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ARTICLE

Science and Technology Information in the Digital Age: Some Thoughts from a Global Perspective

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ABSTRACT

The goals of science and technology information (STI) have not changed since the early days of ideas and practices embraced by the term 'documentation', yet the way they are pursued has changed. This is because the world is being transformed by technological changes dominated by digital age. This means that the digital technology is changing the relationship between science and society. It brings with it huge opportunities for the UK, but also significant risks.

This paper identifies and discusses some preconditions for harnessing STI in the digital age and a digital agenda for the UK. The paper considers hard infrastructure, soft infrastructure, cyber risk management and ethical issues from global perspective. The paper argues that open science could make science more effective and speed the translation of research findings into innovation and socio-economic benefits, but this shift requires adjustments to policy.

The paper also reviews the outcome from recent digital age summit in the UK and paints a picture of communicating science in the digital age. A final section presents some observations from the European Commission about access, dissemination and preservation on scientific information in the digital age.

KEYWORDS: Digital age, Science and technology information, Information ethics

Introduction

The world is being transformed by a series of profound technological changes dominated by the digital age. The digital age refers to the time-period in which personal computers and other subsequent technologies were introduced to provide users

the ability to easily and rapidly transfer information. This is otherwise referred to as the Information Age, a historic period characterized by the rapid shift from traditional industry that the industrial revolution brought through industrialization, to an economy based on information technology. In this age our social, economic and political activities are dependent on information and communication technologies. This is already having a significant impact on the UK. On the one end it brings with it huge opportunities and on the other end also significant risk associated with it. This paper presents some key issues related to science and technology information in the digital age from a global perspective.

Infrastructure and cyber risk

There are some core pre-conditions for harnessing science and technology information (STI) in the digital age. First, hard infrastructure, which means universal internet coverage and the delivery of superfast broadband. There are urban and rural areas experiencing the lack of internet coverage. This will definitely hamper international competitiveness in the digital age. In a global scale internet should be defined as a utility service that is available for all to access and use. This is the bedrock for digital competitiveness.

Second, soft infrastructure, meaning digital literacy across the population. An organisation must have the ambition to achieve this and realise its economic potential. Changing technologies demand constant updating of expertise. The paucity of personal in digital and STEM (Science, technology, engineering and mathematics) is holding back different countries' competitiveness. In UK it has been recognised that girls have to be engaged earlier in digital and STEM subject and across all education levels. Sometimes we say 'don't catch a fish young' but in case of digital and STEM or reading habit we say 'catch them young'. This means a child should be engaged at the early age. ASK (attitude, skill and knowledge) in terms of digital literacy development is of paramount importance.

Third is cyber risk management. This means that the rise of the digital economy brings new risks to individuals, businesses and national security. These risks include loss of assets and lack

of confidence in digital technologies, resulting in unwillingness to use them. The best way to defend against cyber risks and deter attacks is to ensure that an organisation trains and deploys enough people with the relevant skills and expertise. Also every user needs a minimum level of ability in managing the risks associated with the digital technology. If the internet is to be viewed as a utility that is accessible to all and cyber-security must be considered an intrinsic part of a country's critical national infrastructure.

There is an inadequate level of awareness amongst the population regarding online safety and personal risk management. The awareness is also age dependent. A young person's risk taking attitude is different than an adult person. Given its importance, there needs to be a culture shift driven by the government to ensure that the nature of the threat is better understood by the whole population. In UK it has been found that individuals and small enterprises are at particular risk from cyber-security issues due to a lack of awareness. There is a differential awareness that exists between the young person and adult population. Young persons are more risk taking than adults.

Ethical issues

Information ethics has grown over the years as a discipline in library and information science, but the field or the phrase has evolved and been embraced by many other disciplines. In fact, it can now be seen as a confluence of the ethical concerns of media, journalism, library and information science, computer science, management information systems, business and the internet.

In 1980s, Barbara J. Kostrewski and Charles Oppenheim wrote an article entitled "Ethics in Information Science" where they discussed such issues as the confidentiality of information, bias in information provided to clients or consumers, the quality of data supplied by online vendors and the use of work facilities (Kostrewski, BJ and Oppenheim C, 1980). Rafael Capurro wrote an article in German in 1988 on 'Information Ethos and Information Ethics' and (Hauptman R, 1988) started the *Journal of information ethics* in 1992, which discussed ethical issues related to science and technology information. For example, in

case of computer science, both theoretical dimensions and applied dimensions have been considered within the information ethics. The completeness or consistency of a programming language is considered within the theoretical dimension and in case of applied dimension, where to apply is the main ethical concern.

Cyber ethics, a particular branch of computer ethics, has also emerged as an area of ethical concern. According to (Sullivan, PF, 1996), cyber-ethics replaces computer ethics. Cyber-ethics is particularly concerned with ethical issues related to the internet or cyberspace. Topics in this area include expert systems, artificial intelligence, and the ability of robots to reason.

