none of this would have been possible by the collective bureaucracy only a few years ago, let alone by the lone efforts of individual bureaucrats**.** The appropriate deployment of available technology in order to augment bureaucratic workflow efficacy and response capacity, and its intent to align humans and technology with the purpose of delivering social good at scale, made this possible.

Moore’s law and the technology imperative for social impact at scale

Today we are in an era of unprecedented technological progress, where innovation can be deployed for the service of humans in their desire to improve the state of the world around them. Erik Brynjolfsson, an economist at the Massachusetts Institute of Technology (MIT), has observed that "the accumulated doubling of Moore's law[3], and the ample doubling still to come, gives us a world where supercomputing power becomes available to toys in just a few years, where ever-cheaper sensors enable inexpensive solutions to previously intractable problems”[4].

According to Heath (2014)[5], forty years ago the number of transistors in a computer processor was around 2 300. Today that number is around 4 billion. The cost of each transistor is inversely proportionate to Moore’s law, meaning that every 18 months the cost of a transistor is halved.

Thus, more and more computing power will be at our disposal at progressively lower cost. Technology is increasingly available with an exponentially rising potential to solve the world’s most intractable problems even more cost effectively. Solving these problems will require the ability to combine human capability with computing intelligence, in appropriate and sustainable ways.

As Edward Ashford Lee notes, “the real power of technology stems from its *partnership* with humans” and that it “augments our cognitive and physical capabilities” (Lee, 2017). Nowhere is the potential of this partnership, and its associated cost and scale efficiencies, more compelling than in driving social impact.

In 2018, using the Sustainable Development Goals (SDG) framework, the McKinsey Global Institute analysed potential applications of AI technologies when deployed for social good. McKinsey[6] then identified and mapped 160 AI social impact use cases across ten different social impact domains, such as environment, health and hunger, education and crisis response, against the 17 SDGs (Chui *et al.*, 2018). The social impact domains studied were found to have some of the largest number of use cases. McKinsey suggests that existing AI capabilities could contribute to tackling cases *across all* 17 of the United Nation’s SDGs, with the goals related to health, education, governance, peace, equity and justice and the environment, having the largest number of possible use cases and applications.

This is not surprising. Fourth industrial revolution (4IR) technologies – quantum computing and big data analytics, IoT, robotics, blockchain and AI – are making their mark across these social impact domains in significant ways. Drone technologies, for example, have augmented the capacity of forest rangers and environmental enforcers in Nepal to achieve 365 days of zero poaching in 2018 of its flagship species – tiger, rhino and elephant – in the forests of Nepal. This was achieved in part through improved mapping, tracking, object recognition and analytical capabilities via deployment of unmanned autonomous vehicles (UAVs), alongside less technological interventions, such as the deployment of sniffer dogs and routine, physical, forest-ranger surveillance[7].

Machine learning, AI and quantum-computing technologies have helped to build India's Electronic Vaccine Intelligence Network (eVIN), which provides real-time, end-to-end transparency of India's vast vaccine supply chain operations. Between 2013 and 2017, eVIN has achieved a reporting rate of more than 98 per cent from across 10 500 vaccine storage and cold-storage points in over 12 states, and over 2 million vaccine transactions online on the eVIN server every month, driving training through more than 550 batches of training programmes using the eVIN application. It has vastly augmented the capacity of more than 17 000 government staff including vaccine storekeepers, data entry operators and cold-chain handlers to dramatically improve vaccine delivery and immunization outcomes[8].

Capacity augmentation in capacity-building circles

As already noted, in this era of augmented intelligence, human capacity is being augmented through quantum leaps (at an ever-diminishing cost), every couple of years, allowing us to leapfrog in our ability to solve the world's most pressing problems as enshrined in the 17 SDGs.

However, in the context of international development, or global social impact, as it is now often called, human capacity building or capacity development has meant focusing on education, training or technical assistance within the context of development initiatives and programmes (whether in health, education, environment, humanitarian relief etc.), often through programmes funded by international donors in developing countries. This has worked well over the decades to some extent. However, implicit in this approach is the assumption that human capacity is linear and limited, improving in fixed, discrete steps through repeated training programmes delivered at regular intervals or whenever a situation demands.

This approach is linked to an era in which technology was not as widespread, even amongst prospective trainees, who are now themselves avid users of, and contributors to, user-centric, crowd-sourced technological innovations, embedded in mobile phones and in many other devices. These individuals already interact with technology in their regular lives, whether through online booking of tickets on trains at kiosks in local train stations, checking land records and seed prices on mobile phones, using mobile payment apps to transfer money to family or opening rural bank accounts using biometric and digital IDs. Both training and learning today, mediated by technological advancement, has rendered human capacity even more malleable and increasingly, is no longer fixed or limited.

Capacity-building programmes in the context of international development of social impact, have not as yet adapted to this "technology-everywhere" reality. Human capacity is being augmented in non-linear ways outside capacity-building programmes already, and by participants themselves, through their increasing familiarity with technology.

Furthermore, traditional capacity-building programmes are often further limited by donor restrictions on funded activities; by the individual silos of implementing agencies that focus on narrower, programmatically-relevant capacity outcomes; and by budgetary constraints of governments and donors alike. According to a recent study by Johnson & Johnson and GlobeScan (GlobeScan, 2018), "Major donors tend to tie funding for in-service training to major infectious diseases such as HIV, TB and malaria...", where "experts called for additional funding for health workforce to also tackle the rise of non-communicable diseases and other health issues". This can result in unmet capacity needs or in duplication of efforts. It would not be uncommon for different agencies to deliver capacity-building programmes to the same people based on their own individual and separate mandates.

The report also identifies a key limitation of capacity building delivered as programmatic training and education in silos: namely, that it misses synergies that exist across the health sector. These synergies include not only expertise existing within donor and implementation agencies, but also expertise "embedded in a diverse and complex network of other partners: supply chain companies, pharmaceutical industries and transportation and logistics." Thus, building capacity to improve, for example, the quality of health-care delivery requires access to embedded experiences amongst a network of partners that an isolated, single-purpose, programmatic capacity-building programme cannot efficiently provide.

However, capacity-building programmes that integrate human and computing capacity working side by side (as evident in the case of eVIN and RTG in India), while connecting workflows within the ecosystems of donors and implementing agencies, can do precisely that. Such programmes can leverage the non-linear and, thanks to Moore's law, extend human capacity exponentially to deliver impact at ever lower costs, conducive to scaled impacts. For example, today we have the technology to deliver education and training content through content-rich training platforms. It is not only becoming cheaper to compress content into tighter bandwidth (a particular advantage for the low-tech resource environments of many developing countries), but it is also becoming more efficient to deliver such content through mobile technology, to exchange learnings and experiences, and to connect virtually with fellow health workers and supervisors across dispersed networks, through messaging and workflow applications.

Consider the following situation in the context of humanitarian assistance in Myanmar: "In 2014 and 2015, aid agencies working separately delivered nearly 5 000 workshops, launches and events designed to encourage harmonisation and align the various actors within the donor community" (Walton & Tarpey, n.d.). Capacity building traditionally delivered, with good intentions of course, can have the effect of overwhelming and disempowering local communities, officials and donors alike, resulting in coordination failures. Can available learning technologies and education platforms remedy situations like these? We believe they can.

Web-based, adaptive learning, edu-tech platforms are using distance-learning tools and AI to adapt learning content; to continuously evaluate performance; and to tailor instruction and workflow guidance to each user's specific needs. For dispersed workforces, such as frontline health workers in low technology-resource settings, intelligent collaboration platforms, already facilitate collaboration over distances across a variety of bandwidth realities, sharing of field experiences and receipt of timely feedback[9]. These platforms also enable workers communicate issues and seek issue resolution in real-time and to adjust to adaptive targets and incentives.

The augmentation of human capacity that is deployed in partnership with technology through suitable programmatic design, has the potential of not only eliminating duplication of efforts (and hence saving donor funds), but also has the ability to promote integration across issue-based silos, and to ultimately achieve more sustainable impacts and enhanced insights, from across the entire system.

The nature of technology – and certainly of the new machine-learning algorithms on which it depends – is that it scales when applied across silos or use cases, and finds efficiencies while examining cross-sectional, multivariate, unstructured data, uncovering in the process new insights into relationships and dependencies. This creates new pathways, options and possibilities for driving outcomes and impacts across a range of issues.

Finally, there is a limit to the amount of training that an individual can absorb as a trainee or a participant within traditional capacity-building programmes, before diminishing returns set in. This is certainly the case if capacity-building goals are not aligned to individual professional and personal development pursuits, with personal experiences inside the broader society, with individual motivations, or are mismatched with the needs of the job market in which the trainee or participant lives and transacts. An RTG data analyst trained to work within the e-governance programme with the Andhra Pradesh government is now just as easily employable outside the government sector with ever-increasing job prospects. The analyst is not merely a captive of a particular capacity-building programme, supporting a single social outcome. This dynamic is completely missed in traditional capacity-building thinking. A trained participant of a capacity-building programme, increasingly, is part of the broader economy and not just a programmatic human resource. Even more so, when he or she increasingly interacts with technology.

The foundations for capacity augmentation thinking, may have already been laid in more advanced settings, but, as we shall see below, are also emerging in low technology-resource settings, through innovative partnerships.

Impact story: Partnering for capacity augmentation – "Internet Saathi"

"Internet Saathi is an initiative in India sponsored by Tata Trusts, the philanthropy arm of one of India's most iconic companies, the Tata Group, and Google[10]. The aim of the initiative is to address the digital divide in rural India by introducing a digital literacy programme to augment the capacity of women who have been without Internet access to date. This campaign is based on a 'train the trainer' model, wherein the Internet Saathis (i.e. already computer-literate women), recruit women from villages for training on using the Internet, with data-enabled devices.

This initial movement to assist women in villages to access the Internet soon became an enterprising platform to channel passion for positive change, resulting in the creation of new digital-based business models that enhanced women's livelihood opportunities. Here, a traditional training component, combined with technology and an intent to drive positive impact on livelihoods, has attracted not only cross-sectoral partners, but also built an impressive foundation for further augmenting human capacity amongst rural women.

As an example, Saathi women from Karandi village in Pune, Maharashtra were faced with the inability to satisfy demand for their home-prepared food products (Bathija, 2018). Equipped with the necessary skills obtained through the Internet Saathi programme, delivered at scale through a combination of traditional and online training, the women searched the Internet to find automatic food-preparation machines. Once these were purchased and installed in their kitchens, they began to utilize their now freed-up time, to seek online maternal and neonatal health care guidance, as well as searching for new recipes to enhance their catering businesses. The Internet Saathi programme, designed to augment – through Internet technologies – women's entrepreneurial capacity while being full-time mothers, not only changed health-seeking behaviour amongst participating women, but also enhanced their ability to expand opportunities for their home and community-based business which in turn helped develop sustainable livelihoods.

This momentum led to the creation of Foundation for Rural Entrepreneurship Development (FREND), which identifies opportunities to leverage the power of Internet technologies to augment the capacities of women across India, through the Saathi network. Today, 13.5 million women from 130 000 Indian villages have been trained to use the Internet by over 36 000 trained Internet Saathis, with many becoming and having the potential to become social entrepreneurs running their own Internet-enabled businesses[11].

Inhibitors and enablers

Partnerships that bring human and technological capacity together for social impact require enabling conditions that foster collaboration among governments, the social sector, technology innovators and private sector to ensure that the resulting social impacts are scalable.

In their book, 'Winning sustainability strategies', Benoit Leleux and Jan van der Kaaij explain that an appropriate collaboration model between companies and external stakeholders is a pre-requisite for achieving the ambitious SDGs (Leleux & van der Kaaij, 2019).

In fact, at the macro level, government bodies play an important role in creating enabling conditions. For example, the NITI Aayog, India's key policy and planning agency has proposed the creation of a National AI Marketplace in its National Strategy for Artificial Intelligence[12]. It entails a three-pronged, formal marketplace focusing on data collection, aggregation, data annotation and deployment. In this national strategy paper, the Niti Aayog recognizes the important role of technology in the national development agenda in that *'Human capabilities are augmented by the ability to learn from experience and keep adapting over time'* (NITI Aayog, 2018). This sends the right signals to not only domestic players, but also to international donors, NGOs, investors and the private sector players, who wish to collaborate on tech-enabled initiatives to drive social change. Other governments around the world are also in the process of creating similar collaborative (and ethical) frameworks for emerging technologies, recognizing their role in driving social change and associated impacts (Future of Life Institute, n.d.).

We believe that partnerships, such as the one we have described with Internet Saathi, have scaled mainly because technology and the private sector have been the key *and* lead champions, leading the social impact sector and local governments into areas where they would have been uncomfortable to initiate and lead themselves. This is important in the context of the widespread belief in international development, that the social impact sector (including NGOs, international organizations etc.), remains the main catalyst for scale impacts through partnership initiatives that are led and initiated by NGOs and international organizations and in which others, such as innovators and private sector companies participate.

We foresee the private sector, together with entrepreneurial innovators, taking the lead in many innovative opportunities in social impact, rushing to fill the space that has either been vacated by the social impact sector, or taking the initiative in those spaces in which the social impact sector has been unable to move fast enough.

Often donor restrictions, internal policies, organizational risk aversion and a lack of understanding of new technologies within social impact organizations, are the real inhibiting factors to scaling technologies that have otherwise scaled elsewhere with successful outcomes.

Monitoring and evaluation (M&E) reporting, results-based frameworks and log frames, which are the mainstay of many donor-related initiatives to measure impacts of donor-funded programmes, are unable to keep pace or remain relevant to measuring impacts obtained through technological interventions. From personal observation, most social impact organization have at least one instance of a promising new technology that, when included within the context of internal organizational initiatives of a development organization, failed to meet the promised potential, while remaining successful elsewhere outside that context.

In the coming decade, armed with more agility, resources and an increasing sense of purpose with respect to their role in society, private sector (including innovative finance) and entrepreneurial innovators will lead, and the traditional social impact sector will likely follow. The latter will often be more effectively and increasingly deployed as a risk-mitigating, guarantee layer or as a market shaper where markets fail. This is simply the reality of the new world where technology and entrepreneurial initiative can move faster and wider than social impact organizations.

Conclusion

In the context of transitioning to an era of capacity augmentation in social impact, we leave the reader with five key insights from examining the partnership between human and technological capabilities for driving social impact:

- Human and computing capacity can be deployed in partnership for driving social impact. Technological advancement will not occur at the expense of human capacity, but will help augment human capacity, requiring far-reaching changes to programmatic design, change management and digital transformation across the social sector.
- An enabling framework is key to ensuring effective and sustainable collaboration between social sector, governments, private sector and entrepreneurs.
- SDGs cannot be achieved in the time that has been set until fundamentally the scale economies and efficiencies of humans working in partnership with technologies is embedded in programme design. Moore's law – and the cost efficiencies and scale imperatives it implies – will elude the social sector, in the absence of leveraging programmatically, organizationally and at scale.
- We are moving into an era when investors, entrepreneurs and the private sector are assuming leadership positions in driving social impact, with social sector organizations more inhibited by internal operational, risk attitudinal and skill constraints. However, the latter will continue to serve as important

technical experts, risk mitigators and market shapers, in a space increasingly crowded by these other sectors at the forefront.

- The means to evaluate social impacts, the use of M&E frameworks, log frames and other traditional development evaluation frameworks must evolve rapidly to leverage the non-linear and disruptive nature of technology-driven outcomes.

Capacity building conceived in the traditional sense, locks us into a paradigm that focuses on the linearity of human capacity and fails to appreciate the non-linear, leapfrogging potential of the expansion of human capacity, which is the central tenet of capacity augmentation.

Furthermore, capacity augmentation or the idea of augmented intelligence should be a fundamental inclusion in capacity building in the context of reaching SDGs. With the advent of new technologies, not only digital business models but also economic models are being disrupted. In turn, the way in which individuals, firms, governments and non-profit organizations, engage in society is also changing. This includes the opportunity for innovative financing and partnerships across the public, private and entrepreneurial sectors facilitated by the application of augmentation technology to support social impacts in such areas as health, environment, education and crisis response.

The cases highlighted in this paper point to a trend over the next decade, in which social impact will undergo a radical transformation towards more agile, non-linear, sustainable and cost-effective capacity augmentation models. These will enable partnerships between computing capacity and human capacity, together working in a more embedded and organic manner, programmatically and organizationally and at scale, leveraging Moore's law economics.

