Digital Transformation for a Sustainable Bhutan

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Frontier Technologies and Digital Transformation for Sustainable Development: The case of Bhutan

Introduction

The emergence of frontier technologies — such as quantum computing, Artificial Intelligence (AI), Internet of things (IoT), Big Data, 3D printing and Blockchain — have ignited a series of far-reaching transformations globally. Examples abound — autonomous or driverless vehicles, cryptocurrencies, machine-learning-empowered medical diagnosis and AI-enabled cyberattacks. Supported by an exponential growth in data availability, computing power and analytical capabilities, groundbreaking solutions, products and knowledge are being developed and introduced to markets and users on a daily basis.

These new phenomena have also compelled re-thinking around the conventional application of Information and Communications Technology (ICT) for the advancement of the Sustainable Development Goals (SDG). Across the globe, developing countries have made significant progress in the digital transformation by extending ICT connectivity and mainstreaming ICT applications in the form of e-agriculture, e-learning, digital trade, intelligent transport systems, smart grid and e-governance, just to name a few. While significant progress has been made, the need for inclusive development and poverty reduction through ICT has remained one of the top priorities of the majority of developing countries.

Now, the emergence of frontier technologies has added a new dimension to the landscape of the ongoing digital transformation in developing countries. In addition to the need to scale up and deepen the inclusive digital transformation, the countries are urged and compelled to embrace the frontier technologies and catch up with technologically advanced countries. Otherwise, they may be excluded from global supply chains,

changing global consumer expectations and wide-ranging benefits that frontier technologies offer for the achievement of national development goals and SDGs.

Bhutan is no exception to the above predicament. Through the newly developed Digital Drukyul flagship programme, the country now has a unique opportunity to accelerate digital inclusion and transformation, introduce the frontier technologies and strive towards Gross National Happiness, if planned and executed strategically. It requires a careful examination of tangible and intangible assets, as well as learning from past and existing initiatives to capitalise on their data, resources and capabilities. A recent MIT study[1] concludes that enterprise capabilities are key to delivering successful digital transformation, and such capabilities provide the basis to launch newer, more efficient frontier technology-driven solutions. These digital enterprise capabilities are identified as 1) single, authoritative sources of information, 2) reliable end-to-end processes and 3) back office shared services.

Objectives

Against this background, this article aims to identify the essential factors which could help guide digital transformation processes in the implementation of the Digital Drukyul programme, in light of the rapid advancement of frontier technologies. In order to draw a conclusion, this article first reviews building blocks and uses cases of frontier technologies which may be applicable to the Bhutanese context. Then, this article presents some of the salient features of Bhutan's digital transformation, followed by possible digital transformation trajectory and essential factors which are expected to accelerate it.

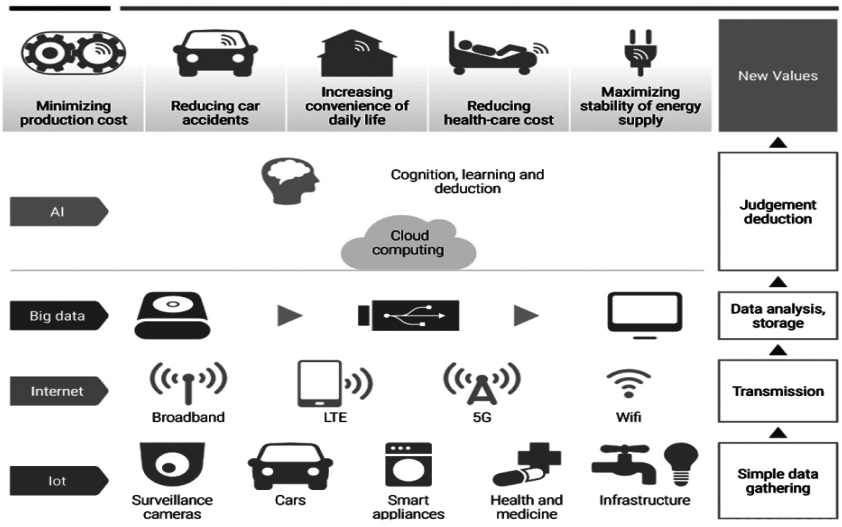
In this article,[2] I narrow the scope to Internet of Things (IoT), Big Data and AI (predictive analytics, machine learning) which are expected to add value to the existing and planned digital government systems and initiatives in the context of Bhutan, including the Digital Drukyul programme. However, it does not mean that blockchain or 3D printing are not as important as IoT, Big Data or AI. It is hoped that this article contributes

[1] Ross, Sebastian & Beath (2018) How to Develop a Great Digital Strategy, How to Go Digital: Practical Wisdom to Help Drive Your Organisation's Digital Transformation, MIT Sloan Management Review, p. 3-11

[2] Due to the page limitation, this article will not provide details on definitions and technical requirements of each frontier technology.

to stimulating debates on the type and scope of digital transformation that prepares its citizens for frontier technologies and at the same time ensures digital inclusion, with no one left behind digitally.

