Digitization History and its Impact on the Economy, Employment, and Society

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ABSTRACT

The rapid Digitization of the global economy has ushered in a transformative era, leaving a profound impact on various facets of society. This article delves into the history of Digitization, tracing its roots from the emergence of computers to the Internet age. It explores how this digital revolution has increased productivity and efficiency in the economy, creating new opportunities for businesses and individuals. However, it has also raised concerns about job displacement and the digital divide. Ultimately, the article highlights the imperative for policymakers to balance technological advancement and inclusive economic growth to ensure a prosperous and equitable future.

Key Words: Digitization, History, Economic Impact, Society, Employment

INTRODUCTION

Companies today face high dynamics, complexity, globalization, and digitalization. Competition has recently intensified due to opening of national boundaries, expanding global corporations, and digital networks. The economic performance of organizations depends on their innovation. Innovations drive half of economic development in industrialized countries, making them crucial for macroeconomics. Innovation is both a success factor and a commercial necessity. It offers competitive advantages and prevents market suppression (Gibson & Turner, 2012).

Globalization, shorter innovation cycles, higher invention costs, and industrial digitalization have led to increased innovation dissemination. Many companies need to create new products quickly. The innovation cycle for notebooks and smartphones is approximately a few months. Many Chinese competitors need only a few months to design and launch a low-cost replica of a product. Protecting product innovation through trademark rights is crucial for companies investing in future-oriented research and development (Dekkati, 2022). Only enterprises that protect their technological innovations through patents, trademarks, utility models, or designs can acquire economic advantages over competitors. Today, companies can only afford innovation with adequate protection mechanisms. Innovations are crucial for technology-intensive organizations to maintain their worldwide competitiveness and provide future growth prospects. Innovation processes have become more complex with the rise of decentralized competency centers and digital networking. Modern communication and information use (Rafiq & Ameen, 2013)

New technologies, such as Internet innovation networks, offer opportunities for research collaboration. Many problems can be solved faster and more efficiently with online user-group-sourced crowd-innovation (Rahman & Dekkati, 2022). Teams using Scrum will increase project management with few rules and freedom instead of overkill in planning and documentation. This will change enterprise structures and hierarchies. Changed. Social networking, workshops, roadshows, open spaces, and digital life days will encourage innovation and autonomous creativity. Current obstacles for firms include complexity, dynamism, and investment expenses. Digitalization. Future-focused companies innovate to acquire an edge. In some locations, clients receive customized products. Other innovative branches strive for long-term differentiation and product updates. The products reflect changing customer needs. On this, numerous firms need to reply.

The World Intellectual Property Organization says The Business School Insead and Johnson Cornell University Germany ranks 10th, two places ahead of the 2016 global innovation index. This shows that Germans take more. Participate in inventions and improve commercial items. Leading the pack, the Swiss economy remains among the most inventive. The Confederation leads for the sixth year. Following Sweden on 2–5 are Great Britain, the US, and Finland. China enters the top 25 for the first time. India is 66th and Brazil 69th. Companies' good cooperation is viewed as causally positive by the study. German universities and research centers, and SMB investment in innovative technologies. The German innovation rating is weaker at the foundation of businesses. New foundations have decreased during the past 20 years. The World Bank checked which nations encourage startup culture. Germany placed 107th out of 189 states, following Tajikistan, Colombia, and Senegal. Because the newest startup companies drive technology revolutions, Germany must catch up quickly to build future-guiding technologies here.

HISTORY OF DIGITIZATION

In 1999, the Biodiversity Informatics Subgroup of the Organization for Economic Cooperation and Development's Megascience Forum recommended creating the Global Biodiversity Informatics Facility (GBIF) to access vast biodiversity data for scientific research and natural world knowledge. GBIF served over one billion biodiversity occurrence records, including roughly 150 million (or 15%) based on preserved specimens in natural history collections. The Australian Virtual Herbarium was created in 2001 in conjunction with GBIF and on the recommendation of the Council of Heads of Australasian Herbaria (CHAH). Its success led to funding for the ALA, a much broader initiative to digitize Australia's biodiversity knowledge for biodiversity research collaboration. In the past decade, the ALA database has grown to about 73 million occurrence reports, 12.6 million of which are preserved specimens.

In addition, several countries in South America are working together to compile biodiversity data. The CRIA of Brazil established the species link network in 2002 to integrate the species and specimen data that are available in natural history museums, herbaria, and culture collections and make these data openly and freely available on the Internet, along with tools that promote interoperability, integration, visualization, and data cleaning. The species link network has been a success, achieving its goal of integrating species and specimen data. Nearly 9 million data points have been served by speciesLink, almost half georeferenced. GBIF is also serving at least part of these records and is one of the most prominent aggregators in North America. In addition, the Brazilian government created ReFlora in 2010 to provide access to information regarding Brazilian plant specimens in herbaria outside the country. These data sources have become a significant input to the conservation efforts in Brazil.