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Rethinking capacity building in the digital era: The African context

By Ikechukwu Adinde

Introduction

Over the years, Africa has been perceived as a continent with a huge deficit of capacity to drive critical sectors of its economy, leapfrog its development and join the league of developed nations. From the informal to the formal sectors of the economy, there is evidently a pervasive deficiency of capacity to leverage the vast opportunities in natural and human resources that abound in the continent.

Relying mainly on a qualitative and normative framework, this paper discusses capacity building in the context of what is appropriate for the African continent in a changing global environment marked by rapid change in knowledge, skills and digital technology. It presents a case for a fundamental shift in the conception, design and delivery of capacity building in the digital age, citing the pervasive impact of digitization and technological transformation across countries, sectors and industries. The paper underscores the importance of leadership and attitudinal change in the process.

Amidst the growing conversations about the unequivocal importance of an active youth population, particularly in Africa, this paper considers how capacity-building strategies can be driven by the younger generation. It identifies impediments to youth participation and offers practical solutions for engaging, encouraging and empowering youth in an attempt to improve capacity building and the digitization of the continent.

The word 'capacity' signifies the knowledge, skills, relationships, values and attitudes that allow individuals, groups, countries and organizations to carry out functions to achieve set development objectives and goals over time (Mwawasi, 2014). Against this backdrop, Mwawasi (2014) stated that capacity building emphasizes the importance of strengthening the capacity of individuals and institutions by updating their knowledge and adapting to change to achieve efficient outcomes.

According to the European Parliament (2017), the term 'capacity building' became popular in the 1970s in the United States, when improvements were required in the capacity of state and local government authorities to implement fiscal decentralization policies. Since then, capacity building has been adopted as a core concept in many emerging economies today and has become a core element of policies across different sectors. Although capacity building is still a commonly used expression, a new term 'capacity development' is now preferred in academic and scholarly articles. While 'capacity building' refers to the creation of something new from scratch, based on a pre-imposed design, 'capacity development' encompasses a method that aims to expand on existing skills, knowledge and expertise to create a flexible and dynamic environment where learning is always possible (European Parliament, 2017).

What does digitization and technological transformation mean for Africa?

According to a report by the World Bank (2005), the digital age is altering how we do things – socially, economically and politically. The increased pace of globalization and technological advancement is expanding the divide between Africa and other regions, making capacity building a critical agenda on the continent. The key drivers of digital transformation such as artificial intelligence (AI), big data and the Internet of Things (IoT) are becoming increasingly relevant as foundations in the development of a modern economy. They are also seen to potentially disrupt many sectors – particularly service and manufacturing. More specifically, the refrain – soon a robot or a machine is likely to take your job – has become a common cliché. This indicates that machines are now doing more jobs, therefore people have to quickly learn new skills to do different jobs. This rapid shift in skills in the digital era suggests that individuals, organizations and countries should be active in updating their population with the accurate knowledge needed to survive and thrive in the digital economy. This is where capacity building becomes crucial.

Research has been undertaken by the World Economic Forum (2018) to create a snapshot of changed jobs and skills in the digital era. Some of the findings include:

- 58 per cent of tasks will be performed by humans and 42 per cent by machines by 2025;
- organizations will recruit employees with specialized knowledge and experience by 2022;
- 50 per cent of companies believe that automation will lower their full-time workforce by 2022;
- statistics show that by 2020, 85 to 90 per cent of jobs will require ICT skills, Commission on Science and Technology for Development (2018).

These findings highlight the need for rethinking how we view jobs and skills to ensure that the entirety of the population is not left behind.

Ndung'u (2018) claims that digitization is transforming African economies via four key avenues, namely: retail payments systems, financial inclusion, sustainable business models and revenue administration.

On digitization and retail payments system, Ndung'u (2018) notes that many African economies are saving billions of dollars annually by utilizing electronic payment systems and centralizing those payments e.g. via e-commerce, e-health, mobile banking and telemarketing. The retail payments infrastructure has thrived under mobile phone-based payments and transactions platforms. On financial inclusion, digitization has enabled easier market access and bridged the gap between lenders and borrowers. Ndung'u states that it has eradicated the obstacles to financial access and enhanced savings and investment opportunities across the continent. On sustainable business models, he postulates that the digital platform, particularly in the energy and agricultural sectors, has improved productivity and consumer satisfaction. Finally, on revenue administration, Ndung'u also believes that digitization has improved service delivery and promoted a more efficient method of revenue administration. He cites Kenya's e-citizen digital platform as an example. The digital platform has greatly reduced bureaucratic complexities and improved citizens' access to government services.

Africa is, of course, nowhere near its full potential, but it is moving in the right direction and could experience rapid development in the digital world if policies, projects and agendas continue to be implemented consistently and efficiently. Several countries are already making headway. According to the 2017 Global Innovation Index, several African countries have been classified as "innovation achievers" in the continent, including Kenya, Mozambique, Malawi, Rwanda, Uganda and Senegal (Dutta, Lanvin & Wunsch-Vincent, 2017).

Many African nations are aware of, and in fact benefitting from, global advancements in technology. However, many of these nations are not operating at full capacity due to various impediments, including:

- **Inadequate infrastructure (e.g. electricity and broadband)**: This is perhaps one of the most crucial factors preventing many African countries from experiencing the full benefits of digitization and technological advancement. The lack of stable electricity and poor telecommunications infrastructure limits access and incurs high costs for consumers. To put this into context, consider a start-up tech company which intends to digitize its business and empower its employees with information and communication technology (ICT) skills to increase productivity and efficiency. It must consider additional costs such as petrol costs to power the facility, the cost of broadband and the cost of training and purchasing necessary equipment. All of these factors discourage capacity building and technological advancement on the continent. Research also suggests that a major constraint to technological advancement in Eastern Africa is the availability of affordable and sustainable ICT infrastructure, suggesting that existing infrastructure is neither sufficient nor capable of delivering efficient outcomes in the technological sector (World Bank, n.d.).
- **Shortage of ICT Infrastructure (hardware, software) and skills:** The demand for ICT learning has been remarkable, yet the number

of experts in the field available to offer training is incredibly low, causing a discrepancy between demand and supply. The deficit in digital literacy limits ICT adoption and innovation at an individual and commercial level. Many African governments have failed to prioritize ICT innovation and training as part of their budgetary allocations because of sheer ignorance or the lack of financial resources. Furthermore, expanding on the previous point, ICT infrastructure and learning tools are relatively expensive. In particular, computers are expensive and despite the noble efforts made by the government agencies, non-governmental organizations (NGOs), private organizations and individuals to donate some of these facilities or equipment to where they are needed the most, the difference is marginal.

- **Insufficient data:** The lack of reliable and accurate data and statistics makes it difficult for governments to make data-driven policies that promote innovative technological practices.

Other factors include weak public-private partnerships, weak institutions and limited financial resources.

Approaches to improve capacity building in Africa

Reach the youth

It is common knowledge that the population of Africa is growing at a rapid pace – studies show that by 2050 the continent will be enlarged by an additional 1.3 billion people[1]. Furthermore, around 11 million young Africans are expected to join the labour market annually in the next decade. These data immediately indicate that young people should be the targeted demographic when efforts are underway to improve capacity building in the digital era (Raja & Ampah, 2016).

Technology, especially ICT, has played a major role in the growing visibility, success and accomplishments of youths globally. They are being recognized for their innovativeness, creativity and talent. ICT has enabled them to mobilize, collaborate and amplify their voice. From the increasing usage of social media sites such as Facebook, Twitter and Instagram, youths are more connected than ever before.

Identification of the target demographic is only a small portion of the task. The next and perhaps the most important question is how to actually improve capacity building to ensure optimum results. The agility and eagerness of the youth population also implies a high level of impatience and lower tolerance for traditional methods of learning.

This is a signal that African nations must alter how they present information to young people in the digital age. The very first step is to increase awareness. Young people need to know about the value and benefits associated with the possession of digital skills and knowledge. Secondly, African governments must alter the way they engage with youth. Television advertisements and billboard campaigns have less impact than previously. As most youths are fixated on their mobile devices, disseminating information and promoting agendas through this avenue might prove to be more effective. Thirdly, African governments need to modify existing learning systems. For instance, they should consider adopting e-learning tools and webinars, which have become very popular in the last decade with their ease of access and flexibility. These new methods are not only trouble-free, but they are also engaging, intellectually stimulating and highly collaborative. They directly address the issue of impatience and lack of interest amongst the youth population.

However, there are some policy implications that should be considered. One is the issue of brain drain. According to the World Economic Outlook, brain drain is a looming concern in Africa. Many talented young people are leaving their respective countries in search for better opportunities abroad (International Monetary Fund, 2016). Many governments might be deterred from investing in their youth because of the fear that they might leave and so yield no returns from their investment. In addition, the costs of financing these innovative methodologies are high. Consequently, the government might have to reduce budgetary allocations for key sectors to allow for the expense of the new initiatives, and this may be unpopular for the masses. Finally, there is also a time lag between the acquisition of these skills and visible implementation and impact in the economy.

The following section will expand on specific strategies that can be implemented to engage, encourage and empower youths in the ICT and digital innovations sphere.

Reduce brain drain

The incidence of brain drain in Africa is real and potent. While it has existed before now, in the recent years, statistics indicate that it has assumed a worrisome dimension that threatens Africa's very existence. The migration of skilled workforce from African countries to Europe and America is prompted mainly by the search for better economic opportunities by young people due to unsavoury economic conditions in many African nations. Ironically, the phenomenon not only depletes Africa's scarce skilled human resource, but affects the most critical sectors, especially health and information and communications technology.

Indeed, brain drain is a salient issue across many sectors in Africa and it has had a negative spill over effect on productivity and public service delivery in many nations. According to the African Union (2018) around 70,000 skilled professionals emigrate from Africa annually. While Africa has the youngest youth population in the world, it is only able to create around 3 million jobs each year. This deficit in employment opportunities and the attraction of better pay has forced many young Africans to go in search of greener pastures in Europe and America (Firsing, 2016). The solution to this issue is simple; create jobs. African governments need to prioritise the creation of productive jobs for members of society. Not only would this catalyse growth and curb a number of societal ills, it will also ensure that countries reap the dividends of their investments, particularly in the ICT sphere.

Invest in digital infrastructure

The digital capacity of countries is only as effective as its digital infrastructure. It will be an impossible task to accomplish capacity building in Africa if the structures and infrastructures required to facilitate learning are absent (Commission on Science and Technology for Development (2018). Whilst human capital is important, Africa needs to invest heavily in its digital infrastructure.

For instance, broadband connectivity in many African nations, when available, tends to be relatively slow, unreliable and expensive, restricting the ability of individuals and businesses to use it productively and effectively. Some countries, such as Rwanda, Botswana, South Africa and Nigeria, are implementing ambitious broadband plans to increase Internet penetration rapidly both within the metropolitan cities and the rural communities. Such projects will enhance accessibility, affordability and availability of connectivity services, which will foster faster youth inclusion in the digital space.

Related to the Internet infrastructure is the power supply challenge, which is a dominant feature of most African economies. Even with robust broadband Internet access, the absence of power on the grid systems across Africa means that little can be achieved on a sustainable basis. There is also the major issue of multiple stakeholders being involved, which could potentially slow down implementation and create unnecessary complexity. Other possible challenges include multiple taxes and associated costs and the lack of adequate security to prevent theft and vandalism.

Create innovation hubs

African governments are encouraged to kick start initiatives and programmes that attract youth in the digital economy. In addition to modern methods, including training from experts, webinars and conferences, e-learning, social media and community activities that facilitate the exchange of ideas, the notion of innovation hubs should be explored. The use of innovation hubs is an engaging approach not only to boost skill acquisition, but to promote innovation and creativity in a dynamic and challenging community. By creating a conducive and inclusive ecosystem where they can interact and network, young people are more likely to come together to drive the innovation that is needed in the digital era. Although some initiatives have already been implemented in certain countries, such as Kenya, Nigeria and Rwanda, to improve the ecosystem for start-ups and accelerate innovation, there is still vast room for improvement.

One of the challenges of this strategy is the lack of sufficient expertise within the continent to drive the implementation of these hubs. As established in previous sections, there is a paucity of ICT and digital skills in the continent and this may hamper the successful execution of this strategy. Another potential issue to consider is that of continuity and sustainability. One salient feature of many African governments is their inability to sustain projects, either due to lack of resources and/or political will, and this may compromise the effective running of existing innovation hubs.

Prioritize STEM subjects in educational institutions

The traditional academic curriculum adopted by many institutions (primary, secondary and tertiary) is outdated and does not offer the skills and knowledge required to succeed in the globalized world.

A study implemented by several African organizations, to gain an understanding of the current ICT skills of teachers in schools, concluded that a profound number of teachers struggled to implement teaching techniques that make the best use of ICT (United Nations Educational, Scientific and Cultural Organization, 2015). As a result, there was a noticeable disconnect between ICT advancements and their incorporation into teaching in school settings.

A reform of curricula and the introduction of courses in entrepreneurship and digital technology would be advantageous for individuals and society in general. Teachers are an important part of the capacity building equation. Adequate training also should be provided to teachers across all levels to advance their competencies in areas such as digital skills, entrepreneurship and computational thinking (United Nations Education, Scientific and Cultural Organisation, 2015).

A possible limitation of this strategy is the negative attitudes held by many towards science, technology, engineering and mathematics (STEM) subjects. According to a research by IET (2008), these subjects are perceived as difficult by many young people, owing to the mathematical element in many of the courses. Another pertinent issue is the lack of infrastructure to execute fully all the elements of taught programmes and to encourage a hands-on learning approach. Presenting only theories in relation to technology and innovation with no opportunity for practical experience might render the goal of capacity building futile.

Bridge the data gap

According to The Economist[2], "data is the new oil". The emergence of smartphones and the Internet have made data a hot property. Africa has a poor history of measuring, collecting and storing data, and even when this is accomplished, the figures tend to be understated or exaggerated for reasons beyond the scope of this paper (African Capacity Building Foundation, 2017). The lack of data and trustworthy statistics have hindered the continent's ability to make evidence-based decisions in the policy sphere. For instance, the nature and type of digital skills most required in Africa is often determined more by rule of thumb than actual empirical findings. This means that the design of capacity building does not reflect core industry or market needs justified by data. In order to fully reap the benefits of the digital era, African governments ought to make an active effort to keep up-to-date and accurate records that reflect the state of their society, and then channel this data towards improving the lives of its populace.

A challenge for this intervention is the negative attitude towards data collection in the continent, particularly by the less informed members of society. Many are not always comfortable disclosing certain information about their personal lives to the government. The fragility of trust between society and the government may exacerbate the difficulty of this already arduous task.

The problem of entitlement

The narrative of Africa as a place where development struggles is perhaps also rooted in the value and philosophy underlying capacity building. For the most part, policy-makers, decision makers and managers in public and private institutions tend to perceive training as an entitlement rather than an opportunity to improve skills and enhance productivity. An organizational culture in which people view training not as an engagement for intellectual development, but rather as an opportunity to pursue personal objectives such as family holidays, shopping and tourism, patently defeats the fundamental objective. There is a widespread belief that because of this practice, in most cases, despite the huge investments in training, little improvements are recorded in terms of the impact on individual and organizational performance.

A hindrance that might arise for this intervention is a lack of political will caused by vested interests. The majority of policy makers who are recipients of the monetary benefits from these frequent seminars and trainings may not always be in favour of any attempt to eliminate these allowances.

Conclusion

Overall, the findings from this paper underline the significance of prioritizing capacity building in Africa and ensuring that African nations are making results-driven and evidence-based decisions to achieve the objective of digital transformation.

Science, technology and innovation have become vital in raising domestic and regional competitiveness and productivity across key sectors. Moreover, they are an essential element for tackling poverty, driving growth and achieving sustainable development. The continent needs to adopt an innovative approach that focuses on skill development to ensure that spill-over benefits of the digital era are experienced across all regions. This means that Africa must become an active creator and not just a passive consumer of technology.