Figure 1. AI and the emerging ICT landscape



Source: Korean Ministry of Science, ICT and Future Planning, "Mid-to Long-Term Master Plan in Preparation for the Intelligent Information Society: Managing the Fourth Industrial Revolution, undated. Available from http://www.msip.go.kr/dynamic/file/afieldfile/msse56/1352869/2017/07/20/Master%20Plan%20for%20the%20intelligent%20uinformation%society.pdf.

It illustrates the interlinkages among components of frontier technologies, such as IoT, Big Data and analytics, but in combination, additional insights and new values are possible. Each layer contributes to the afore-mentioned digital enterprise capabilities.

International Data Corporation (IDC) defines IoT as "a network of networks of uniquely identifiable end points (or things) that communicate without human interventions."[5] The instrumented devices include smart phones, automobiles, building automated systems, smart meters, thermostats, sensors, medical electronics and industrial controllers. IoT provides the

[3] Among others, this article uses the definitions and concepts of frontier technologies in the following reports and articles: Forrester (2019) Predictions 2020: On The Precipice Of Far-Reaching Change; Ramalingam, B., Hernandez K., & Martin, P. et al. (2016) Ten Frontier Technologies for International Development; UNCTAD (2018) Technology and Innovation Report: Harnessing Frontier Technologies for Sustainable Development; Wilkinson, J. (2019) 5 frontier technology trends shaping international development.

[4] ESCAP (2017) Artificial Intelligence and Broadband Divide: the State of ICT Connectivity in Asia and the Pacific at https://www.unescap.org/publications/artificial-intelligence-and-broadband-divide-state-ict-connectivity-asia-and-pacific

[5] Brooks, A. (2015) The Importance of Internet of Things for Communities

ability to translate vast quantities of sensor-based data to action. For instance, it can be used by manufacturers to monitor the wear and tear of their equipment, and optimise preventive, predictive maintenance.

In agriculture, IoT is implemented to monitor the level of moisture in soil, and temperature and movement of produce to the market. According to a report by Oracle,[6] IoT deployments are expanding in manufacturing, logistics, asset management, smart grids, smart cities, construction, telecommunications and healthcare, among others. The use cases in these sectors highlight the growing implementation in fleet management, production monitoring, and remote patient monitoring, just to name a few.[7] The benefits include increased productivity, faster time to market, process automation, reduced costs and better decision-making.

This growth trend is also verified in the latest ITU telecommunications data, which shows exponential growth in machine-to-machine data traffic generated by IoT devices and sensors in Asia and the Pacific. Eriksson estimated that 29 billion IoT devices would be deployed globally by 2022, surpassing the number of mobile phones,[8] and as many as 41.6 billion by 2025.[9] A new report from IDC predicts that the global spending on IoT will increase to USD 398.6 billion by 2023, and the development in Asia and the Pacific will be led by China, Republic of Korea and Singapore.[10]

Big data, machine learning and AI solutions can be used to assess and predict various types of risks and opportunities and provide unparalleled accuracy in insights and services, using data, texts, speech recognition and natural language capabilities. According to QAT Global,[11] AI is a summation and simulation of human intelligence by learning (collecting information), reasoning (using rules to come to a conclusion) and self-correction.