International Centre for Information Ethics (ICIE) embraces scholars and scholarships from all over the world. Capurro mentioned that "An important aspect of today's understanding of ethics concerns issues of individual and social responsibility with regard to the impact of our choices in light of the influence of science and technology" (Capurro R, 2019). Capurro raised an important issue about the intercultural information ethics. The foundation of philosophy and ethics in western roots is based upon European and early Greek history. Capurro maintains that it is problematic in our global information society to assert that the grounds for ethics, in particular information ethics, lies in this Western tradition. If we are trying to create a genuine dialog about ethical values and ethical reasons in the multicultural internet world, we cannot be bound solely to this tradition, because, for example, 'Chinese and Indians have engaged in ethical thought and ethical reasoning and the grounds for the resolution of their ethical dilemmas may or may not be the same as those offered in Western society' (Capurro R, 2004).

For a truly intercultural information ethics, one must take seriously the diverse cultures of the world and their own historical traditions. This would also include the feminist perspective that has long been ignored or under validated in both Western and Eastern cultures. The idea of pluralism in information ethics has also been reflected in UNESCO's Info-ethics agenda (UNESCO Infoethics, 2019). In sum, information ethics is a dynamic and evolving field, flowing from various disciplines and perspectives and cultures, critical in these times of intercultural exchange and dialog.

Open Science

Open science could make science more efficient and effective and speed the translation of research findings into innovation and socio-economic benefits. But this shift also requires adjustments to policy. Open science has three main pillars: open access to scientific publications and information, enhanced access to research data and broader engagement with stakeholders. In order to find out an appropriate policy response for the open science agenda one has to understand four trends that are evident regarding innovation and digitalisation.

First, data is a key input for innovation. Second, digitalisation enables services innovation. Third, digital innovations speed innovative cycles and fourth, collaborative innovation.

The OECD's 'Going digital' project examines how government policy can help ensure benefits of increasing growth and improving well-being through the digital transformation. The key recommendations that have emerged for fostering science and innovation in the digital age are as follows (OECD, 2019):

- Advance the transition to open science, which could make science more efficient and effective and speed the translation of research findings into innovation and socio-economic benefits.
- Ensure and facilitate access to data for innovation and balancing economy.
- Prepare to address emerging issues in data policy such as privacy and intellectual property concerns.
- Develop digital skills by creating institutions and incentives that permit rapid responses to changing skills demand.
- Ensure the availability of complementary infrastructures, such as high-performance computing (HPC) and broadband networks.
- Commit to public sector research and consider using well-structured public-private partnerships.
- Foster the diffusion of digital technologies, as most countries, regions and companies are primarily technology users, and diffusion is often slow.
- Develop technology and sector-specific expertise in government.

- Optimise digital information systems to support science and innovation policies

Digital Age Summit

The Digital Age Summit held in July 2016 in UK identified three tiers of skills: basic digital literacy skill, digital skills for the general and digital skills for ICT professional. Basic digital literacy skill means the skills needed by every citizen to become 'digitally literate'. These are the skills needed to carry out basic functions such as using digital applications to communicate and carry out basic Internet searches. Digital skill for the general workforce means all the basic digital literacy skills plus skills needed in a workplace. Digital skills for information and communication technology (ICT) professions means all of basic digital literacy skills, digital skills for the general workforce and skills needed for the diverse IT sector. They include digital skills linked to the development of new digital technologies, and new products and services (ECORYS, 2016).

The summit recognised that the digital skills are increasingly required for citizens to engage effectively in modern societies. Digital skills provide benefits for employment and social mobility. They are important for the productivity generally, and the digital and creative sectors specifically. Some of the findings from the summit are as follows (Foresight, 2017):

- Digital skills are currently stratified in the UK. Older people have lower digital skill levels than younger people. Women are underrepresented in the ICT profession.
- Lifelong learning is generally taken up by those who are young, middle-class, well-qualified, in employment and have parents who experienced extended education.
- The exact nature of digital skills in the future is difficult to predict. However, rather than trying to predict future digital skills, a resilient policy approach can start by addressing gaps in digital skills provision and attainment. It can build the foundations for lifelong learning across the population.
- The need to update digital skills will be on-going as new technologies continue to arrive. It is likely that coordinated interventions will be required across the digital skills

landscape and also different interventions will be required for those already in the workforce.

- Improving UK digital skills requires collaboration between the organisations that demand and use digital skills, as well as those who supply them.
- Further research is needed on how to build lifelong learning across the population, how to codify and accredit learning outside of the formal education system and how to make digital skills provision more responsive to demand.

Science Communication

The digital age is changing the relationship between science and society because technology, de-regulation and the legacy of science are producing new opportunities for dialogue, engagement and deliberation. The role of new technologies has profound impact on our daily life. Citizens can now engage interactively with the developments in science. Technologies also allow people to learn about a range of high profile science and emerging issues that have relevance to their daily life such as climate change issue. Research suggests that new media are of particular interest to young people as they are more likely to embrace new technologies as they enter the marketplace (Holliman R, 2008).