The following recommendations should be prioritized in driving efforts to digitize Africa and improve capacity building within the continent:

- **Lower the cost of access to digital services:** African governments are advised to tackle the direct cost of accessing mobile and Internet services by improving the regulatory and competitive frameworks for existing operators, and providing a friendly environment to encourage new entrants. They should also prioritize investments in digital infrastructure, particularly in regions where the youth are active.
- **Foster government-private sector engagement and collaboration:** The government and private sector are the two instrumental players in the success of an economy, and this also applies in relation to capacity building. By opening a channel of communication, they can establish approaches for achieving the goal of capacity building and the roles they will play in facilitating successful outcomes. For instance, together they can create and manage digital infrastructure projects where the private sector focuses on implementation and the government supervises and ensures transparency and accountability.
- **Expand digital and ICT skills:** The case for African countries to keep investing in education is now stronger than ever. To fulfil the mandate of capacity building, it is important that the right people possess the right skills. Human capital is a challenge for many African countries, not because of the lack of it, but simply because a vast number of people have not been empowered and equipped with the necessary tools and knowledge to drive productivity and ultimately growth. Strategies to ensure skill acquisition should include: supporting primary and secondary schools, especially those in the rural areas; revamping the curriculum of tertiary institutions to mirror the needs of the global environment; and supporting the development of technical skills by teaming up with the private sector.
- **From brain drain to brain gain**: Africa is blessed with an abundance of talents in many fields, not the least is ICT. However, many of those with core digital skills are forced to leave the continent for Europe and America in search of better opportunities and conditions of work. For Africa to realize her ambition for development in the so-called fourth industrial revolution, African governments must seek to create the necessary incentives to lure her elite in diaspora home to lead and support initiatives for the digital transformation of the economy.

  Recently, a lot of accomplished graduates have been returning home in search of opportunities. One of the reasons for this shift is the ubiquitous perception that many African countries are still operating below their potential; therefore, there is room for exponential growth if the right investments are made over time. Also, with more stringent immigration policies in America and the dilemma of brexit, a great uncertainty looms over career prospects for those in the diaspora (Cox, 2017). Against this backdrop, there is a need for governments to take advantage of this narrative and install structures that attract young Africans in the diaspora back home. Nwoye (2017) claimed that professional career services such as Talent2Afirca have been instrumental in connecting talented Africans abroad with great opportunities in

Africa. Based on this, governments are advised to strengthen such organizations and widen their reach. Finally, to tackle the issue at the grassroots level, respective governments should invest heavily in higher education and raise their academic institutions to the same standards of those in the West; by doing this, the number of youths who intend to leave the country to further their studies can be drastically reduced.

- **Create synergy across key sectors:** There is a need to strengthen relationships between academic institutions, government, the private sector and the labour market. This is crucial to ensure sustainability of projects and policies and also to create employment opportunities for those who have acquired the necessary skills and expertise. The coordination of all these different actors and bodies will foster an evidence-based approach towards capacity building and ensure that the skills being imparted align with the skills demanded by the job market. This will also create a cycle where education and training push innovation and investment.
- **Promote inclusivity in the ICT sphere:** African governments also must accelerate their efforts towards bridging the gender gap in the ICT sector. This could be achieved by developing programmes that promote female participation across all levels. There is also a need for an attitudinal change; STEM related subjects are not limited to males only. More females should be encouraged to pursue science and technology-related programmes and should be given the support they need to emerge successfully. Finally, governments should also tailor programmes and policies for people with special needs and other vulnerable groups to ensure that no one is excluded.

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Addressing the challenges of teaching the Internet of Things

By Anna Förster

Introduction

The Internet of Things (IoT) has become one of the fastest growing fields and is predicted to grow further in an unprecedented manner. Consequently, an increasing number of jobs require expertise in this field. While a promising new programme currently under development is the training programme on IoT by the ITU Academy, very few academic institutions are offering targeted degrees in the field of IoT. This paper explores the academic background required for future IoT experts and the specific challenges to be solved when designing IoT curricula.

IoT is not a stand-alone technology, scientific discipline or paradigm. Rather, it is a combination of existing and well-established fields, including but not limited to communication networks, embedded programming, artificial intelligence and computer security. One of the main challenges when designing a curriculum is to combine these fields into a meaningful programme, which is naturally limited in time and depth. Each of these topics can be easily developed into a full-fledged programme itself. The second challenge is to bring these rather isolated fields together and to explore and teach their interactions. Third but not last, students need to obtain practical experience with all these fields.

Apart from the technical curriculum, students need to obtain some important "soft skills". They also need to be able to follow the extremely fast pace of their field, where hardware and software changes on a daily basis. In other words, what students have learnt during their studies will surely be outdated by the time of their graduation.

These challenges can only be addressed with a combination of modern teaching methods, moving away from lecturing towards intensive self-study and group work with multimedia and software tool support. Peer instruction, online video tutorials and group projects with real hardware are promising options, which have already shown their potential. These methods are also better suited to meeting the fast-changing nature of the field itself and for training students how and where to obtain new information and expertise.

These three dimensions – technical content, soft skills and teaching paradigms build the basis of a successful IoT curriculum. The details of these dimensions are explained in the next sections.

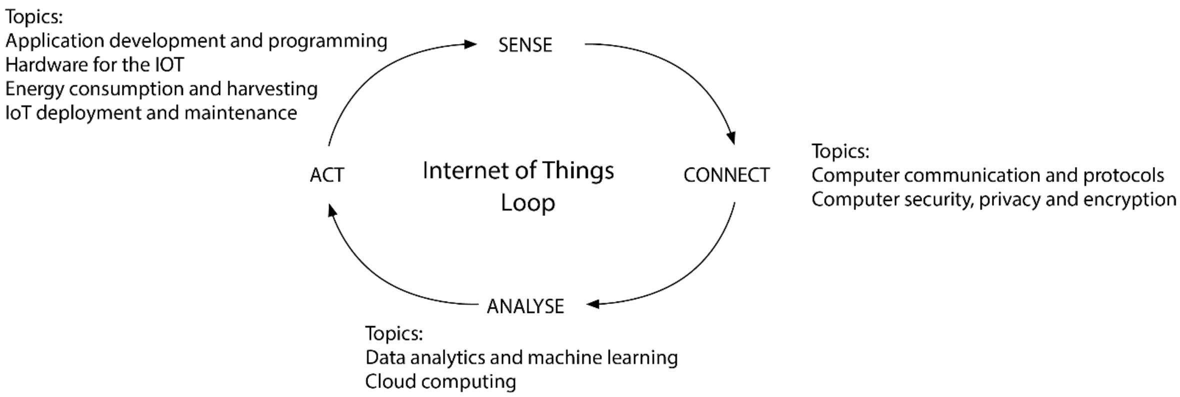
Technical content

IoT is a relatively new term, apparently first used by Kevin Ashton from Procter & Gamble in 1999. The idea of connecting things to the Internet directly is as old as 1982, when a Coke vending machine was connected at Carnegie Mellon University to report its stock directly over the Internet.

IoT is not really a scientific area. It is rather a business or application domain, combining recent innovations in communication, machine learning, data analytics and embedded computing. These areas have enabled new application areas, where computation can be performed on small devices, which communicate directly to each other without the intervention of people. Most of the applications reside in the area of automation: from automatic field irrigation to autonomous factories.

Some other fields are closely related to IoT. Wireless sensor networks (WSNs) have been a very active research area in the last two decades. WSNs focus on organizing autonomous networks of connected devices, whether connected or not to the global Internet. This area has produced some very innovative energy-saving mechanisms, most prominently the so called "duty cycling" (Polastre & Culler, 2004), of devices and all its implications for sensing, acting and communication. Cyber-

Figure 5.1: The main IoT loop



Source: Author's own 2019, unpublished

physical systems (CPS) have focused more on integration of systems and their pervasive nature. Mobile ad hoc networks (MANET) have paved the way for flexible, mobile communication protocols, while mesh networks have explored in detail how to extend the Internet into areas with no traditional infrastructure coverage.

Some universities have been offering courses on WSN, CPS, MANET or IoT for many years. However, full degrees are still very rare. The University of Bremen offers a course on IoT as part of several Master's degree programmes in communication and information technologies. The technical content of the IoT course is described in detail in Förster et al (2017). Here instead, the focus is on which technical concepts need to be covered for a successful degree in IoT.

General introduction and application scenarios

Before discussing the technical details of IoT and its enabling technologies, an overview is needed to set the context for the topic. This includes a general overview of application scenarios for IoT, their requirements and challenges. Furthermore, the main IoT loop should be introduced (see Figure 5.1). This helps the students to understand why and where the other technical content is needed. In terms of application scenarios, there should be a focus on the variety of application scenarios and their heterogeneous properties. Several applications may be discussed in detail.

Computer communications and protocols

One of the main challenges in IoT is how to exchange data and control information between the individual devices. Usually, this communication is wireless and a variety of communication protocols exist. It is important to cover:

- wireless communication basics, such as radio propagation, interference, path loss, hidden terminal and exposed terminal problems (Förster, 2016);
- duty cycling principles and medium access protocols (Förster, 2016);
- main wireless standards and technologies, currently IEEE 802 Family, Zigbee, Bluetooth, RFID, LoRa and SigFox; some industrial standards, for example ISA100 and WirelessHART;
- routing and clustering approaches, mainly from the area of wireless sensor networks, such as low power wireless bus and collection tree protocol.

These topics need to be taught in a practical and hands-on manner, preferably as laboratories or small projects. The second group of topics (protocols) is rather boring, but crucial for the capacity building of the students. Good teaching methods here are again lab exercises or poster sessions.

Computer security and encryption

Security and encryption are vital for the development of IoT. Its wireless and pervasive nature, its many heterogeneous stakeholders and the role it plays in applications predestine the IoT as a target for misuse and attacks. Three main topics need to be covered and their social, financial and political implications discussed: data privacy, encryption and IoT security.

Data privacy encompasses where the data resides, which risks arise from the physical storage of private data and how to protect data from misuse. One crucial topic is how to give the user full control of her data, without limiting offered services. The current law and regulations around the world also need to be discussed.

Encryption is one the main solutions to protecting private information. Basic mathematical foundations as well as the implementation of encryption in communication standards need to be covered.

IoT security, on the other hand, needs to cover topics such as security attacks on IoT systems. Such attacks could also target private data, but more importantly they usually attempt to corrupt the normal operation of the system, for example by overloading it, or by inserting false sensor data. Different types of attacks and state of the art solutions need to be discussed.

Application development and programming

Application development for IoT is a gift and curse at the same time. On one hand, it is really easy and accessible, even for non-expert programmers. Children nowadays have their first programming experiences in primary schools with Arduino programming (García-Peñalvo *et al.*, 2016). On the other hand, when large systems need to be developed, such as factory automation or smart city applications, the complexity grows exponentially. Application development for IoT includes mastering heterogeneous hardware and software platforms and connecting them with each other (which is rarely trivial). This paper recommends the use of the Arduino platform and its various hardware and software components.[1] Teaching should again be hands-on and based on laboratories and practical exercises in the beginning, growing into full-fledged projects (Förster et al, 2017).

An advanced course in application development should also cover graphical user interfaces for mobile devices and usage of standard cloud services. Security and encryption issues arise here again and should be discussed and practised.

Hardware for the IoT

The Arduino platform we recommend is in fact a hardware prototyping platform with a corresponding programming environment. The main idea of Arduino is to be able to combine different hardware components, such as sensors, actuators and communication modules, into a prototype to program and test. Connecting these components to each other requires some basic knowledge in electronics and computer architecture. Arduino is open-source and parts are available from numerous manufacturers, but everybody can also self-design Arduino-compatible hardware.

Energy consumption and harvesting

Energy is the most important resource for IoT. Many applications require battery-driven deployments either because wall power is not available at the deployment site (e.g. agricultural applications), or because wall power presents a security risk (e.g. surveillance applications). Even if wall power is available, the sheer scale of many IoT applications (e.g. factory monitoring and control), necessitates imposition of financial limits on energy consumption.

Two main topics need to be covered here: How to save energy by hardware and software design and how to harvest energy in a sustainable way. Energy saving mechanisms always require optimization both at the hardware and software levels, e.g. the well-known duty cycling mechanism of wireless sensor networks (Polastre & Culler, 2004). They span all design and implementation layers, starting from eliminating all non-vital hardware components and going up the software stack to the application layer. Examples from the real world need to be studied, such as the design of an underground wireless sensor node in Zaman *et al.* (2016).

Energy harvesting needs to cover typical technologies such as solar panels, vibration and piezoelectricity, human power, wind/air, thermoelectricity, and micro-fuel cells. Students also need to be trained in energy consumption and battery models in order to be able to compute expected lifetime and energy consumption of IoT deployments.

IoT deployment and maintenance

Another important aspect is how to plan, deploy and maintain an IoT system. Problems include energy availability, first-time and ongoing configurations of the components, error tracking, hardware and software updates. Cost calculation is important, with separate estimates of investment costs and maintenance costs. Real-world examples (e.g. from local industry), need to be studied and projects need to be conducted by the students, since this topic cannot be easily taught in lectures.

Data analytics and machine learning

What comes out of an IoT system is large amounts of sensor data, which need to be processed, analysed and converted into decisions and actions. The data analysis stages are:

- Gathering the data and transmitting it to a central place (as covered in the section of this paper titled computer communications and protocols).
- Analysing and representing the data. While theoretical basics need to be addressed (e.g. statistics, data representation, graphing), practical experience with large and noisy data sets is also required. Even if data analysis software exists, for teaching purposes it is better to use a programming language and self-made solutions. Currently, Python is a very popular data analysis language, with many different analysis and graphing libraries, such as NumPy.[2]
- High level analysis and decision making. This step is very challenging and can potentially fill a graduate programme itself. Here, we propose to cover some basics in stochastic decision making and machine learning. A good framework for machine learning is TensorFlow.[3]

Cloud computing

Cloud computing has become one of the most influential and game-changing concepts in the last decade. Even if discussions are ongoing as to whether third-party hosted cloud services are a secure solution for all customers, system architectures will never become the same again.

Even if this topic is too large to be fully covered in an IoT Master's programme, basics need to be addressed and some practical experience with existing systems and their application programming interfaces (APIs) need to be gathered. Security and privacy issues are a very important aspect of this topic and should be covered in an open discussion and joint analysis.

Soft skills

We refer to soft skills as all skills, which are not purely technical. Typical examples are presentation skills, general computer literacy or time management. Soft skills become more and more important, but are rarely targeted in academic curricula. Different technical fields often require the same soft skills, even if some soft skills are more or less important for the different technical fields.

The most important soft skills for future IoT experts include:

- ability to find information about new products, technologies and paradigms, without external help;
- ability to grasp new technologies and paradigms quickly and compare them to existing ones; abstraction from details;
- ability to see and understand interconnections between different technologies and paradigms;
- ability to lead large development projects.

Why are these skills needed? Imagine the following situation: The IoT engineer of a large factory hears about a new communication technology, which is cheaper to install than the existing one, which in any event is in need of replacement. First, details must be gathered about this technology, preferably not only from the provider/producer. Does anybody already have experience with it? Is it not promising too much? What are the implications of installing it on all other existing and future components? This information is hard to obtain – professional networking, and travel to some international fairs and conferences may be required. Once this information is finally available, the impact of the new technology on the factory's system needs to be evaluated – how does it influence the security protocols installed? Does it support the five-year plan of the company to install new machines and start new product lines?

Even if such questions are everyday challenges for IoT experts around the world, they are not taught in the respective engineering curricula. However, the market is nowadays exploding with new products, technologies, and standards. Due to time and financial restrictions, experience with these new products is missing. In general, these new products are only marginally different from others and differ from each other mostly in the associated support services (e.g. deployment or maintenance support). This makes the decision even more complex, which often boils down to the question: To self-develop or not to self-develop? Self-development offers the potential of fully adjusting the IoT technology to the needs of the company and to be independent from producers and third-party developers. This is especially true in the modern era of open-source hardware and software, most prominently Arduino. However, self-development requires in-house expertise, time and money. Buying complete product lines with service support saves the company the initial investment, but makes it dependent on third parties. Those third parties can be small start-ups themselves, often disappearing from the market after only a few years.

All this is confusing for young experts and even for experienced professionals, who enter the IoT arena. It is also very different from other software and hardware related issues, where in-house development was never an option for smaller companies. What company has ever considered designing its own operating system or database servers? However, with the open-source principles and low investment costs of IoT, this becomes possible. The best way to address this challenge in a curriculum is to run several full-fledged projects, preferably in an internship setting.

Teaching paradigms

The above discussion makes clear another point: We cannot only rely on the traditional lecturing/tutorial/exam system for successfully teaching IoT.

IoT should be taught only at the graduate level, based on solid technical foundations, such as an undergraduate programme on computer science, electrical engineering, computer engineering and similar. The technical content is very broad and in the available time, cannot be covered in depth. This is not necessarily a problem, but surely a challenge for teaching. In the previous sections, the need for teaching complex interconnections between constantly changing technologies has been discussed. However, our own experience at the University of Bremen shows that students cannot follow very well theoretical explanations in such topics – for example, when experts simply share their experiences with them. It always appears clear and trivial. Nevertheless, once they are faced with the problem themselves, they are not able to transfer the lecturing material to their problem. Thus, hands-on experience is crucial and should comprise at least two-thirds of an IoT curriculum.