AI applications in logistics and supply chains are already transforming operations to bring analytic and predictive capabilities, automation and

[6] Oracle (2018) Transformation Industry Use Cases
[7] Oracle (2018) Transformation Industry Use Cases
[8] Eriksson (NA) Internet of Things Forecast, available at https://www.ericsson.com/en/mobility-report/internet-of-things-forecast
[9] IDC (2019) The Growth in Connected IoT Devices Is Expected to Generate 79.4ZB of Data in 2025, According to a New IDC Forecast, available at https://www.idc.com/getdoc.jsp?containerId=prUS45213219
[10] IDC (2019) New IDC Forecast Expects the Internet of Things Spending in Asia/Pacific* to Reach USD 398.6 Billion by 2023, available at https://www.idc.com/getdoc.jsp?containerId=prAP45362119
[11] QAT Global (2019) 9 Emerging Technologies That You Need to Know About, available at https://www.qat.com/9-emerging-technologies/

efficiency. For example, AI is used to predict traffic congestions and optimal time to approach the port in New York City.[12] Predictive analytics uses algorithms to find patterns and produce accurate predictions, in such areas as banking, healthcare, marketing, and credit scoring.

According to an Economist article on 19 November 2019,[13] machine learning is revolutionising market intelligence by analysing texts available on the Internet, predicting in financial sectors and assessing the sentiments among people on reforms in a country. Big data analytics is increasingly used in supply chain management, such as inventory optimisation, price optimisation and improved accuracy of demand and forecasting. It is also used to identify sources of food contamination in food supply and risk management. More use cases are introduced in ESCAP's report on AI and broadband connectivity.[14] Such capabilities are being realised mostly in developed countries, but in a developing country context, there are significant deficits, such as data availability, data governance, quality infrastructure, and a limited advanced skills and data driven culture.

Broadband connectivity is found to be particularly important to the development of AI. An article[15] further elaborates that fixed broadband infrastructure may be more important than mobile broadband for the development and uptake of AI. There was evidence that fixed broadband infrastructure was correlating with AI development, while its relationship with mobile broadband infrastructure development was not conclusive. Evidently, mobile broadband is important to deliver data-intensive applications and services to citizens, but the development of computing-intensive solutions, such as AI, Big Data, e-commerce and e-government, may need robust fixed broadband infrastructure. It may not be a coincidence that full-fledged e-commerce and e-government development is taking place where both mobile and fixed broadband connectivity are well developed.

[12]https://www.unescap.org/sites/default/files/Using%20AI%20to%20Optimise%20a%20Supply%20Chain%2C%20Element%20AI.pdf

[13] Economist (2019) How machine learning is revolutionizing market intelligence, available at https://www.economist.com/finance-and-economics/2019/11/21/how-machine-learning-is-revolutionising-market-intelligence

[14] ESCAP (2017) Artificial Intelligence and Broadband Divide: the State of ICT Connectivity in Asia and the Pacific at https://www.unescap.org/publications/artificial-intelligence-and-broadband-divide-state-ict-connectivity-asia-and-pacific

[15] Okuda, A. & Ofa, S. (2018) Artificial intelligence and broadband development through the Asia-Pacific Information Superhighway, Journal of Infrastructure, Policy and Development, Vol 2, No 2 (Published) at https://systems.enpress-publisher.com/index.php/jipd/rt/printerFriendly/1047/0

The review of the existing use cases and planned implementation also shed light on other key characteristics of frontier technologies, which is that the new insights, solutions and products are developed, uniquely and flexibly combining the component technologies, such as IoT, Big Data and machine learning. Furthermore, as developed countries move forward and middle-income countries catch up, it would become increasingly difficult for developing countries to be integrated into the global value chain and compete with other developing countries, unless some of the above-mentioned components are strategically put in place.

Digital Transformation Efforts in Bhutan: Challenges and Opportunities

The earlier mentioned digital enterprise capabilities are produced by various digital initiatives and form the basis to transition to the deployment of emerging technologies. In this section, I will examine two dimensions of digital initiatives in Bhutan — e-government initiatives and broadband development. It aims to identify factors which help accelerate digital inclusion, deepen the use of digital technology within the government and at the same time transition to newer capabilities of frontier technologies.

The Royal Government of Bhutan developed its first E-government Master Plan in 2014,[16] while some e-government initiatives date back to before 2014. The Master Plan was developed with the objective of achieving GNH and promoting ICT for information society, good governance and sustainable socio-economic development in the country. The 30 initiatives listed on the Master Plan represent the critical foundation for Bhutan's digital transformation, but compared internationally, Bhutan's progress would need to be accelerated and strategically steered in the implementation of the Digital Drukyul flagship programme.