In Mexico, the CONABIO organization, founded in 1992 to promote, coordinate, support, and carry out activities targeted at biodiversity understanding, conservation, and sustainability, recently marked its quarter-century anniversary. Through its World Biodiversity Information Network (REMIB), CONABIO can now service almost 6 million entries. The majority of these records are specimen records from natural history museums. Activities related to digitalization and the mobilization of data have also made progress in Asia. Within China's National Science and Technology Infrastructure Framework, the National Science and Technology Information Infrastructure (NSII) is one of the 28 projects supported by funding from the Ministry of Science and Technology. In addition to acting as the GBIF node for China, the NSII's primary mission is to collect data that may be put toward preserving and protecting China's rich biodiversity (Vilariño & García, 2013). The recently proposed DiSSCo includes participation from 21 countries and 114 European natural history museums. Its goal is to mobilize, unify, and deliver "bio- and geo-diversity information at the scale, form, and precision required by scientific communities, transforming a fragmented landscape into a coherent and responsive research infrastructure." The Naturalis Biodiversity Center in Leiden, located in the Netherlands, serves as the epicenter of the project on which work is now being carried out.

Launched in 2011, the US National Science Foundation's ADBC program, its national resource, Integrated Digitized Biocollections (iDigBio), and several associated Thematic Collections Networks (TCN) generate and aggregate a wealth of digitized collections data to address grand challenge questions, encouraging biodiversity specimen data digitization, mobilization, and aggregation. ADBC includes 708 collections from over 500 institutions in all 50 US states and most collection kinds (Asadullah ET AL., 2022). The iDigBio platform has around 115 million text and 26 million media entries from various universities. Since specimen object data typically indicates aggregated specimens housed in lots, trays, matrices, or by collection event, these 115 million records represent 300–400 million physical specimens.

Many more prominent museums with sufficient resources have been digitizing collections for at least two decades and serving data through institutional websites, with many now contributing data to leading aggregators. The Paris Herbarium has 5.4 million specimens digitized; the Natural History Museum in London has 8.9 million specimen records; the Naturalis Biodiversity Center in the Netherlands has 37 million objects, of which 4 million have been digitized; and the Museum für Naturkunde in Berlin focuses on whole-drawer insect tray digitization. The Global Plants Initiative, which made type plant specimens available, led to Digitization worldwide. The New York Botanical Garden (NYBG), Harvard's Museum of Comparative Zoology (MCZ), the Harvard University Herbaria, the Yale Peabody Museum, the Sam Noble Museum at the University of Oklahoma, and the Museum of Vertebrate Zoology (MVZ) at UC Berkeley, which computerized its specimen data in the late 1970s and early 1980s and made it available online in 1997, were among the first to digitize. MVZ pioneered procedures, data quality norms, and label digitization standards for VertNet, a collection of discipline-specific subprojects. FishNet, now FishNet 2, was an early partner with VertNet and a leader in georeferencing standards, protocols, and fish specimen data aggregation.

Despite global Digitization, key regions still need to be represented. Russia has many biodiversity databases in local databases that are inaccessible online. However, Russia-based digitization projects are expected to continue. Digitalization is also underway in Africa under the guidance of SANBI and GBIF. SANBI launched The African Biodiversity Challenge in Malawi, Rwanda, Ghana, and Namibia after developing a mobilization strategy in 2013–2015. Several national databases track biodiversity information for India, although specimen-based digital data from Indian collections is relatively scarce. The iDigBio platform included 361,000

Indian specimen records as of June 13, 2016, mainly from US and UK institutes. The India Biodiversity Data Portal, launched in 2008, provides species, maps, and data, including over 1 million observation records. India has been a significant collecting destination for at least three centuries (Lal et al., 2022). Hence, considerable interest exists in digitizing Indian specimens in museums abroad and India.

DIGITIZATION

All information in today's digital civilization may be represented by one of two binary strings: either a zero or a one. These strings encode the data, enabling individuals to generate, manipulate, and share data in truly revolutionary ways. "Digitization" is the process of changing analog material into binary electronic (digital) form, as described by Pearce-Moses (2005). This is done to store and use the information on a computer. Through Digitization, materials are transformed from analog formats humans can read into digital formats that machines can only read. Digitizing knowledge content can use various technologies, including scanners, cameras, etc. These technologies make it possible to digitize nearly any material, including written papers on paper, rare documents, images, voice recordings, and moving pictures (Weiss, 2016).