Which teaching tools and paradigms are most successful? Our experience shows that the answer is not in tool or paradigm X, but in changing the game continuously. Similar to muscle training, where repeating the same exercise has only limited influence on strength development, we have come to the conclusion that offering new tools and paradigms has the most positive effect on learning. The University of Bremen, for example, employs a potpourri of teaching tools in delivering its IoT course, including:

- **Short technical lectures**: Even quite traditional, short lectures covering complex technical matters, still represent an effective teaching method. It is important to enable students to interact with the lecturer. Direct questions and discussions are sometimes possible (depends on the teaching culture), but we have found clicker systems more effective. Nowadays these systems are purely software-based, running in tablets, smartphones and laptops. The lecturer gains important and broad feedback from the students and knows how to proceed, while students from all cultural and technical backgrounds are encouraged and enabled to participate easily.
- **In-class open discussions:** Very often, technical content has important effects on society and personality. For example, data privacy and security are an ongoing debate, especially in the context of pervasive systems like IoT. These topics need to be discussed in class and an open discussion between groups of students is important.
- **In-class assignments and tests** are very favourable to deeper understand subjects.

Longer lectures should be interrupted regularly with exercises, processed and discussed immediately. Again, clicker software is beneficial in allowing all students to respond and for the teacher to access the learning process. Exercises can be individual or in small groups. Tests are very practical in the beginning of classes to "tune in" the students to the topic.

- **Peer review exercises** are slightly different from usual exercises. Students are asked to first individually work on an exercise and submit their results (e.g. through clicker software or any other multiple-choice real-time test system). Without revealing the results, the students are then asked to work in teams on the same problem and to submit their results once more. Both results are shown and discussed.
- **Poster sessions** are very useful for processing and reflecting on scientific publications or technical standards. Rather than lectures with content, the students are given reading exercises, which are summarized and presented in a poster session. The resulting posters can be used very well to show the progress of the class to a broader audience (e.g. other university members or the general public).
- **Lab exercises** are very important for teaching IoT and go beyond normal in-class exercises. Usually, the teachers prepare a hardware/software setup, which enables the students to quickly test and make their own small modifications. Topics include different programming environments and tools, hardware components, and communication protocols.
- **Projects** are well suited for summarizing and combining all new knowledge from longer periods of time (e.g. a full semester course). Conducted in groups, projects also practise team management and presentation skills. The project topics can be designed in a way to produce demonstrations to show to a broader audience (e.g. during university exhibitions and similar).
- **Blended learning**, such as online videos and exercises, is an emerging trend, gaining more and more interest. The approach is extremely useful to address particular challenges, such as time and place flexibility of students. Many students nowadays work part-time and study in full-day programmes. Blended learning minimizes the time required to be spent in school and at the same time maximizes the learning outcome.

The combination of the above paradigms keeps the students agile and flexible and also teaches them to grasp the new "rules" quickly and to adapt – consistent with our soft skills requirements. Every year, we continue to be surprised by our students' genuine enthusiasm when we present the next exercise or task. By the end of the semester, they show a much higher participation rate and willingness to work, discuss and contribute than students from more traditional courses.

Conclusion

IoT has been a very fast developing concept in recent years and is predicted to grow exponentially in the coming years. It offers unique opportunities not only to companies and innovators, but also to individuals, governmental and non-governmental organizations. It will undoubtedly also contribute to the progress of many of the sustainable development goals of the United Nations.

Unfortunately, teaching and training efforts have not been well organized to date. Training programmes have focused mainly on technical content with the goal of quickly entering the playground. This article attempts to contribute to closing this gap by offering some practical solutions and experiences, which may assist in the design of new IoT curricula. Especially soft skills development and a combination of technical background with practical experience are central to a successful training programme in IoT.

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Skills shortages and mismatch in the ICT labour market: Challenges for skill development in India, Indonesia and Thailand[1]

By Nicola Duell

Introduction

Digitization is having a profound impact on economies and societies throughout the world. The labour markets of India, Indonesia and Thailand are expected to be significantly affected by the growth and development of the global information and communication technology (ICT) sector as well as trends in their domestic markets. All three countries are increasingly experiencing shortages of highly-skilled ICT specialists, mainly due to a mismatch between the skills of graduates and job requirements in the ICT labour market.

This paper is structured as follows:

- An overview of the development of the ICT sector and the labour market for ICT specialists and skills mismatch in India, Indonesia and Thailand.
- A brief review of policies and analysis on the capacity of the education sector to address skills mismatch challenges.
- Conclusions, which provide possible policy responses on ways to promote the skills development of ICT specialists.

This paper is derived from research based on an extensive literature review, background reports prepared by national consultants in each country and three week-long research missions to New Delhi, Bangalore, Bangkok and Jakarta. In total, approximately 40 interviews were conducted with representatives from government, training institutions, universities, industry associations, trade unions, recruitment agencies and private companies operating in the ICT sector.

Trends in the ICT labour markets and skills mismatch in study countries

Transformative digital technologies and innovations have resulted in an increasing demand for highly-skilled ICT specialists, both within the ICT sector as well as across other sectors in the digital economy.

Employment of ICT specialists

India's information technology (IT) and IT-enabled services (ITeS) sector emerged in the early 1990s, when US-based companies started to outsource work to India. The IT services sector in India covers a wide range of tasks, including both low value-added and highly specialized tasks. In contrast to Indonesia and Thailand, Indian firms became multinational companies with delivery centres across the globe, including in the US (India Brand Equity Foundation, 2018). These developments were enabled by digitization-driven transformation within the economy. This led to high demand for Internet of things (IoT), big data analytics, cyber security, industrial software and embedded software systems and design, all of which are used by businesses in their production processes and service delivery. In Indonesia, the development of ICT has been linked to e-commerce and other digital services which is increasingly driving demand for ICT specialists[2].

ICT specialists do not fit into an easily defined occupation category. While the research project departed from the definition that the Organization for Economic Co-operation and Development (OECD) and Eurostat have developed, comparable data were not available.[3] In India, the IT business process management sector, defined by the industry association NASSCOM, employs nearly 4

Table 6.1: Employment in the ICT sector in India, Indonesia and Thailand

	Number of persons employed in manufacture of computer, electronic and optical products, telecommunications, computer programming, consultancy subsectors[1]		Number of persons employed in sector J "Information and Communication"[2]		
	2012	2015	2012	2015/16	2018
India	3,102	Not available	3,201	Not available	Not available
Indonesia	588	615	541	575	998
Thailand	532	641	215	231 (2016)	Not available

[1] Source: ILOSTAT, labour force survey (LFS) for Thailand and India, Employment-Unemployment Survey for India, For Thailand data refer to 2013 instead of 2012. Retrieved from International Labour Organization (ILO) website.[8]

[2] Source: ILSOSTAT, Sector J, international standard industrial classification (ISIC) rev 4: The main components of this section are publishing activities (division 58), including software publishing, motion picture and sound recording activities (division 59), radio and TV broadcasting and programming activities (division 60), telecommunications activities (division 61) and information technology activities (division 62) and other information service activities (division 63).

million knowledge workers in 2017.[4] In Indonesia there are about 500 000 ICT professionals and technicians working across all industries.[5] In Thailand, there are about 386 000 ICT specialists,[6] who account for 1 per cent of total employment. These number differ from employment in the ICT sector. Table 6.1 provides an overview of a comparison of workers in ICT fields, from a sectoral perspective , using harmonized data as far as available and other relevant national data sources.[7]

Roughly a third of all employees in the ICT sector in India, Indonesia and Thailand are women. Women in all three countries tend to be at a disadvantage in terms of career progression (see, for example, Babu, 2013). This suggests that the labour force of women is underutilized, and potential supply of female ICT specialists might be higher if the right incentives were in place.

Looking to the future, in the assessment of interviewees in the three countries the net employment effects of digitization are positive, when considering both automation effects and expanding demand. In the case of India, it is estimated a strong increase of high-skilled jobs in IT-Business Processing Outsourcing (BPO). These require creative problem-solving, analytical skills and critical thinking. Nevertheless, there is a risk that automation in the context of digitalization will reduce the demand for intermediate and highly-skilled ICT specialists. Automation potential is considered significant in the area of software development and testing. However, the sector will lose low- and medium skilled jobs (Federation of Indian Chambers of Commerce and Industry, 2016).

Educational level of ICT specialists

The structure of the educational level of ICT specialists varies across the three countries quite significantly.

In India, the broadly defined ICT sector workforce comprises a diverse mix of individuals with varying skill sets. On the one hand, there is a pool of highly-skilled engineers, programmers, designers and network specialists. On the other hand, there is another pool of low- to medium-skilled workers who work in the ITeS and business process outsourcing sectors as data entry operators, clerks and telephone-based sales assistants (Wheebox et al., 2016).

In Indonesia, half of all ICT specialists hold a degree from a senior high school (Sekolah Menengah Atas: SMA), or a vocational secondary high school (SMK). 15 per cent of ICT workers have a lower level of education, while 10 per cent have received a diploma from an upper vocational institution and 23 per cent have a Bachelor's degree from an academic institution. According to the statistical office of Indonesia, in 2018, only 2 per cent of ICT specialists held a Master's degree.

In contrast, in Thailand, two-thirds of ICT specialists held a degree from a higher education institution in 2017. Among all ICT specialists, approximately 24 per cent had completed upper-secondary level or lower and 11 per cent held a post-secondary non-tertiary level qualification. About 56.8 per cent held a Bachelor's degree and 7.4 per cent held a Master's degree. Very few ICT specialists had obtained a Doctorate-level degree[9].

In all three countries, women are underrepresented in science, technology, engineering and mathematics (STEM) study fields, which explains their low shares among ICT specialists. For example in India, in the 2016-2017 academic year, less than 30 per cent of undergraduate students in engineering and computer science were women. In all three countries, women tend to be better represented at the postgraduate level and above, as compared with undergraduate levels or below. Noticeably, among Thai ICT workers, women are in general better educated than men. There is a higher incidence of under-education among men than among women in Thailand, with women tending to be over-educated more often than men[7].

Skills requirements

Increasingly, jobs in advanced ICT fields require transversal skill sets. For example, the recent integration of tech, finance and other related fields is now an essential consideration in the provision of ICT services in banking and financing.

In India, FICCI identified a set of technical skills, soft skills,[10] emotional intelligence and cross-cultural competencies as key skills of the future (FICCI &EY, 2016). Soft skills such as higher order critical thinking and analytical skills are becoming ever more crucial and are in demand by companies. The need for soft skills has also been stressed by interviewees in Indonesia and Thailand.

The skill sets demanded of ICT specialists will undoubtedly expand and/or change as digitization continues. The Employers' Association in Delhi cites the following three skills as being in demand: vanilla skills (e.g. Java developers, server managers), niche skills (e.g. the SAP software for enterprise resource planning,) and super-niche skills (cloud computing, artificial intelligence). NASSCOM, the Indian industry association of the IT business process management sector, in collaboration with the Boston Consulting Group (BCG), identified 55 job roles in eight technology areas that will gain relevance in the immediate future (NASSCOM, 2018). In India, FICCI estimates that 60 to 70 per cent of the current IT workforce will need to be retrained in areas such as biotechnologies, nanotechnologies and smart technologies and advanced analytical skills (FICCI & EY 2016).

Skills gaps and skills shortages

According to employers in all three countries, while there seems to be a sufficient number of graduates with technical vocational education and Bachelor's degrees in ICT, workers appear to lack both technical and soft skills. Workers' representatives in all three countries expressed concern about a lack of access to training and upskilling for specific technical skills.

Interview partners ascertained that in all three countries, there is a shortage of ICT specialists at the level of Master's degrees and above. Further, there is a labour shortage of graduates with specific technical and soft skills required by the ICT industry. In addition, ICT specialists in Indonesia and Thailand often lack adequate English language skills[11].

In 2017, there was an estimated shortage of 45 000 ICT specialists in Thailand, based on the Establishment Survey on the use of ICT (ILO, 2019 forthcoming). In addition to shortages of highly-skilled ICT specialists, Thailand faces shortages of semi-skilled ICT workers who provide support and maintenance for ICT services, including support for networks, servers, software packages and computer equipment. In Indonesia, according to employer association AINAKI, the multimedia industry is one of the sectors facing skills shortages. There are insufficient opportunities in these countries to obtain training in the relevant skills.

Skills development policies, strategies and challenges

Given the rapidly changing skills requirements in the field of ICT as well as the skills gaps identified above, it is crucial that countries develop appropriate skills anticipation strategies. An overview of skills development strategies and policies is given in the following, highlighting key challenges.

Vocational training and higher education schemes

In India, ICT is primarily taught at secondary schools, upper vocational education institutions and in certain areas of the university education system.[12]The higher education, or "tertiary education" system, has both a vocational stream and an academic stream. Thus, advanced vocational education in ICT may be pursued at a university or as part of a technical and vocational education and training (TVET) course at a polytechnic or industrial training institute (ITI). Below the higher education level, ICT courses are taught under the umbrella of vocational studies within secondary school education. In addition to formal ICT education and training, it is possible to obtain an ICT education in the non-formal education system.

A number of elite academic institutions have been established over the past decades in India. According to an act of parliament, a teaching institute is considered an Institute of National Importance (INI), or a “premier institute”, if it is deemed to play a pivotal role in the country’s development. Such institutions include Indian Institutes of Technology (IIT), Indian Institutes of Information Technology (IIITs) and National Institutes of Technology (NIT), with prestigious faculties in ICT and related study fields.[12] INIs receive special financing from the government. Entry exams for these institutions are highly competitive. Only 113 700 of the 4.4 million students in India are enrolled in undergraduate programmes at INIs.

One of the greatest challenges predicted for IITs and other institutes is global competition. At present, there is limited cooperation between universities and industry and one potential weakness of higher education institutions in India is their limited focus on research, but the number of partnerships with universities worldwide has recently increased.

In Indonesia, there are more than 120 public and 4 000 private higher education institutions, which often provide different types of advanced vocational and academic education. Bandung Institute of Technology (ITB), the foremost technology-oriented university in Indonesia, currently ranks 331st in the 2018 QS World University Rankings. According to the Indonesian National Accreditation Agency for Higher Education, only four out of 99 higher educational institutions received an accreditation at the highest level (level A)[13](BAN-PT, n.d)[14].

One peculiarity of the Indonesian education system is that there is a formal equivalence system in place between the upper level of the vocational stream (D4-Level), which focuses more on practical training, and the Bachelor’s degree level (S1) of the academic stream, which focuses more on theoretical education.[15] However, the market values of these two degrees differ, with those with a D4 degree generally being paid lower salaries throughout their careers than those with an S1 degree due to social perceptions. Some universities offer both streams. In India the reputation and image of the vocational stream was questioned by many interviewees. In response to this general perception, serious attempts are being made to mainstream vocational education and formally link vocational skills to academically equivalent degrees through the Occupational Standards and Qualification Framework.

In Thailand, in 2017, there were 34 300 graduates in science, mathematics and computing, equivalent to 10 per cent of all graduates. There were only few students within the TVET system pursuing ICT as a study field in 2014 (National Economic and Social Development Board, 2015). It seems that the TVET curriculum has not been updated on a regular basis and has failed to respond adequately to changing labour market needs and technological trends.

Work-based training and learning

With rapidly increasing technological change, there is a growing need for work-based training and development of new skill sets – including both technical and soft skills. Entry-level training is provided in order to adapt skill sets to the specific needs of companies. In addition, in-company training may be needed to compensate for skills gaps in the TVET and university system. In India, ICT companies, which employ mainly ICT specialists, on average offer three to six months of entry-level training (Arnand, 2018). Overall, in the IT business process management sector, about 2 per cent of industry revenue is spent on training employees, and of this amount, 40 per cent is spent on training new employees. Numerous firms have forged alliances with leading education institutions with a view to providing appropriate training to future employees (IBEF, 2018).

Companies have also started to develop “re-skilling” and “up-skilling” programmes for their most promising employees. Other employees have to up-skill and retrain on their own initiative. Due to rapid technological change in ICT job roles and the spread of technologies such as cloud computing, virtual reality, big data analytics and

IoT, there is a great need for continuous training, as noted by interviewees in India. One of the key issues related to lifelong learning in all three countries is access to continuous training and the way responsibility for continuous training is shared amongst employers, workers and the government. While large ICT companies offer continuous training courses, this is generally not the case in small and medium-sized enterprises. Workers who do not participate in up-skilling and re-skilling activities in ICT are more likely to lose their jobs and to encounter difficulties in finding new jobs.