The e-government survey, conducted biannually by the United Nations Department of Economic and Social Affairs (UNDESA), measures the level of e-government maturity across the world by telecommunication infrastructure, human capital and online services. According to the latest Survey 2018,[17] Bhutan is ranked at 126th out of 193 countries for the overall score. While Bhutan was rated relatively well on human capacity

[16] MOIC (2014) Bhutan E-Government Master Plan
[17] UNDESA (2018) Untied Nations E-Government Survey 2018: Gearing E-Government to Support Transformation towards Sustainable and Resilient Societies, available at https://publicadministration.un.org/en/research/un-e-government-surveys

and online services, the telecommunication infrastructure may require further improvements. In the same Survey, Bangladesh is ranked 115th, Nepal 117th, India 96th and Sri Lanka 94th.

While conducting research, I found only one academic research paper on e-government in Bhutan. Miyata[18] examined the vehicle registration system developed by the Road Safety and Transport Authority (RSTA) of the Ministry of Information and Communication (MoIC) of Bhutan and its impact, including on corruption, in the country. She concluded that governance benefits outweigh cost efficiency, as computerisation in a small LDC is costly. While the system was not evidenced to reduce costs, survey respondents stated that the time needed for registration was reduced and adherence to rules increased significantly.

When the implementation of e-government initiatives started, various concerns were shared by government employee users. I am sharing some of the reported concerns here as they form the context and are related to challenges. They ranged from the need for reliable Internet connectivity, back up of sensitive online documents and cybersecurity, to proper infrastructure in the offices in earlier years[19]. Other issues emerging in the course of e-government implementation included lack of coordination for implementing ICT initiatives, low rate of adoption among government agencies, lack of sufficient budget and human resource capabilities. A policy was suggested to provide clear guidance in coordination and implementation of e-government initiatives, which would enable the government to leverage existing and emerging technologies and avoid multiple and redundant investment and infrastructure.[20]

In terms of broadband infrastructure, Bhutan has made significant progress. In Asia and the Pacific, South Asia is a sub-region with the slowest growth in fixed broadband connectivity, but Bhutan has outperformed most of its neighbours. According to the latest ITU figures,[21] Bhutan has the highest percentage of individuals using the Internet among neighbouring countries, as shown in Table 1. The mobile subscriptions in Bhutan are on par with

[18] Miyata, M. (2011) Measuring impacts of e-government support in least developed countries: a case study of the vehicle registration service in Bhutan, Information Technology for Development, 17:2, 133-152, DOI: 10.1080/02681102.2010.537251

[19] Kuensel (2016) Training to implement paperless initiative commences, available at http://www.kuenselonline.com/training-to-implement-paperless-initiative-commences/

[20] Kuensel (2017) Policy will require all Govt. agencies to make services online, available at http://www.kuenselonline.com/policy-will-require-all-govt-agencies-to-make-services-online/

[21] Released in December 2019, available at https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

other countries in South Asia, as illustrated in Table 2. However, what could be striking is the slow progress made in fixed broadband development as shown in Table 3.

Table 1

Country	Percentage of Individuals Using the Internet					
	2000	2005	2010	2015	2016	2017
Bangladesh	0.07	0.24	3.70	14.40	18.02	15.00
Bhutan	0.40	3.85	13.60	39.80	41.77	48.11
India	0.53	2.39	7.50	17.00	22.00	34.45
Nepal	0.20	0.83	7.93	17.58	19.69	34.00
Sri Lanka	0.65	1.79	12.00	12.10	16.40	34.11

Source: ITU world telecommunications indicators, at https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx, accessed on 10 February 2020.

Table 2

Country	Mobile-cellular Telephone Subscriptions Per 100 Inhabitants						
	2000	2005	2010	2015	2016	2017	2018
Bangladesh	0.22	6.47	46.03	84.08	86.08	94.53	100.24
Bhutan	0.00	5.55	57.52	92.84	94.80	98.00	93.26
India	0.34	7.85	60.94	76.41	85.15	87.32	86.94
Nepal	0.04	0.88	34.04	101.85	117.81	130.63	139.45
Sri Lanka	2.29	17.20	85.68	114.31	122.72	133.47	142.65

Source: ITU world telecommunications indicators, at https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx, accessed on 10 February 2020.

Table 3

Country	Fixed-broadband subscriptions per 100 inhabitants					
	2005	2010	2015	2016	2017	2018
Bangladesh		0.28	3.13	4.17	4.57	6.34
Bhutan		1.27	3.83	2.24	2.24	1.43
India	0.12	0.89	1.29	1.41	1.33	1.34
Nepal		0.22	1.12	0.82	1.82	2.82
Sri Lanka	0.11	1.13	2.99	4.24	5.78	7.27

Source: ITU world telecommunications indicators, at https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx, accessed on 10 February 2020.