It is becoming increasingly challenging to keep up with the ever-increasing volume of literature with the assistance of information technology because various media generate information in multiple forms at an accelerating rate. The process of digitizing information resources results in improved access to those resources. Users can conduct speedy and exhaustive searches for collections using digital projects, which are accessible from any location at any time. The process of digitalization reveals things that were previously hidden from view. Multiple people can access the same document without encountering any difficulties simultaneously. Users no longer have to go to locations that physically contain the contents to access them, eliminating another potential barrier caused by distance (Lal, 2019).

Although Digitization is a venture that requires much time and is highly expensive, it is a powerful approach to cope with the constant shortage of journals and other technical literature at institutions, universities, and technical schools in developing countries. Many organizations and academic institutions are digitizing documents, artifacts, archives of newspapers, theses and dissertations, and other types of historical photographs (Hosen e al., 2021). This provides scientists, administrators, students, and other people looking for knowledge with broader access to advances that are possible at the proper time but were previously outside their sphere of influence. Many different definitions of "digitization" have been proposed by various academics. According to Witten and David (2003), Digitization is "the process of taking traditional library materials that are in the form of books and papers and converting them to electronic form where they can be stored and manipulated by a computer." Conventional library materials include things like books and papers.

The United States Institute of Museum and Library Services (IMLS) describes the process of Digitization as "the process of converting, creating, and maintaining books, artworks, historical documents, photos, journal entries, and other types of written materials in electronic representation so that they can be viewed via computers and other devices."

NECESSITY OF DIGITIZATION

The primary goal of Digitization is to maximize one's utilization of information and communications technology (ICT) resources to gain access to global resources that are simultaneously beneficial to society. The shift toward digital practices is becoming

increasingly necessary to maintain a clean and secure environment. Various organizations are digitizing their content because they are convinced of the enduring value of such resources for educational purposes (Chen et al., 2020). Because users worldwide can learn about an institution's collection and use its resources regardless of their location, Digitization contributes to an increase in the institution's reputation. The primary benefits of digitizing are increased accessibility and enhanced long-term preservation. Through digitizing their collections, institutions can make information publicly available that was, in the past, restricted to a particular audience of users. The Digitization of materials can also help conserve them by making high-quality digital images available electronically, and it may lessen the wear and tear on brittle and fragile papers (Elster & Jablonowski, 2015).

BENEFITS OF DIGITIZATION

Users can access rare, delicate, or brittle original documents if a digital copy of the original document is developed, protecting the original document from being damaged by being handled or displayed (Hosen et al., 2019). This particular desire drove the digitalization of many different artifacts. The following is a list of the several advantages that digitalization has.

- The documents are accessible at any time of the day or night and from any location worldwide.
- The documents can be printed immediately from the website.
- Users can quickly and independently find what they are looking for.
- It can reduce the time spent on staff reference inquiries by providing answers to frequently asked topics on the Internet.
- It can digitally enhance photos to be viewed with more excellent legibility.
- It encourages greater use of collections and makes learning and scholarly research more accessible.
- The staff is not required to re-shelve the documents or look for them in any way.
- The documents are handled infrequently, reducing the wear and tear they experience.

There are certain unique benefits of Digitization that, in addition to the broad benefits outlined above, may contribute to society's economic and ecological sustainability.

ECONOMIC IMPACTS OF DIGITIZATION

The idea of Digitization comes about as a result of the changes that have taken place in the technological aspects of information and communication technology. The proliferation of the Internet has led to a shift away from using printed materials to digital media to disseminate information to the greater community (Lal, 2022). This shift has made it possible for a vast quantity of information to be made available to all individuals. Thanks to Digitization, which enables this process, knowledge is being produced, processed, shared, and archived digitally in ever-increasing quantities. The economics behind Digitization can be broken down into two categories. The first question is: How financially feasible is the process of Digitization? Moreover, secondly, the effect it has on the national economies of the countries (Lu et al., 2014).

Digitization's economy relies on the generation, preservation, dissemination, and use of digital information. The Digitization of knowledge is economically beneficial for society today. Digitization is initially not cost-effective, but later stages can result in increased returns, zero marginal cost, and long-term community usage. Digitization, while initially costly (designing a website, scanning documents, editing text, and implementing software), saves

production costs and is more cost effective than traditional information distribution methods (Koehler et al., 2020). Digitization technology saves money by reducing the marginal cost of document production. Staff digitization, computer systems, and internet information flow incur fixed or first-copy costs. Issuing many copies of a document has a lower marginal cost. Digitization has long-term benefits for society, but it may take years to realize them fully. In the digital economy, short-term investments yield long-term advantages.