Continuous training itself is undergoing a change. In the short term, digital technologies will provide more channels for affordable and efficient online training, thus allowing more workers to keep their competencies up-to-date and to continue improving their skills. Online courses with short video lectures, discussion boards for students and automated systems that grade coursework, have become widespread. At the same time, "adaptive learning", or courses tailored to individual students, could finally become a reality thanks to new machine-learning techniques that may make learning both more flexible and more inclusive (International Organization of Employers, 2017). Therefore, skills such as learning to learn, and the ability to unlearn and relearn are increasingly important key competencies for ICT specialists. One challenge for higher education institutions is the need to ensure employability of their students both in the short- and long-term: providing students with ready-to-use marketable technical skills (for ensuring employability in the short-term) and teaching more theoretical approaches (for fostering employability and the capacity to learn, unlearn and relearn from a long-term perspective).

Challenges for the education system

Reasons for the above-mentioned skills shortage and skills gaps in all three countries include:

- changing technological trends;
- low quality instruction in mathematics at all levels, including at primarily and secondary schools, as well as technology and ICT in some TVET and undergraduate streams;
- a lack of developing logical thinking skills of students and interest in technology at school levels (as stressed in the case of Thailand);[16]
- teaching methods deployed at all levels that do not allow students to sufficiently develop their soft skills;
- a lack of trained teachers for ICT courses;
- a lack of IT-enabled infrastructure in many remote areas (as noted in the case of India);[17]
- an uneven balance between teachers with academic versus practitioner backgrounds at TVET institutions, with the latter being underrepresented, as evident in the case of Indonesia[18];
- there is a perceived lack of coordination between education/training institutions and all key actors in the labour market including ministries of labour, workers' and employers' organizations;
- lack of high-quality information and career counselling services available to students (ILO, 2018);
- inflexibilities to rapidly adapt curricula to technological changes.

Moving forward: Policy responses to reduce skills mismatch

In all three countries, various ministries and government agencies and key stakeholders are taking action to enhance ICT education and training in three main areas:

- improving cooperation between government, education institutions and enterprises;
- improving the link between theoretical education and workplace training;
- developing occupational standards.

Improving cooperation between government, education institutions and enterprises

During the period 2010-2014, the National Skill Development Council (NSDC) in India established 38 sector skills councils (SSCs) to prepare a future workforce training framework for leading growth sectors of the economy. During this process, SSCs conducted skills gap studies and communicated with industries on their skill requirements.

In Indonesia, the networking committee for the alignment of information and communication technology (KPTIK) was established to improve coordination between the government, training institutions and industry needs. The networking committee comprises 17 organizations in the ICT sector, several companies, and a large number of secondary vocational schools.

The Thailand Professional Qualification Institute (TPQI) and the Office of Vocational Education Commission (OVEC) have collaborated with entrepreneurs, governmental agencies and private organizations to develop a competency-based curriculum for vocational education and training in order to close the skills gaps of new graduates.

Improving the link between theoretical education and workplace training

In all three countries, internships are seen as the primary means of practical training for ICT specialists. Internships facilitate the combination of vocational tertiary education and university education with workplace-based learning. All three governments are determined to improve and mainstream TVET, in order, *inter alia*, to improve employment opportunities and tackle skills shortages of a growing labour force that is comprised mainly of young people. The Indonesian Ministry for Research and Higher Education Institutions is developing a new curriculum at polytechnics for implementing the so-called "3,2,1 scheme" - 3 semesters at the campus, 2 semesters at the industry, 1 semester back at campus.[19]

In all three countries, it is a challenge to strengthen links between the industry and universities. Examples of new study formats to address this challenge are being implemented at premier institutes in India. In addition, approximately 25 per cent of students participate in the internship programme. Currently in Thailand OVEC and the Ministry of Education, in collaboration with private sector agencies, are working closely to improve TVET policies and practices. *Inter alia*, they have introduced the "Dual Education Programme", which combines company internships and school-based vocational education into one course.

Linking education and training policies of the government to the needs of the industry would also be important for existing ICT workers and those changing jobs and not only for initial TVET and higher education. Universities must start to provide continuous education courses on specific issues to employed people.

Developing occupational standards

Setting common qualification standards is essential for increasing transparency and ensuring the quality and portability of qualifications. Standards create benchmarks for the recognition of prior learning, and a certification system for courses as well as for validating prior learning is a key part of the process. All three countries have taken steps to establish professional standards for ICT specialists.

In India, the SSCs designed a competency framework, known as the National Skills Qualification Framework (NSQF), and created qualification packs (QP) corresponding to national occupational standards in order to assess and certify workers for particular job roles (Ministry of Skill Development and Entrepreneurship, n.d.). The QPs were validated by the industry representatives and approved by the National Skills Qualification Committee. The NSQF offers training measures and provides the certification for individuals who have undertaken formal or informal learning.

Thailand and Indonesia are also currently developing their own national qualification frameworks that, at a future date, will be referenced against the AQRF. TPQI in Thailand has developed competency-based occupational standards in five main ICT fields. TPQI has also developed a certification scheme for the skills and competences of graduates from TVET and universities, as well as for workers who warrant recognition of prior learning based on their own non-formal learning. In Indonesia, several standards for ICT specialists are in place and lead to a certification (Pinprayong, 2016). Recently, an occupational ICT field map was prepared by KOMINFO and stakeholders, covering 16 key function areas.

In order to increase transparency and to create shared standards in countries belonging to the Association of South-East Asian Nations, the ASEAN Qualifications Reference Framework[20] was developed in 2014[21].

Conclusion

The availability of highly-skilled ICT specialists will become an important factor for competitiveness in existing industries, the production and provision of IT services to industry 4.0 and other ICT services, and developing innovative industries and services. In all three study countries, future demand for ICT specialists will depend on the dynamics of domestic markets across most of the economic sectors as well as, particularly in India, on global demand across other sectors. Most importantly, digital technologies are likely to alter both job tasks and the skill sets required in specific jobs.

As digitization continues, ICT skills will need to become more and more universal. To obtain a solid foundation for the skills development required in the future, education at all levels must be modernized. Schools need to equip young people with sound numeracy, literacy and digital skills, as well as to develop soft skills such as logical thinking, creativity and communication skills.

Skills gaps are notable, since workers may have the formally acquired educational level, but lack skills required for performing their work tasks. Therefore, efficiency may be compromised in the tasks they perform. In some cases, companies will prefer to hire workers with a higher qualification level than typically needed in order to compensate for the skills gap. On the other hand, workers may not have acquired the necessary formal qualification level but may have acquired such qualifications through informal or non-formal learning. The official recognition of non-formal learning is important, particularly if this can be combined with up-skilling.

Skills development of women in STEM subjects should be perceived as an opportunity, since current trends will increase the need for skilled work and future automation will largely affect low-skilled and semi-skilled jobs. Furthermore, digital technologies should help increase flexibility regarding a balance between work and family duties. In order to make the most of these opportunities, employers will need to adapt their human resource management strategies.

Skills strategies are not yet focused on the impacts of automation, economic and occupational restructuring, despite the potential impact on ICT occupations and job roles. To date, only small up-skilling and re-skilling programmes exist at the vocational training level and consequently, a large proportion of the workforce may not be well prepared to cope with economic restructuring or technological advances in the future.

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Endnotes

1 This paper draws on the research report “Skills shortages and labour migration in the field of information and communication technology in India, Indonesia and Thailand”, the first outcome of the International Labour Organization (ILO) development cooperation project entitled “The future of work in information and communication technology” funded by the Japanese Ministry of Health, Labour and Welfare. The author prepared for the research report as an external consultant of the ILO. The views expressed in this paper are those of the author and do not necessarily reflect the views of ILO. See ILO (2019).

2 https://www.boi.go.th/upload/content/digital_economy_5a4fa470adda5.pdf

3 Availability and reliability of labour force survey data permit only an assessment of employment following this definition for Thailand. For the other two countries insights from data and interviews were collected to ensure consistency with this definition as far as possible.

4 Source: NASSCOM (2017), employment in 2012: 2012: 2,800

5 Source: Statistical Office of Indonesia (BPS), based on Klasifikasi Baku Jabatan Indonesia (KBJI) which adopts international standard classification of occupations (ISCO), data provided by BPS.

6 Source: Labour Force Survey, ICT specialists include the following occupational subgroups (ISCO classification), in the sense of OECD classification of ICT occupations: Software applications developers and analysts, database network professionals, ICT operations technicians, ICT user support technicians, web technicians, broadcasting and audiovisual technicians, broadcasting and audiovisual technicians, ICT service manager, electronics engineers, graphic and multimedia designer, medical imaging and therapeutic equipment technicians, contact centre information clerks, contact centre salesperson, ICT installers and servicers. Data provided by ILO 2019.

7 Only for Thailand is it possible to provide numbers of ICT specialists according to the above-mentioned OECD definition. For the other two countries, microdata at 3- or 4-digit levels are not available or unreliable. Furthermore, India has not recently conducted surveys such as the previous employment-unemployment household survey by the national statistical office. It is possible to give a broad approximation of employment in ICT for some of the subsectors at a 2-digit level for the year 2012; this does correspond to the definition of the ICT sector according to OECD. Numbers provided by statistical offices, ILOSTAT and industry associations for ICT specialists are not comparable between countries, as definitions differ.

8 https://www.ilo.org/ilostat.

9 Labour Force Survey, 2012-2017, based on microdata provided by the National Statistical Office

10 There is an extensive body of literature listing different skills and competencies among soft skills. In accordance with ILO (2015), they can be categorized under four broad headings: learning to learn, communication, teamwork and problem-solving. For a literature review see Gibb (2014), referring e.g. to the following categories of soft skills: communication skills, interpersonal skills, leadership skills, organization skills, self-motivation skills and creativity skills.

11 https://www.researchgate.net/publication/305220348_ASEAN_ICT_Manpower_Case_Study_of_Thailand_Indonesia_and_Vietnam.

12 Currently, there are 23 IITs in India, 20 IIITs and 31 functional NITs.

13 Indonesia’s higher education accreditation system has three grades of A, B and C according to their scoring on seven points.

14 https://banpt.or.id/direktori/prodi/pencarian_prodi

15 As recognized by the ministry through the Minister of Education Decree No. 234 / U / 2000 article 1 (16).

16 Institute for Promotion of Teaching Science and Technology, Bangkok, personal communication, June 2018

17 This is likely to be an issue in the two other countries as well (MEITy, Delhi, personal communication; NASSCOM round table, Delhi, personal communication, July 2018).

18 http://www.gbgindonesia.com/en/education/article/2016/vocational_education_in_indonesia_crucial_to_compete_in_the_asean_11489.php.

19 Information provided by Ristekdikti, Jakarta

20 https://asean.org/asean-economic-community/sectoral-bodies-under-the-purview-of-aem/services/asean-qualifications-reference-framework/

21 ASEAN ICT Skills Upgrading and Development. TOT Academy.

Achieving digital transformation in Small Island Developing States

By Louis-Ray Harris

Introduction

Recent advances in the use of information and communication technologies (ICTs) in various industries have resulted in improved efficiency, enhanced customer service, and an increased gross domestic product (GDP) of many countries. These benefits are important given the increased competition for goods and services owing to globalization.

Analyses of recent global trends indicate that economic growth is linked to the degree to which new ICTs are adopted by major industries, such as manufacturing, finance, and telecommunications. However, for countries to benefit more from the application of ICTs, there is a need for capital investment and human resources, which may not be available to many Small Island Developing States (SIDS). According to the United Nations (UN), SIDS comprise "a distinct group of developing countries facing specific social, economic and environmental vulnerabilities"[1,2] . There are 38 SIDS with UN membership, along with 20 non-UN members. These island states are in the Caribbean, Pacific, Atlantic, Indian Ocean, Mediterranean and South China Sea (AIMS) regions.

SIDS are susceptible to the effects of climate change and extreme weather conditions, with an increased frequency and intensity of natural disasters, such as hurricanes. Coastal regions in SIDS are particularly at risk from rising sea levels and beach erosion, which have already led to widespread losses in industries such as agriculture, mining, and tourism. For SIDS, future implications of climate change include greater unpredictability in water supplies owing to varying rainfall patterns, as well as increased difficulty with respect to prioritizing zoning of lands for housing, agriculture, and industrial purposes.

Another issue faced by SIDS is their inability to provide the variety of employment opportunities available in more developed countries (MDCs). Improved travel connections and study opportunities at overseas universities have enabled many individuals to pursue training in technical fields that are in demand worldwide. However, in their home countries, budgetary constraints limit the extent to which their governments can invest in the development of these fields, so few opportunities exist locally for their skills to be utilized. Inevitably, in many cases, even with a desire to contribute to their own countries' development, these highly skilled individuals opt to migrate. This brain drain is worsened by the recruitment practices of some developed countries, which fund the hiring of overseas workers to address their own labour shortages. Examples of professions adversely affected in this way include health (both doctors and nurses) and education.

This paper first reviews efforts to realize digital transformation in key sectors in SIDS, primarily in the Caribbean and Pacific regions, with a focus on the agriculture, health, tourism and environmental sectors. For each of these sectors, the paper examines current efforts in selected SIDS to upgrade the human capacity skillsets of the twenty-first century workforce.

Thereafter, selected issues that have been faced during the digital transformation process are addressed, as well as approaches employed to overcome these challenges.

Digital transformation in specific sectors in SIDS

Agriculture

Issues faced by the agricultural sector in SIDS are unique owing to their small sizes and reliance on imported goods such as fuel, raw material and processed foods. Owing to globalization, there is increased competition for agricultural and mining products which are critical to their economies. In principle, access to external markets may enable SIDS to benefit from foreign exchange, but it is difficult to produce quantities on a sufficiently large scale to enable competition with similar products in MDCs.

Historically, the agricultural sector has been a significant contributor to the GDP of many SIDS, and it provides direct and indirect employment for many locals. For crops such as sugarcane, bananas and other fruits and spices, the tropical climate experienced by most SIDS is ideal. However, as most of these crops are seasonal, increasingly unpredictable weather patterns have caused significant challenges with respect to their ability to maintain viable crop yields. Recent cases where the vast majority of agricultural crops in SIDS have been decimated by intense storms or drought include Dominica and other islands in the Eastern Caribbean, where hurricanes Maria and Irma virtually destroyed entire agricultural industries (Food and Agriculture Organization of the United Nations, 2017; Instituto Interamericano de Cooperación para la Agricultura, 2017[3]). Further, in some cases, the duration of the seasons in which some crops traditionally grow has shortened.

For such industries to recover in a sustainable manner, the challenge is to develop and implement strategies which would help farmers to better identify the optimum conditions under which seedlings should be planted and harvested to maximize yield. It is also necessary to use technology to monitor and harvest soil and crop conditions. To realize this goal, much attention has been given to the application of digital technologies to agriculture, especially with respect to the use of remote-sensing technologies. Internet of Things (IoT) devices have been employed to sense field parameters such as the soil moisture content and temperature. Sensed data are then transmitted in real-time via wireless links to servers or handheld devices and are subsequently plotted and analysed to determine critical points in the harvest cycle. Rural farmers can therefore benefit from long-term data analyses performed using software, and they can incorporate into their planting and harvesting plans information related to soil, plants, weather patterns, etc.

In the Pacific region, an online fishing tool called OnBoard[4] enables fishermen to more rapidly and accurately provide data pertaining to their daily catch; this system has been employed by vessels in several islands, including the Cook Islands, Fiji, French Polynesia, and New Caledonia. In another

Figure 7.1: Demonstration of drone employed for agricultural applications in Jamaica

Picture by RADA, 2016

case, drone technology (Figure 7.1) has been employed by the Rural Agricultural Development Authority (RADA) in Jamaica to acquire data related to the state of farmlands after natural disasters, to observe the status of fisheries reserves and to curb instances of praedial larceny[5, 6].

Health

Most SIDS are in tropical regions with higher temperatures and precipitation, and there is an increased risk of both water-borne and vector-borne diseases, as well as a corresponding risk of reduced labour productivity. There is also a varied geographic range of the vectors, such as the Anopheles and Aedes mosquitoes, which are responsible for the transmission of diseases such as malaria, chikungunya, zika, and dengue[7].

In many SIDS, it is being increasingly acknowledged that the quality of healthcare directly affects patients' recovery time, and by extension workforce productivity and GDP. To this end, there have been some efforts to devote more resources to digitally transform this sector.

One area in which digital transformation has taken place is the digitization of reporting processes required by medical personnel. During outbreaks of communicable diseases, reports are submitted by medical officers in the field to medical surveillance units. However, the patient information is usually handwritten, and the reports are processed by individuals who are required to interpret the writing. This approach is time consuming and can lead to delays and/or errors in interpretation. In collaboration with governments in the Caribbean, an Information Systems for Health (IS4H) framework was developed by the Pan American Health Organization/World Health Organization (PAHO/WHO) for implementation throughout the region, and it recognizes four goals that should be targeted, one of which is data management and information technologies[8]. The use of tablet/laptop devices to enter this data should enhance the reporting and surveillance of medical conditions, enabling a more efficient public health response to new and emerging infectious diseases.