The process of communication has been moved from strictly linear to being more interactive and dynamic. This means that the communication becomes a dialogue between users as they exchange information that is relevant and useful to the activity/phenomena they are discussing; in effect, producing a form of collaborative authorship. The other factor is the development of citizen science because of new technologies. As for example, Friends of the Earth has launched an ambitious citizen science project to measure air pollution and help the public find out about the quality of air they're breathing. Clean Air Kits enable people to test air quality where they live, as well as providing tips on avoiding air pollution and what they can do to support the fight for clean air. As a result, regulators communicate local air quality status by engaging citizens monitoring their own air quality using new technologies.

The influence of deregulation is also important. In practice, deregulation is likely to have two key effects. First is fragmented audience. This means that audiences are increasingly switching from one channel to another. Second, the influence of public sector broadcasting will diminish. These effects have important implications for science communication, because deregulation is likely to bring greater commercial influence to the broadcast media, meaning that science will have to compete to maintain its current position in broadcast schedules and in viewers' programme choices.

The legacy of science-based issues that have dominated the media in the past can have some implication in science communication. For example, science communication, particularly in the form of news media reporting, played an important role in informing members of the public about developments in the mad cow disease and variant Creutzfeldt–Jakob disease in UK and Europe. Research suggests that the wider legacy of such episodes can be characterised by a "crisis in trust" between official sources, scientists, the food industry and citizen-consumers (Holliman R, 2008). It is suggested that openness and transparency in science communication should form an important part of communications strategy.

In recent times, climate change is another important issue that has captured the imagination of general public because of its relevance to the citizen's daily life. However, these interfaces between science and society become more blurred in terms of the distinction between experts and non-experts. One should not ignore that a citizen might have local knowledge which would have value when interpreting any science-based issue but the real challenge is to ascertain that the engagement is genuinely inclusive and meaningful to those affected by the outcomes.

Commission of the European Communities (EC) Perspective

EC has recognised the importance of access, dissemination and preservation of scientific information in the competitive knowledge-based economy. The production of knowledge through research, its dissemination through education and its application through innovation are some key factors. The system by which scientific information is published is pivotal for its

certification and dissemination and thus has major impact on research funding policies and on the excellence of European research. Public authorities fund around one third of European research and therefore have a clear interest in optimising the scientific information system.

Regarding access to and dissemination of scientific information in the digital age, the key arguments put forward by stakeholders in the EC are as follows (Commission of the European Communities, 2007):

Researchers and related organisations

- Open access can increase the impact of scientific research and innovation through improved access to and rapid dissemination of research results.
- The Internet should bring the costs of scientific publications down, but journal prices have increased. This affects access to scientific information.
- Research is generally funded by public fund, peer review through reviewers' salaries, and journals throw library budgets. It is natural that public actors should request a better return on their investment.

Publishers

- There is no access problem. Access to scientific information has never been better.
- Publishing has a cost. Publishers add considerable value to the research process by guaranteeing the quality of journal articles in the most efficient way possible.
- The publishing market is highly competitive and does not require public intervention.

However, these have raised some issues and challenges such as organisational issues, legal issues, technical issues and financial issues. In an 'author pays' model costs for accessing data are shifted from one part of the public institution such as library to another part such as university. This may raise some disruption due to a lack of organisational funding gap. Also if there is no integrated approach to digital

repositories, then responsibility for depositing the material remains unaccountable.

Legal issues may arise for the dissemination of personal data and some sort of research data. In case of research data intellectual property right (IPR) issue is different from personal data, but where personal data and research data are complementing each other, then what legal and ethical issues involved, needs to be examined further. The way authors can exercise their right on the digital environment is different from non-digital environment. Technological progress can greatly contribute to the accessibility and use of scientific information. However, technological open access standard is crucial. Financial issues are also an important factor to get access to scientific information. For example, the value added tax for digital product is higher than paper product. This needs to be rationalised.

EC recognised the problem of long term preservation of digital material and issues and challenges related to this matter. At the European level some actions have been considered and implemented. Fully publicly funded research data should in principle be accessible to all. However, a clear strategy is needed for the digital preservation of scientific information. All stakeholders should be involved in any transformation process regarding access to, dissemination of and preservation of scientific information. The future actions that would be managed by the European Commission are access to community funded research results, cofounding of research infrastructures, input for the future policy debate and coordination with stakeholders (Commission of the European Communities, 2007).

In the digital age, it is not only technology but also change management is an important issue. Digital technology provides possibilities for efficiency gain through the customer's intimacy with the information. In case of science and technology information intimacy comes with some security and ethical issues. This also needs to consider stakeholders apprehensions about the future of the digital age. It is recognised that access to, dissemination of and preservation of scientific information are major challenges of the digital age. Success of each of these areas is of key importance. However one should recognise that in the digital age change is the only constant.

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