Electronic sources represent the evolving information distribution model in today's society. Access to digital information through electronic sources, such as e-journals, consortiums, and online databases, is more cost-effective than print subscriptions. Online information purchases represent significant cost savings compared to print versions. The cost of purchasing print sources includes storage, shelving, and physical material storage, which are direct expenses for companies. The move to electronic content has lowered physical material maintenance costs but has somewhat increased content preservation costs (Deming et al., 2018). Over time, networking technology has become more affordable, making digital information delivery more affordable for creators, distributors, and users. Additionally, cheap digital information access has spread.

It benefited many consumers. Some organizations can save money by generating digitized collections for online publication or distribution. Access becomes the dominant knowledge delivery mechanism. Learning to think critically about accumulating digital content as electronic reserves or short-loan collections may save institutions by lowering library hours or staff time needed to manage such laborious work. Additionally, such approaches can substitute postal print costs. Information with web-based documents and these savings are deemed Digitization's indirect benefits. It brings financial rewards and extra value, like user happiness and learning progress research. There needs to be solid data to support economic numbers. Digitization's institutional value: Many elements will affect the evaluation. These considerations aid in determining the worth of digital resources while digitizing. Not all collections are cost-effective. Digital assets that will boost the prestige of their creators and maintainers and encourage scholarship without losing the benefits of working with originals

Digitizing technology has led to open-access publication, which reduces costs. The open-access strategy aims to preserve and distribute documents at a lower cost than traditional closed production methods. Open access allows non-commercial usage of scholarly work on the web, including reading, downloading, reusing, and redistribution. Open-access resources, such as institutional repositories, online databases, and e-journals, offer advantages over payment-based methods for producing and accessing scholarly work. Restricting access to information is costly and laborious, requiring security systems, billing procedures, user databases, and queries (Fadziso et al., 2023). This complicates the process of mounting information on a computer and providing access via the WWW. Open-access web material is not accessible to generate, although it is significantly cheaper than traditional publishing, with most costs being fixed. The sustainability of Digitization depends on long-term remuneration for creators and producers of digital intellectual content. By replacing and upgrading existing services, Digitization can serve the most people with the same resources, such as staff and cash (Dekkati, 2022).

Factors like pricing, reliability, speed, and ease of use determine any geography's digitization level. Digitization has been shown to reduce unemployment, improve quality of life, and increase access to public services. Digitization enhances government transparency and efficiency, spurring economic growth only after some time. Digital technology is used to improve economic activity in the slow global economy. The mass adoption of digital technology through connected services and devices has accelerated economic growth and employment creation, but its effects vary by country. —Digitization boosts growth and productivity in developed nations but reduces

employment creation in emerging nations. Digitalization's effects on developed and emerging nations differ primarily due to their economic systems (Maiti & Kayal, 2017).

The Booz & Company analysis examined how Digitization affects global economies. A digitization index was developed by Booz & Company, a management consulting firm, to quantify the influence of digitalization on cross-country economic advancement (Dekkati et al., 2022). The Digitization Index is tested to quantify how digital technologies affect economic development, unemployment, and societal benefits. This six-year survey comprised 150 nations, including India, from 2006 to 2010. This survey categorized countries as digitally constrained, emerging, transitional, or advanced based on digitalization activities and their impact on economic growth, job creation, and social welfare.

IMPACT ON EMPLOYMENT

Information and Communication Technology advancements affect employment by creating additional jobs in the IT sector, including software development, outsourcing, hardware manufacturing, and related industries. These technologies have also affected other service areas, including trade, industry, banking, and health care. Booz & Company's econometric analysis found a 0.84% decrease in the unemployment rate due to a 10% increase in digital activity. Digitization-related activities contributed to the global economy by adding 19 million jobs from 2009 to 2010. From 2007 to 2008, an estimated 18 million jobs increased by over 5% (Schuster, 2015). According to 2011 research by Booz & Company, Digitization led to a US$193 billion increase in global economic productivity and created 6 million new jobs. Digitization in the Middle East and North Africa led to $16.5 billion in output and approximately 380,000 new jobs in the same year (El-Darwiche & Singh, 2013). In recent years, the development of hundreds of millions of jobs worldwide has significantly boosted society and the country's economy. Digitization enables economic growth and prosperity by creating work opportunities for people.