In some SIDS, consultants have been engaged to develop and implement software tools to digitize patient data. In recent years, there have been attempts to digitize individual hospital management systems to enable the digital conversion of patient records. A centralized database management approach enables the updating of patient data even when he/she is seen by medical practitioners at different hospitals and health facilities. A company in Jamaica has developed in-house products to help to digitize both hospital and pharmacy data. Its vision is "to develop a worldwide network of partners to execute our 'solutions' aimed at making online, real-time processing of healthcare transactions… significantly more efficient and cost effective"[9]. While this digital conversion process is time

Figure 7.2: Members of Women in Business Development Inc., which encourages certified organic farming enterprises in Samoa

Picture by Women in Business Development Inc., 2019 consuming and tedious, it is expected to result in significant future savings.

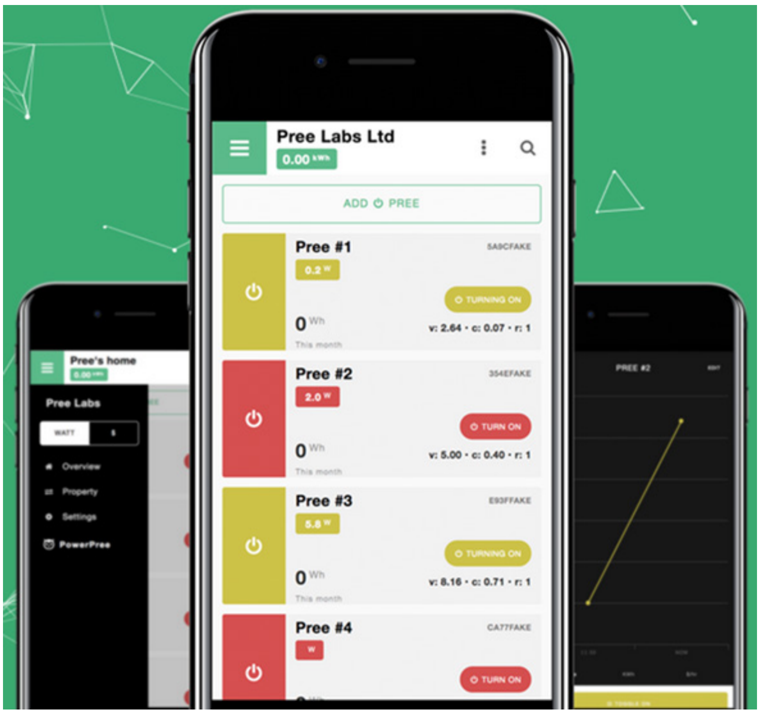
To support the ICT infrastructure being developed in SIDS, there have also been partnerships with Internet providers to provide high-speed connectivity, without which the processing of real-time transactions would be slow.

Tourism and the environment

Owing to their warmer climates, countries in SIDS are holiday destinations of choice for persons living in temperate regions. Over the years, there have therefore been many investments in infrastructure to accommodate visitors to SIDS, and in several countries, hospitality and service industries have been developed primarily to serve tourism needs. Entire communities have become dependent on this industry as hotel employees, local fisher folk, transportation companies, and farmers rely on the income earned from visitor spending. In Samoa, the organization Women in Business Development Inc. (WIBDI)[10] aims to increase linkages between hoteliers and organic farmers to provide "farm-to-table" produce (Figure 7.2). The goal is to provide 80 per cent of produce consumed by hotels and restaurants. This was implemented using an online "m-Link" system, which provides data related to crop availability and organic certification and shares information weekly about products, prices and nutritional information[11]. In 2016, the Chefs for Development (Chefs4Dev) platform was launched to link farmers with chefs, who then demonstrate the value of the local produce using their culinary skills[12].

However, despite the advantages of tourism, one disadvantage is the increased stress on natural resources such as water (examples include higher personal consumption and golf course maintenance), vegetation (often removed to build hotels), and the power grid. It is therefore important for SIDS to consider sustainable ways of offsetting both direct and indirect impacts of tourism. This may be achieved by encouraging the development and implementation of advanced energy-efficient digital technologies within this and other sectors. In some cases, hotels have embraced alternative energy sources such as solar and wind energy and have embarked on environmentally friendly initiatives in order to acquire Green Globe Certification. However, this is optional, and local monitoring agencies in SIDS are usually not well equipped to independently monitor for compliance with local environmental laws and

Figure 7.3: Interface of app developed by local entrepreneur to encourage reduced energy consumption



Picture by Yekini Bryan, 2019

regulations. To increase energy efficiency, a recent start-up in Jamaica called Pree Labs[13] focuses on introducing home-owners and small business owners to advanced methods of reducing energy consumption using IoT technology (Figure 7.3). The monitoring of environmental variables such as coral reef health and water quality near beaches also requires advanced remote-sensing methods.

Building human capacity in SIDS

This section focuses on current efforts to build human capacity in the sectors discussed above. The development of future-proof digital skillsets requires the application of new approaches to human-capacity development as there exist advantages and disadvantages to current certification and degree programmes of study. Further, because of the disparity in incomes compared with similarly qualified persons in MDCs, as well as active recruitment by MDCs, there is an increased risk of migration by highly skilled individuals in SIDS. This would be detrimental to the goal of realizing digital transformation in SIDS.

Agriculture

It is important to consider different approaches to building human capacity as a multi-faceted approach affects a wider cross-section of any industry. Recognizing the need for ICT-specific training in the agricultural sector, some academic institutions have embarked on programmes which aim to improve the skillsets of individuals involved in agriculture. Two different approaches were recently announced by tertiary institutions in Jamaica. First, RADA and the University of Technology, Jamaica launched a Master's in Integrated Rural Development, which aims to prepare both public and private sector specialists in agricultural areas related to rural development, and to enhance the awareness of technological applications in this field[14]. Also, in 2017, the University of the West Indies (UWI) and RADA developed an online 12-week training course in Agrobusiness Management. Their online platform was developed in-house and was designed to be facilitator-led and interactive in nature[15]. Although these programmes are instructor led, there is a clear need for participants to have technical skills related to drone development and maintenance. Therefore, other programmes of study which are currently offered by these institutions, such as electronics, microcontrollers and robotics, should be strengthened to prevent future skill shortages in the development and operation of IoT devices in agriculture.

The drone company AGC Drones (formerly known as Agrocaelum Limited), which markets drone services such as coastal surveillance, crop monitoring and spraying to the Caribbean market, also provides sensitization sessions to educate key stakeholders about the applicability of drone technology to improve farming practices and yield[16]. This could be expanded to provide certification in the use of drone technology for this application.

Health

Medicine is an important field of study, but the average degree programme takes five years, and human-capacity investments in this field take longer to reach fruition. However, the realization of digital transformation in health sectors in SIDS cannot be achieved by simply training more medical personnel, and less expensive approaches can be employed, such as developing skills related to science, technology, engineering and mathematics (STEM) for application to medicine.

In 2013, the development of a cardiac simulator at the UWI Mona campus was hailed as a ground-breaking achievement that showed the ability of the UWI to develop a world-class ICT-based innovation, which has since been patented and shared with universities in the United States (UWI, 2013[17]; UWI, 2012). This innovation resulted from a partnership between a local surgeon and a computer science lecturer and highlights the importance of such partnerships to address technical issues in the field of health. There is a close link between real-world projects and tertiary programmes offered by the UWI in fields such as electronics, instrumentation, medical physics, material science and computer science. More importantly, students are prepared for multidisciplinary tasks which require a background in the application of technology to medicine. The medical insurance industry has also benefited from the development of apps which provide clients' medical backgrounds to first responders in the event of an emergency[18].

In addition, owing to the interconnected nature of global health issues, the PAHO/WHO provides extensive support to SIDS in order to develop human capacity in the area of health. One approach is to organize conferences and training sessions in different SIDS, where local health practitioners are trained in the use of advanced technologies, such as advanced software utilized to analyse health data, ensuring standardization with respect to the presentation of health trends. An example of such an event is a recent PAHO conference in Grenada[19].

Tourism and the environment

Given the importance of both the hospitality industry and the environment to SIDS, an environmentally sustainable, collaborative approach is required to develop human capacity in this field. According to the World Travel and Tourism Council (WTTC), the hospitality sector currently faces increases in human-capital shortages, and universities and training institutes regionally need to consider how to provide students with the required skillsets to ensure functionality in both technical and managerial areas. This could involve offering joint programmes which prepare individuals to address issues spanning both areas. Many traditional programmes focus either on tourism/hospitality management or environmental sciences, and this is partly explained by the different requirements for matriculation in these fields of study (i.e. management vs science-based prerequisite courses). In addition, job descriptions for employees at the management level tend to focus more on tasks such as customer experience and plant management, rather than tasks which directly affect the environment.

Owing to the projected impact of tourism on the environment, there is a need for professionals who are skilled in sustainable tourism development. The ideal scenario should see training provided in a variety of skillsets, including computer programming, artificial intelligence (AI), and remote-monitoring applications. Upon completion of such courses of study, whether at the certificate or degree level, graduates should be sufficiently versatile to enable placement in any related department, with the expectation that interests of both the environment and the hotel will be addressed.

Challenges to digital transformation in SIDS

This section provides examples of challenges that have been faced by SIDS with respect to realizing digital transformation. These challenges relate to funding, implementation and cybersecurity issues.

Funding challenges affecting SIDS

Many SIDS experience difficulty accessing funds required to implement plans to digitally transform different critical sectors. Despite facing issues such as small size and climate change, they are classified as lower-middle-income and upper-middle-income economies, leading to less favourable financing terms. An example is Mauritius, which encountered difficulties with respect to implementing the Barbados Plan of Action and the Mauritius Strategy for Implementation (MSI), (Government of Mauritius, 2014), caused by problems with obtaining suitable financing terms. This has reduced the funding available for on-lending to local entrepreneurs. In addition, other factors such as high interest rates and insufficient collateral limit many persons' access to credit facilities, resulting in a relatively low take-up of financing by entrepreneurs with new digital innovations. To develop project ideas into prototypes and subsequent commercially available products, graduates in electronics and robotics related fields require access to hardware modules, both for testing and large-scale production. Further, entities seeking to procure such parts for training or to implement upgrades must consider the feasibility of doing so as existing non-digital systems may still be operational.

While the issue of funding has limited the development and application of digital solutions in some SIDS, others have found ways to overcome this hurdle. In Jamaica, the Universal Service Fund (USF) was established to fund the acquisition and installation of ICT infrastructure, such as community access points, in rural towns (Government of Jamaica, n.d.). It is financed by a small levy which is placed on all inbound phone calls (USD 0.03 and USD 0.02 for calls terminating on fixed lines and mobile phones, respectively). The fund has enabled an increase in Internet access for schools and rural businesses. The government also recently partnered with telecommunication service providers (TSPs) to offer free data access to all government-owned websites, including on mobile phones, so data plans are no longer required to access government services online. In Barbados, primary and secondary schools receive Internet access and PCs, and this is provided by the Education Sector Enhancement Programme (ESEP), which was started in 1999[20].

Implementation challenges

The implementation of projects to digitize various industries in SIDS requires reliable high-speed ICT infrastructure, which is not available in some SIDS, particularly in island states with mountainous terrain or which are archipelagos. In these cases, wireless connectivity is poor, and the installation of fibre optic cable is not feasible. Thus, there are limitations to the roll-out of certain digital applications, such as health applications, which require real-time connectivity to transmit patient/pharmaceutical information. However, the small size can also be an advantage in cases where funding is secured as the roll-out does not need to cover a wide geographical area.

From an educational perspective, a variety of digital skillsets are required to achieve and maintain a fully digital economy. This process includes the incorporation of appropriate material in the public and private school curricula, taking initiatives to ensure the retraining of existing teachers in the delivery and assessment process, as well as simplifying the procurement process for hardware and software tools needed in classroom settings in schools, training institutes and universities. This is an important role of governments in SIDS as they are responsible for establishing policies regarding the curriculum and structure of the formal education system.

As an example, the above-mentioned ESEP programme in Barbados provides information technology (IT) coordinators for each school, and IT teachers are trained in computer-assisted teaching and learning. Computer literacy increased from 42 per cent to 75 per cent after this programme was implemented. Therefore, by redefining the classroom as a learning space which is fully equipped with learning tools (hardware, software and trained educators), the learning experience will become more enjoyable, fostering greater involvement by students with varying learning styles, and result in improved performance.

In addition to the above approaches, low-cost environmentally friendly alternatives should be considered, including re-purposing hardware such as monitors to solve the issue of e-waste. The availability of devices such as Raspberry Pi boards and open-source software would make this approach a viable option (Campbell, Wright & Harris, 2018). This is particularly important as the issue of e-waste has become a significant problem in SIDS, which have limited land space for the safe disposal of electronic devices.

Cyber security challenges

With the increasing incidence of cybercrime, the development of the digital economy has resulted in the need for greater investments in the area of data security and privacy. This is especially important as many persons are unaware of the ease with which their data can be stolen. There have been cases of corruption involving illegal access to data, and government websites have been hacked by sophisticated entities in other countries (United Nations Office on Drugs and Crime, 2014[21]; ITU, 2013). Of the 29 SIDS for which data exist, 15 (52 percent) have enacted cybercrime legislation, one (3 percent) has legislation in the draft stage and 13 (45 percent) have no legislation[22]. With respect to data protection and privacy legislation, nine (31 percent) have enacted cybercrime legislation, four (14 percent) have legislation in the draft stage, 10 (34 percent) have no legislation and there are no data for six (21 percent). There is the need for decisive action from governments in SIDS to formulate appropriate legislation to deal with cybercrime and the admissibility of digital evidence, and provisions should be made for the regular revision of such laws to remain up-to-date with technological advances. Simultaneously, law enforcement should ensure that digital forensic capabilities remain current. However, this requires significant investment in training and infrastructure.

For its part, the private sector should invest in developing secure digital solutions, especially with respect to banking services. There have been attempts to utilize digital technology in the financial sector[23,24]. For example, the National

Figure 7.4: Participants at L'École Supérieure d'Infotronique d'Haiti, which is a partner of the AYITIC programme that trains Haitian women to be part of the digital economy

Picture by Jairo Abud

Commercial Bank (NCB) in Jamaica launched a pilot project to provide digital training to computer science students in an effort to "build out Jamaica's digital ecosystem"[25, 26]. It also launched the Caribbean's first Agile Lab, which employs programmers, solution architects, data scientists, user interface designers, user experience designers, digital marketers, scrum masters, agile coaches and product owners to develop customer-centric solutions which can "withstand the digital disruption experienced by other industries"[27, 28].

There are other cases which illustrate the adoption of digital lifestyles by societies, e.g. the possession of mobile phones by many individuals in Haiti has led to the development of mobile money applications which are used in all walks of life, from rural farmers to fishermen. With the help of the Bill and Melinda Gates Foundation, the mobile money system was used to provide e-vouchers to individuals, enabling them to receive a monthly stipend to purchase food and other supplies[29], especially after the January 2010 earthquake. A large number of persons and small businesses have subsequently joined the digital economy, and other opportunities have presented themselves (Figure 7.4), benefiting the Haitian economy[30].

Skillsets for digital transformation

Based on some of the examples discussed above, several skillsets are considered key for digital transformation to be fully achieved in various sectors in SIDS (Table 7.1).

Table 7.1: Key skillsets required to achieve digital transformation of critical sectors

Sector	Skillsets Required
Environment	IT, imaging, remote sensing, wireless communications, data analysis, electronics
Agriculture	Remote sensing, IT, wireless communication, electronics
Health	IT, remote sensing, electronics, wireless communication, instrumentation, virtual reality (VR)
Finance	IT, wireless communication, electronics, data analysis
Education/Training	IT, virtual reality
Tourism	Artificial intelligence (AI), IT, remote monitoring

Source: Author's own 2019, unpublished

With respect to the incorporation of virtual reality (VR) tools mentioned in Table 1, to perform training in the use of new equipment, companies in SIDS can use simulators rather than sending employees oversees, thereby reducing costs. In addition, STEM-related concepts can be taught in schools using VR gaming applications, and VR can assist in the rehabilitation of patients suffering from certain physical ailments, such as stroke therapy (Akinladejo, 2012). One possible way of realizing this is to employ graduates to develop VR software for STEM subjects using low-cost headsets (Wright, Campbell & Harris, 2018).