The investment needed for the development of fibre optic cables is more expensive than the expansion of mobile networks, and has been a prohibitive factor, due to the extensive civil works required. Bhutan's efforts to co-deploy fiber optic cables along the power grid have been recognised as an effective means to reduce the civil works and increase the investment efficiency.[22]

Possible Digital Transformation Trajectory for Bhutan

The above described trends and emerging development put additional pressure on Bhutan in choosing the most strategic digital transformation path. The initiatives and focus of government actions should address the country's development aspirations, while keeping the frontier technologies in sight. A priority should be accorded to the initiatives which address both at the same time and create additional developmental benefits. In this context, I propose the following factors to determine priority actions by the government and society.

First, the accelerated implementation of the Digital Drukyul programme is of paramount importance, as informed and empowered citizens are at the centre of any digital transformation. They represent users of the services but at the same time, they should be able to participate in the discussion of the digital future of the country. The digital literacy and inclusive digital access enabled by the programme will ensure that the technologies serve the people to achieve the national development goals and SDGs.

Second, the core digital government initiative and ecosystem provide critical functions, services and data which will be used for other digital government applications and services, such as citizens ID and tax. According to my ongoing empirical research on e-governance compliance and corruption in Bhutan, the government has been implementing a number of measures to this effect, but such efforts should continue to prepare for the imminent introduction of emerging technologies.

Third, the expansion of telecommunication infrastructure should continue to ensure that digital inclusion is achieved, and create an enabling environment which deepens the use of digital technology within the

[22] ESCAP (2018) ICT Co-Deployment with the Electricity Infrastructure, The Case of Bhutan, available at https://www.unescap.org/resources/ict-co-deployment-electricity-infrastructure-case-bhutan

government and society. The former could materialise primarily by expanding mobile broadband networks, while the latter would require fixed broadband networks when the government and society implement full-fledged AI, Big Data and IoT solutions.

Fourth, cybersecurity should also be taken into account when emerging technologies are introduced. Increasingly, cyberattacks are executed with AI capabilities and the number and sophistication have increased over recent years.[23] A recent example of malware, Triton, which attacked critical industrial infrastructure in Saudi Arabia[24] prompted rethinking among cybersecurity experts and policy and decision makers around the world. This factor would need to be considered in addition to the cybersecurity strategies and initiatives Bhutan has in place.

Finally, the private sector and academia should play active roles in advancing digital transformation and emerging technologies in Bhutan. A report published by the World Economic Forum also emphasised the need to balance the technology and human capacity investment, and the fact that technology governance is not keeping pace with the speed of innovation[25]. The private sector should be able to provide technology solutions which are locally deployed and sustained, while the academia should provide evidence for policy recommendations and impact analysis, as well as generate human resources, with particular emphasis on data scientists, econometricians, social scientists, computer and science graduates with research and development background, and programming skills critically needed for the development of emerging technologies. The Druk Research and Education Network (DrukREN) would be particularly relevant in this context. Furthermore, both the private sector and academia should support the government by systematically monitoring technological developments outside the country. This might require concerned government entities to create a sustainable and inclusive partnership where such information and views could be expressed for policy recommendations and action plans.

[23] ESCAP (2018) Enhancing Cybersecurity for Industry 4.0 in Asia and the Pacific, available at https://www.unescap.org/resources/enhancing-cybersecurity-industry-40-asia-and-pacific

[24] Giles, M. (2019) Triton is the world, 's most murderous malware, and it's spreading, MIT Technology Review, 5 March 2019, available at https://www.technologyreview.com/s/613054/cybersecurity-critical-infrastructure-triton-malware/

[25] WEF (2019) The Global Competitiveness Report 2019H How to end a lost decade of productivity growth, available at https://www.weforum.org/reports/how-to-end-a-decade-of-lost-productivity-growth

Conclusion

This article presented some of the emerging trends surrounding frontier technologies, with a focus on IoT, Big Data, AI and broadband connectivity. It also examined salient features in Bhutan's digital transformation from the e-government and connectivity perspectives. The two parts of this article then led to the identification of five factors which could help accelerate the current digital transformation initiatives, while preparing for the transition to frontier technologies. The focus and strategic investment in technology and human resources is expected to bring multiple benefits and accelerate the achievement of national development goals, as well as SDGs.