SOCIAL IMPACTS OF DIGITIZATION

The relationship between technology and social welfare is fascinating and vital. Digitization allows institutions to originate, cooperate, and create more significance for society's benefit and growth through digital communications and applications (Thaduri & Lal, 2022). The method digitizes books and rare items in bulk. Many libraries and cultural archives have begun digitizing the history of societies, countries, cultures, and languages to preserve knowledge for future generations or make it available to a much wider community than could ever access physical objects. Hughes (2003) states that cultural heritage institutions (e.g., libraries, archives, and museums) have integrated technology into their mission and services for over 30 years. Cultural heritage institutions can make previously restricted material available to the public by digitizing their resources. Libraries, archives, museums, and publishers have digitized and cataloged older documents and rare photographs for years, making them available online (Probst, 2017).

Digitization preserves knowledge content and protects rare original documents from wear and tear when presented to wider audiences. By offering online access to digitized items, institutions allow users worldwide to examine information concurrently or sequentially. Additionally, users save time and money by not having to visit the real place for items. According to Mulrenin and Geser (2001), converting valuable cultural content into digital format enables access to a broader audience, making cultural resources more accessible than before. Users worldwide rely on digital access to quickly discover uncommon resources not available in print collections. Digitization enhances awareness, investigation, and promotion of past and present cultures, increasing pleasure and contentment among individuals.

RESTRICTION OF DIGITIZATION

Digital data proliferation has presented challenges and opportunities, especially in ensuring that aggregated data are complete, consistent, accurate, fit for use, accessible to bias, and follow community-led standards like the Darwin Core Standard (Dekkati, 2021). The critical need to improve data quality has led to procedures, research methods, and best practices for improving and confirming accuracy and fitness, such as combining GBIF and GenBank data to identify potential identification anomalies in mycology, addressing pressing data quality challenges in entomology, mining and analyzing palaeobiology data, discovering research uses for vertebrate trait data, revising and critiquing Several studies have shown data completeness issues, especially where distribution gaps do not match expectations, suggesting under-collection or a lack of mobilized information from one or more key biodiversity collections (Beelen et al., 2017).

Resolving and correcting taxon names in electronic specimen label data and improving geographic coordinate accuracy, resolution, and fitness for use are two significant digital data quality enhancement topics. According to Chapman, taxon name problems include identification, spelling, and format (Dekkati et al., 2019). Zermoglio et al. add misunderstanding, misapplication, and non-adherence to the Darwin Core Standard to this list, and they note the problem of outdated synonyms. Several projects have addressed taxonomy and synonymy, but only some have found comprehensive solutions. Ornithology has a long history of worldwide common name recommendations, and ichthyology uses the Catalog of Fishes as the standard for nomenclature and taxonomy. Successful integration across the universe of digitized specimens will link specimen records to all of their derivatives (e.g., tissues, traits, genetic sequences, and field notes) and commonalities across the Internet, including locality and taxonomic descriptions, temporally and spatially related specimens, directly and indirectly, related literature, and associated media records (Ballamudi et al., 2021). Whether there will ever be universal taxonomies is debatable. Taxonomy as a hierarchy of theories underpins biodiversity science. Various interpretations are likely.

Incomplete coordinates, strings inserted into numeric fields, incorrect coordinate system references, latitude values reported for longitude and vice versa, incorrect or omitted numerical signs, misplaced decimals, and coordinate values beyond a valid range are typical geospatial data errors (Dekkati, 2020). Aggregators utilize filters to fix or recommend corrections for some of these issues. However, precision errors due to the global positioning system device, georeferencing protocols, transcription errors, rounding, and conversions from USPSS references to geographical coordinates can be much more problematic, especially in studies that require highly resolved coordinates. After collection, georeferencers add coordinates to legacy records using scant label descriptions, increasing the chance of inaccuracy.

CONCLUSION

The digital conversion of print materials has advanced dramatically in recent years. Digitization is the social shift caused by the widespread use of digital technologies to generate, process, distribute, and manage digital information. Digitization involves converting all institutional assets into digital format and making high-quality copies for preservation and access. It offers advanced preservation and access to knowledge content and alters collection usage and access. Digitization projects and institutional transformations impact business, society, and academia. Radical changes have led to faster, more accessible, and global access to knowledge than in the past.

Additionally, transferring analog to digital formats minimizes digitization expenses for print source access. However, digital copies should not substitute for original knowledge. Regular maintenance and format conversion are necessary for digital files, which are temporary. To maximize the benefits of Digitization, organizations should carefully pick materials and digitize only those that will benefit administrators and users. Successful digital projects require careful collection evaluation, assessment of institutional goals and priorities, and thoughtful strategy development to create meaningful, high-quality digital versions and effectively manage original and digital assets over time.

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