Conclusion

This paper examined existing digital transformation approaches employed by SIDS in the Caribbean and Pacific regions. These approaches illustrate the potential to achieve some measure of success in terms of tangible positive outcomes. However, compared with MDCs, differences in economies of scale, funding, and the availability of hardware resources highlight the need for additional investment in this area.

Digital transformation requires significant investment in hardware, software, and human capacity development, and with very limited resources, many SIDS are at a disadvantage. In addition, because SIDS' economies rely largely on relatively small-scale industries, when acquiring hardware and software solutions these industries do not benefit from the same economies of scale as MDCs. Thus, there is a need for a consensus on approaches that should be taken by governments in SIDS to prevent the skillsets possessed by their workforce from falling behind those of graduates elsewhere.

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ICT skills in Small Island Developing States: ICT capacity building, economic opportunities and brain drain

By Dennis Redeker and Ingmar Sturm

Introduction

Small Island Developing States (SIDS) progressively integrate into the global Internet economy as new undersea cables are constructed and national telecommunications networks are upgraded. Increased Internet bandwidth and lower costs for end users, especially in the underserved Pacific region, leads to new information and communication technology (ICT)-based economic opportunities. Creation of new employment in areas that require Internet connectivity and even work for specialized ICT professionals offering their services globally are the expressed objective of several SIDS governments. This also carries the potential to reverse the long and persistent trend of out-migration in SIDS. It is not yet fully understood how residents of SIDS will adapt to the improving ICT infrastructure and what they require to fully take advantage of new economic opportunities. To address this gap, our study provides a better empirical understanding of the role of ICT capacity building and ICT skills in unlocking ICT-based economic opportunities in five Pacific SIDS.

Today's workers and entrepreneurs require certain skills to participate effectively in our digitized and globalized economy. ICT skills are important predictors for economic opportunities, including higher salaries and employment opportunities (Falck, Heimisch, & Wiederhold, 2016). There is reason to believe that this link holds in SIDS as much as in developed countries and in larger developing countries. ICT development strategies of Pacific SIDS appear to assume that it does (e.g. Samoan Ministry of Communications, n.d.). To explore the veracity of this hypothesis, we examine the relationship between individual ICT skills, individual participation in ICT capacity-building activities, and perceived economic opportunities. In addition, based on the literature on the causes of migration, we hypothesize pressure to leave SIDS for economic reasons, especially for those people with higher ICT skills and those who have attended ICT capacity-building activities, due to the availability of well-paid employment abroad ("brain drain") (De la Croix, Docquier & Schiff, 2014).

In summary, this paper addresses two separate research questions. Firstly, how does the participation in ICT capacity-building activities and the level of ICT skills of young citizens of SIDS influence the perception of salaries and employment opportunities in their home countries? Secondly, how do these factors influence their intention to migrate abroad?

We selected five SIDS, aiming at a diverse sample of independent Pacific island states, in order to examine our research questions. The sample includes the Federated States of Micronesia (FSM) and Palau in Micronesia, Samoa and Tonga in Polynesia, and Fiji in Melanesia. We administered an online survey to 16- to 35-year-olds with citizenship and resident status in any of these five countries (n=461, of whom 243 self-identified as female, 213 as male, and 5 as "other").

This paper proceeds by providing a literature review of the scholarship on how ICT skills (and thus ICT capacity building) can generate economic opportunities for individuals and entire societies. We then present our hypotheses and research design. Results are presented in three sections. The first results section entails between- and within-country findings for ICT skills in the five SIDS. The following section shows the forms of ICT capacity-building measures in which respondents participated. Finally, we display and explain the results of a regression analysis, examining the relationship between ICT skills and ICT capacity building, and perceived economic opportunities and the intention to migrate. We conclude by providing key implications for policy-makers in SIDS.

ICTs in Pacific SIDS: Revisiting the relationship between ICT skills and economic opportunities

In recent history, the contribution of ICTs to economic productivity and thus economic output has been significant across nations (Jorgenson & Vu, 2016). The economic effects of this "ICT revolution" are brought about, *inter alia*, by the proliferation of ICT equipment and enhanced human capital (Jorgenson & Vu, 2016). This evidence at the macro level has recently been enriched by studies focusing on the ICT capacities of individuals. Falck *et al*. (2016) examined labour-market returns of ICT skills across 19 developed countries, finding that "ICT skills are rewarded quite substantially in the labour market". If the level of ICT skills is positively linked to income, it underscores potentially the importance of ICT capacity development for both economic growth and individual economic opportunities.

However, when examining this link between the level of individual ICT skills and economic opportunities in Pacific SIDS, some caution is required. It might not be sufficient for Pacific Islanders to invest in their ICT skills to gain access to the global Internet economy. The great unknown variable is the effect of geographical remoteness, which might prevent countries, and especially less developed ones, from reaping the benefits of ICT literacy. Assuming Pacific Islanders aim to gain employment in their home countries, it is important to consider the local need for ICT skills, which depends, among other things, on the quality and price of Internet connectivity and the degree to which employers engage in ICT-intensive activities or utilize ICTs at all.

Two countervailing forces can be distinguished that might affect this relationship in Pacific SIDS. On the one hand, it is posited that economic benefits of digitization can be broadly attained, through decentralized production and coordination structures such as in the vision of the "collaborative economy" or "gig-economy" (Schor, 2016). Using the Internet, workers can complete tasks from editing or translation services to developing entire software packages or mobile apps. These forms of employment could, at least in principle, be open to workers in any location including in SIDS. For instance, the World Bank claimed that Samoa's connection to the Southern Cross Cable Network in Suva, Fiji would bring "improved connectivity [which] will support the country's businesses and tourism sectors, and enable improved access to information on health, education and job opportunities" (World Bank, 2015). While Internet access is not sufficient to boost these industries, it can be a facilitating factor. Consequently, the need for ICT capacity-building activities is often included in national ICT strategies and even in national development plans (Samoa Ministry of Finance, 2012).

On the other hand, a number of studies highlight the importance of clusters of knowledge and production, particularly in industries such as hardware and software development, where economies of scale appear to be important (Krugman, 1993). Subsequently, while these industries are relatively globalized in terms of competition, only a few large clusters capture a large portion of the global economic activity. From that perspective, any success in creating such globally competitive clusters in SIDS is unlikely. However, this does not mean that SIDS cannot generate significant employment opportunities in niche ICT industries, and ICT-based export industries, or by using ICT skills to improve productivity in non-ICT-based industries.

Considering that ICT skills can facilitate business relationships within and between islands and with customers, employers and other business partners abroad, participation should be positively correlated with perceived economic opportunities. If this hypothesis is not supported, the question arises as to why ICT capacity building and ICT skills do not translate to elevated perceived economic opportunities. Such an outcome might be explained by the lack of economies of scale in SIDS ICT-intensive sectors.

In addition, the ability to migrate abroad may have important implications. If ICT skills offer less of an advantage for employment opportunities in their country of origin than abroad, people might be more willing to migrate (Kapur, 2010). This may contribute to a "brain drain", further weakening economies of scale.

Table 8.1: Population, GDP per capita, and Internet users in sampled SIDS

Country	Population, 2018 est. (UN, 2019a)	GDP per capita in current prices, 2017 (UN, 2019b)	Percentage of individuals using the Internet, 2017 (ITU, 2018b)
Fiji	912 241	USD 5 382	50%
FSM	106 227	USD 3 188	35%
Palau	21 964	USD 13 417	N/A
Samoa	197 695	USD 4 356	34%
Tonga	109 008	USD 3 950	41%

Source: UN, ITU

Case selection, hypotheses and research design

A total of 38 United Nations (UN) member states can be identified as SIDS, of which a third are located in the Pacific Ocean[1]. For this study, we selected a representative set of five SIDS across the three sub-regions of Micronesia (FSM, Palau), Melanesia (Fiji) and Polynesia (Samoa, Tonga). While English is an official language in all these countries, they have different population sizes, levels of economic development and degrees to which inhabitants use the Internet (see Table 8.1).

Based on the existing literature, we assume a positive effect of higher ICT skills and participation in ICT capacity-building activities on the economic and employment opportunities of young people in SIDS. Hence our first four hypotheses are:

H1: Higher self-reported ICT skills predict higher employment availability perceived by young people.

H2: Participation in ICT capacity-building activities predicts higher employment availability perceived by young people.

H3: Higher self-reported ICT skills predict higher levels of sufficiency of salaries perceived by young people.

H4: Participation in ICT capacity-building activities predicts higher levels of sufficiency of salaries perceived by young people.

An alternative strand of questions relates to another phenomenon perceived in Pacific SIDS, namely that large numbers of young inhabitants emigrate to larger, economically more developed states around the Pacific Rim. ICT skills are globally sought-after and hence opportunities to successfully migrate to an industrialized economy may be enhanced by higher ICT skills. We thus hypothesize:

H5: Higher self-reported ICT skills predict a higher likelihood to have plans to migrate to other countries.

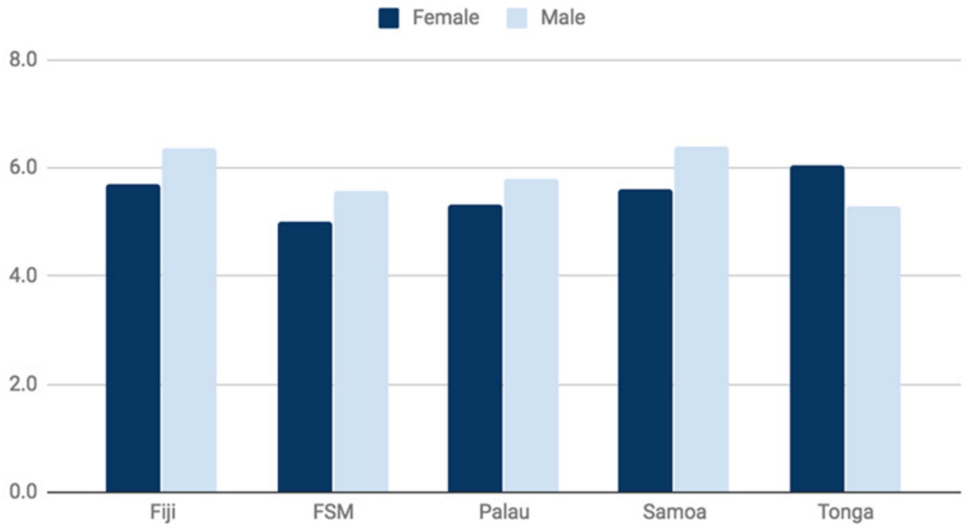
H6: Participation in ICT capacity-building activities predicts a higher likelihood to have plans to migrate to other countries.

The reasoning behind these hypotheses is that young people realize that their small island home countries do not have the infrastructure and commercial networks available to effectively use their skills. This is consistent with theories that assert that ICT industries require a certain degree of clustering in order to flourish, and in turn create ample well-paid employment opportunities for those with the right skills. While ICT skills also offer returns in other sectors, we expect the lack of opportunity in ICT jobs to produce a sufficiently strong effect to be predictive of emigration plans. In this article, we set out to test these hypotheses.

In order to collect the data for our analysis, we administered an online questionnaire using Google Forms. We recruited young people (aged 16 to 35) who live in Fiji, FSM, Palau, Samoa or Tonga and have a citizenship of any of the five countries.

Recruitment took place using two different online advertising tools: Facebook Ads and Google Ads. These, in combination with distribution via personally-established digital channels in the five target countries allowed a relatively swift collection of 461 completed and valid questionnaires to be analysed. The sample procedure represents a non-probabilistic quota sample, including at least 60 respondents from each island state. We removed responses from those who did not fit our sampling criteria but still completed the survey. Data collection took place between 3 February and 1 March 2019. Of the respondents, 163 live in Fiji, 82 in FSM, 65 in Palau, 83 in Samoa and 68 in Tonga. By conducting the

Figure 8.1: ICT Skills Indicator (ISI), by gender



Source: Authors' own 2019, unpublished

survey online, we excluded people with limited digital skills.

The questionnaire included questions about ICT skills, participation in ICT capacity-building activities, economic and employment opportunities as well as migration plans. We added questions concerning demographics, including gender, age, family status, education, income, current occupation and whether respondents lived in an urban or rural area.

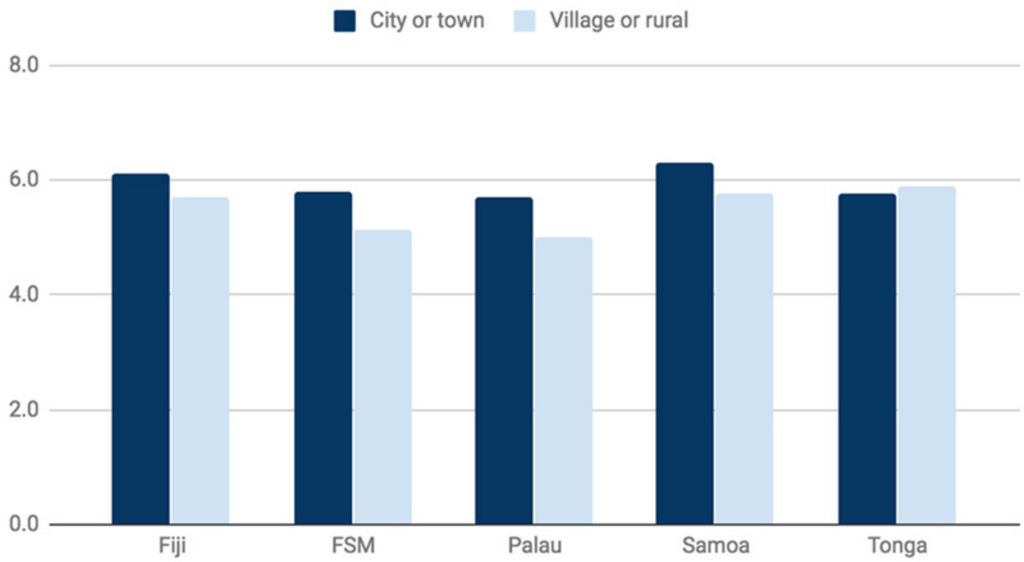
Measuring ICT skills in SIDS

In measuring digital skills, we departed from the nine-item scale as suggested by Eurostat (2012) and adopted by the ITU (2014) by testing for variation within this group of relatively skilled respondents. Consequently, we employed a four-point Likert scale[5] to query respondents about three items that we considered as requiring advanced skill levels, specifically asking for the ability to "manage content of a website", "design a website" and "write a computer program using a specialized programming language". We assumed that if someone self-reports a medium-high or high level of mastery in writing a computer program, that person would also be able to engage in less complex tasks – such as "finding, downloading, installing and configuring software". Using this measure, we compiled a score for each individual. We believe that the resulting ICT skills indicator (ISI) is a useful measure for ICT skills, given the parameters of this research project. Across the 461 respondents the range of the ISI score is 3-12, as expected, with an average score of 5.8.

We find that the ISI score is strongly context-dependent across the five study countries. On an aggregate level, we can show that the ISI score is highest in Fiji and Samoa (6.1 and 6.0), followed by Tonga (5.8). The average score is significantly lower in Palau (5.5) and in FSM (5.3). Within the five countries, gender differences regarding the ISI score of the respondents become apparent. In four out of five countries, the average score of males is significantly higher than that of females (see Figure 8.1). Only in Tonga, we find that the opposite is the case. Tongan women report skills that amount to an average ISI score of 6.0, while men's reported skills average 5.3. Further inquiry would be necessary to uncover the reasons for Tonga's exceptional situation. The findings – with the exception of Tonga – are generally consistent with previous findings regarding the ICT skills gender gap across a range of countries (ITU, 2018a). Social scientific research has shown that this gap appears to be an important factor in developing countries (Steeves & Kwami, 2012, 2017), while others have demonstrated an absence of gender gap in Internet skills in high income countries (Van Deursen & Van Dijk, 2011).

Similar ICT skills gaps become evident when comparing the ISI score of rural and urban locations. It should be noted that the distinction between rural and urban is quite important for SIDS. In some cases, particularly in FSM with its 65 inhabited but highly dispersed islands, a rural

Figure 8.2: ICT Skills Indicator (ISI), by location



Source: Authors' own 2019, unpublished

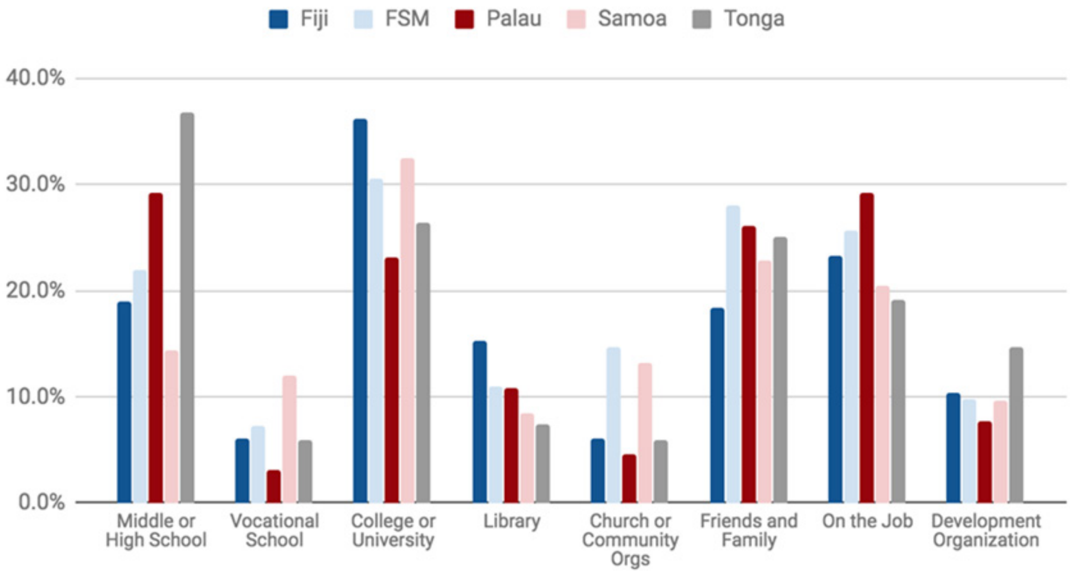
location may mean lack of fast and affordable Internet access and limited access to ICT capacity building. Figure 8.2 shows that respondents living in cities and towns self-report significantly higher skills compared to their rural counterparts. This gap is most pronounced in FSM and Palau (gap of 0.7 each) and favours urban locations (or more populous centres/islands). Significant rural-urban gaps also exist in the ISI score for young people in Samoa (0.5) and Fiji (0.4). Again, Tonga is an outlier here, showing relatively similar scores for both groups, with a minimal skills advantage for respondents residing in rural locations. The overall picture is consistent with statistics published by the ITU indicating skills levels are higher in urban settings compared to rural ones in the countries included in the analysis (ITU, 2018a). It should be noted, however, that the statistics published by the ITU cover everyone including those without any knowledge of the use of computers. Our online-survey design is unable to account for those people which is why we likely undersampled illiterate portions of the population. Interestingly, no apparent relationship exists between the per capita income of countries (see Table 8.1) and their average ISI score, a common finding in comparisons between developed and developing countries (ITU, 2018a).

Participation in ICT capacity building in SIDS

In this section, we provide an initial assessment of the types of ICT capacity-building activities in which young people participate in the five study countries. We queried respondents about the types of ICT capacity-building activities they have engaged in within the past twelve months. We provided ten categories of venues or providers for such activities and respondents were able to indicate that they participated in none, one or several of the options. No respondents indicated that they had engaged in either self-instruction using books or e-learning. The results for the remaining eight categories are shown in Figure 8.3. A total of 30.8 per cent of respondents did not participate in any ICT capacity-building measures during the last twelve months.

In a between-country analysis we find that the share of respondents' participation in any of these categories during the last twelve months is highest in Tonga (75.0 per cent), Samoa (72.3 per cent) and Fiji (71.8 per cent). The share of participation is lowest in Palau (58.5 per cent) and FSM (64.6 per cent). Of the 461 respondents, most participated in activities at a college or university (31.2 per cent), on the job (23.4 per cent), received ICT training by friends or family (23.0 per cent) or in middle- or high-school (22.8 per cent) during the past twelve months. Respondents from FSM and Samoa participated in ICT capacity building offered

Figure 8.3: Participation in ICT capacity building, by category



Source: Authors' own 2019, unpublished

by churches or community groups at higher rates than respondents from other countries (14.6 and 13.3 per cent respectively). In Samoa, *Fesootai* centres are an example of this. These centres are operated by women and supported by the Samoa Ministry of Communications and Information Technology (2018) to provide computer training. Libraries appear as another avenue for engaging in ICT capacity building, and are particularly popular in Fiji, where 15.3 per cent of respondents participated in an activity offered in that context. Given the age of the respondents and the fact that 23.6 per cent of our sample are currently in training (59.0 per cent are employed, and 17.1 per cent are unemployed), the high scores for participation in the context of schools, colleges or universities is not surprising.

Within-country findings indicate a likely participation gap between males and females as well as rural and urban areas. With the exception of Fiji, males were more likely to have participated in any capacity-building activity during the last twelve months. The largest gender gaps can be found in FSM (12.4 percentage points) and Samoa (9.5 percentage points). In Fiji, female 16- to 35-year-olds are more likely to have taken part in a capacity building exercise than their male counterparts (10.0 percentage points). In most of the studied countries, urban dwellers are more likely to have participated in capacity-building exercises in the past twelve months. The gap is most pronounced in Tonga (23.6 percentage points) and FSM (13.7 percentage points). The only exception to this trend is Fiji, where respondents who live in rural locations are somewhat more likely (2.6 percentage points) to have participated in a capacity-building activity during the last twelve months. Again, similar to the ICT skills gap, the accessibility of ICT capacity-building activities is likely to be shaped by the small size, isolation, and remoteness of the study countries.

The impact of ICT skills and ICT capacity building on economic opportunities in SIDS

In order to test the relationship between ICT skills and ICT capacity building on the one hand and perceptions of job availability, job salaries as well as plans to migrate on the other, we conducted a regression analysis for each country and outcome variable. We estimated the likelihood of these outcome variables, which are each recorded on a 4-point Likert scale, using an ordered probit model. An ordered probit model is used to estimate relationships between an ordinal dependent variable and a set of independent variables. Specifically, our model can be represented in the following way:

Table 8.2: Overview of significant relationships between variables

Dependent variable: Perceived job availability										
	Fiji		FSM		Palau		Samoa		Tonga	
	Dir.	Signif.	Dir.	Signif.	Dir.	Signif.	Dir.	Signif.	Dir.	Signif.
ICT Skills	+	No	+	No	–	No	–	No	+	No
ICT Training	–	No	+	No	–	No	–	No	+	No
Interaction	–	No	+	No	–	No	+	No	–	No
Dependent variable: Perceived salary										
ICT Skills	–	0.05	–	No	+	No	–	No	+	0.1
ICT Training	–	0.1	–	0.1	–	No	–	No	+	No
Interaction	+	0.05	+	0.05	+	No	+	No	–	No
Dependent variable: Migration plans										
ICT Skills	+	No	–	No	–	0.05	–	No	+	0.1
ICT Training	–	No	–	No	+	No	–	No	–	No
Interaction	+	No	+	No	–	No	+	No	–	No
"Dir.": Direction of the relationship. "Signif.": The significance level.										

Source: Authors' own 2019, unpublished.

$$Y_i = \beta_0 + \beta_1 AnyICTTraining_i + \beta_2 ISI_i + \beta_3 AnyICTTraining_i * ISI_i + \beta_4 X_i + \varepsilon_i$$

Y_i	Outcome variable for each of the models, respectively: perceived job availability, perceived salary, or migration plans.
AnyICTTraining	Indicator variable whether somebody participated in any ICT capacity building activities within the past twelve months.
ISI	ICT skills index, ranging from 3 to 12.
X_i	Control variables, specifically age, rural/urban, gender, education, family status, occupation, and income.
ε_i	Error term: Anything not accounted for by the model that also affect Y_i.

To economize on space, we report the direction of the relationship and the significance level for each of the models in Table 8.2. Positive signs indicate a positive relationship between the predictor variable and the outcome, whereas negative signs indicate the opposite.

A cursory glance at the findings reveals that there are no significant coefficients for perceived job availability, and a few significant coefficients for perceived salary and plans to migrate. A closer investigation allows us to consider the implications for each of our hypotheses. First, we do not find evidence that higher self-reported ICT skills predict higher perceived employment availability among young people (H1). The coefficient is not significant in any of the five countries and the signs of the coefficients show that the observed relationships do not point in the same direction. Similarly, we do not find evidence for H2, i.e. that participation in ICT capacity-building activities predicts higher perceived employment availability among young people in any of the five countries.

As regards perceptions of salary sufficiency, the results are mixed. In Fiji, we find that ICT skills are negative and significant at the 0.05 level and ICT training is negative and significant at the 0.1 level. This means that, holding other variables constant, higher ICT skills as well as having attended ICT training within the past twelve months are associated with a greater likelihood of perceiving salaries as insufficient. This provides evidence against our hypotheses H3 and H4.

For Fiji, we find that participating in ICT training actually makes a positive difference but only at higher levels. For this we tested for an interaction between ICT skills and ICT training and found it to be positive and significant at the 0.05 level. This means that among people who participated in ICT training, higher ICT skills were associated with better perceived salaries while holding other variables constant. This interaction effect is larger than the main effect of the ICT index, resulting in a more positive perception of salary sufficiency among those who attended ICT training.

In FSM, the results are highly similar to those observed in Fiji. Here, the ICT training variable and the interaction term are significant, but the ICT skills variable is not. In this case, the interaction has an even greater magnitude meaning that among people having participated in ICT training, better skills are associated with greater perceived salary sufficiency whereas among those who did not participate, better skills are associated with less perceived salary sufficiency. Since the results do not imply any particular chronology, the reverse is also true: For those with better ICT skills, having attended ICT training is associated with a lower likelihood of perceiving salaries as insufficient than among those with lower ICT skills. Among inhabitants of Tonga, only the ICT skills variable is significant and is associated with better perceived salaries.

In the results for plans to migrate, only the ICT skills variable is significant and only for Palau and Tonga. However, the relationship goes in opposite directions. In Palau, where the variable is significant at the 0.05 level, the relationship is negative, suggesting that people with better ICT skills are less likely to have plans to emigrate. In Tonga, where the relationship is positive and significant at the 0.1 level, participants with better ICT skills are more likely to have plans to emigrate.

Thus, only the results from Tonga support our hypothesis that participants with better ICT skills are more likely to have plans to migrate to other countries. In the case of Palau, the evidence points against our hypothesis. In all other countries as well as for the ICT training variable in general, we do not find any statistically significant evidence to support or reject our hypothesis.

How can the lack of statistically significant evidence for our hypotheses be best understood? There are three possible interpretations. First, there may not be a relationship between these two variables. For example, participating in ICT capacity-building workshops or having better skills is not causally related to higher perceived job availability. Second, the sample size might be too small to find effects given the variation in answers and the relatively small magnitude of the effects, necessitating further research. Third, the estimates might be biased because we overlooked a relevant control variable. This last point also applies for the cases where we did find significant results, meaning that by including relevant control variables the significance might disappear. We therefore caution the reader to interpret these regression results as only one additional data point to be taken into consideration when drafting policies.

Conclusion

New undersea cables allow for "reliable high-speed and competitively priced Internet connectivity [...] essential for aggregation business and satisfying tourism demand" in SIDS (Government of Samoa, 2015). While these large-scale projects can help unlock economic potential for individuals and for society in SIDS, our findings indicate that additional efforts are necessary to limit inequities and to realize greater individual ICT-based employment opportunities for medium- to highly-skilled young Pacific islanders.

We find variations of ICT skills among young people in SIDS that suggest that broader findings concerning both male-female and rural-urban digital divides hold true in four of the five study countries. In all study countries except Tonga, women and people living in rural locations report significantly lower ICT skills relevant for ICT-based employment than their male and urban counterparts. Such inequalities can potentially affect the ability to equitably participate in economic opportunities unlocked by the development of more sophisticated ICT infrastructure in these countries, disadvantaging certain groups.

Policy-makers should address these gaps by encouraging women to participate in ICT capacity-building activities at the same rate as men, which – according to our data – has only been (over-)achieved in Fiji. The rural-urban gap needs to be addressed by ensuring Internet access in rural locations and remote islands as well as by the creation of ICT capacity opportunities for the relevant populations. Specifically, we found that ICT capacity-building activities via e-learning have yet to achieve uptake in the study countries. Even in the absence of larger population centres (and thus vocational schools or colleges), reliable, fast and inexpensive Internet access could allow young people to foster their ICT skills using e-learning offerings.

Most importantly, we find that there is no strong link between ICT skills or ICT capacity building and perceived employment opportunities and the sufficiency of income offered by employment. These results might be explained by a lack of reward for these skills and activities, or young people change their preferences and expect higher salaries as their ICT skills increase, or because of other, unobserved factors. Moreover, while higher

ICT skills or participation in ICT capacity-building activities do not *per se* point to a higher likelihood for an intention to emigrate, these factors also do not incentivize people to stay in SIDS.

SIDS policy-makers may consider stimulating local ICT-based industries in addition to the large-scale projects represented by undersea cables. Specialization and thus the creation of micro-clusters may help SIDS to compete with other ICT centres around the world linking ICT skills to better domestic economic opportunities. This will reduce the number of young SIDS residents migrating towards more developed countries.

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Endnotes

1 https://sustainabledevelopment.un.org/topics/sids/list

2 http://data.un.org/Data.aspx?q=population&d=PopDiv&f=variableID%3a12.

3 http://data.un.org/Data.aspx?q=GDP&d=SNAAMA&f=grID%3a101%3bcurrID%3aUSD%3bpcFlag%3a1.

4 https://www.itu.int/net4/itu-d/idi/2017/index.html

5 A Likert scale is commonly known as "rating scale" and asks survey respondents to indicate their agreement with a statement. In our case, we employed a 4-point scale with end points labeled with "not at all" and "very much" as well as similar points of agreement.

About the Contributors

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Ikechukwu Adinde currently heads risk management at the Nigerian Communications Commission (NCC). Until April 2019, he was the Administrator/CEO at the Digital Bridge Institute (DBI), a subsidiary of the NCC, a position he held for four years. He has over 30 years' cross-sector experience that includes areas such as accounting and finance, taxation, information technology, commercial and investment banking, banking regulation, advisory/consulting, auditing and public sector governance. He has a first degree in Mathematics/Economics from the University of Nigeria, a Master of Business Administration with specialization in accounting and a Master of Science degree in Economics. Adinde holds a doctoral degree in Public Administration and is also a Fellow of both the Institute of Chartered Accountants of Nigeria and the Chartered Institute of Taxation of Nigeria

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Pratik Bhatnagar has worked in leadership positions across the private, non-profit, government and international development sectors, with organizations such as PwC, KPMG, the World Economic Forum, WWF and Gavi, in management consulting, strategy, innovation, partnership development and impact performance roles. Influenced by human-centred design approaches, he has led digital transformation and associated change management initiatives globally, recognizing that people remain at the core of such initiatives and are key elements in their design, structure and implementation. Pratik is passionate about enabling people and new technologies to work collaboratively for a better world. Pratik has an MBA from IMD Business School, Switzerland; a Master's in International Relations from Yale University, USA; and a Masters in Economics from the Delhi School of Economics, New Delhi, India.

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Nicola Duell, a German and French national, has been a managing partner at Economix Research & Consulting since 2000. She is an expert in the area of labour market analysis and policy, education and training, international labour migration, social protection, regional labour market development, scenario techniques and labour market foresight. She has over 25 years' experience in comparative analysis of labour markets and has consulted for national and international organizations such as the OECD, ILO, World Bank, Inter-American Development Bank, the European Commission, and the German Ministry of Labour and Social Affairs, as well as public institutions of other countries. She worked for several years as an official at the OECD. She held a temporary position as professor in Economics at the University of Applied Sciences in Munich from 2012 to 2015.

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Anna Förster obtained her MSc in computer science and aerospace engineering from the Free University of Berlin, Germany, in 2004 and her PhD degree in self-organizing sensor networks from the University of Lugano, Switzerland, in 2009. She also worked as a junior business consultant for McKinsey & Company, Berlin, from 2004 to 2005. From 2010 to 2014, she was a researcher and lecturer at SUPSI (the University of Applied Sciences of Southern Switzerland). Since 2015 she has led the Sustainable Communication Networks group at the University of Bremen. Her main research interests lie in self-organizing and autonomous sensor and opportunistic networks. She applies various artificial intelligence techniques, from machine learning and swarm intelligence, to various aspects of wireless communication protocols and applications. Furthermore, she is active in designing and developing simulation models and benchmarks for wireless networks. Her research group focuses on how to achieve better sustainability of communication networks and how to boost everyday sustainability by innovative applications.

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ISBN: 978-92-61-29331-4

9 789261 293314

Printed in Switzerland
Geneva, 2019

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