# Analyzing the Nexus Between Digital Transformation and Structural Change in Developing Countries

## تحليل العلاقة بين التحول الرقمي والتغير الهيكلي في الدول النامية

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## Abstract:

**Purpose**: The study aims to analysis the relationship between digital transformation and structural change in developing countries, Therefore, it has been hypothesized that technological upgrading (digital transformation) of the primary sectors contributes to the structural change through two main venues 1) the contribution of value-added to the economy and 2) the re-organization of the share of the employment in 3 primary sectors of the economy (structural change).

**Methodology:** The literature on structural change considers technology as an engine of value added for each sector as a percentage of GDP and job transfers among economic sectors

moreover, the phenomenon of digital transformation will be proxied using the dimensions of digital economy and society index (DESI). According to the availability of data for our sample of countries, a set of data called human capital, connectivity and business digitalization examines the level of technological advancement.

**Results:** Results indicate that digital transformation has a positive impact on structural change on the 3 primary sectors except the service sector that requires more efforts through investing in education sector and development digital infrastructure ،In addition to effective digital training.

**Keywords:** Digital transformation, structural change, developing countries

**الملخص:**

**الهدف:** تهدف الدراسة إلى تحليل العلاقة بين التحول الرقمي والتغير الهيكلي في الدول النامية، لذلك تم فرض بأن التقدم التكنولوجي (التحول الرقمي) يساهم في التغيير الهيكلي من خلال مكونين رئيسيين ١) القيمة المضافة ،٢) إعادة تنظيم قوة العمالة في ثلاث قطاعات رئيسية (التغيير الهيكلي).

**المنهجية:** تشير الأدبيات المتعلقة بالتغير الهيكلي والتكنولوجيا، بأن التحول الرقمي يعد محركًا أساسيًا للقيمة المضافة لكل قطاع كنسبة مئوية من الناتج المحلي الإجمالي وانتقال الوظائف بين القطاعات الاقتصادية، علاوة على ذلك، تم الاعتماد على أبعاد الاقتصاد الرقمي ومؤشر المجتمع (DESI)، حيث يتكون من ٣ محاور.( رأس المال البشري والاتصال ورقمنه الأعمال ) لقياس مستوى التقدم التكنولوجي في الدول محل الدراسة.

**النتيجة:** توضح نتائج الدراسة إلي أن التحول الرقمي يلعب دورا هاما في إحداث تغير هيكلي في اقتصاديات الدول محل الدراسة في القطاعات الرئيسية محل الدراسة عدا قطاع الخدمات الذي يتطلب جهودًا كبيرًا لتعزيزه ، ويتم ذلك من خلال الاستثمار في التعليم وتطوير البنية الأساسية الرقمية، إضافة الي التدريب الرقمي الفعال.

**الكلمات المفتاحية:** التحول الرقمي، التغير الهيكلي، الدول النامية.

## 1. Introduction

The most important part of macroeconomic theory and policy is devoted to the study of economic growth. Economic growth theory deals with the problems of dynamic equilibrium and attempts to get through efficient allocation of available

production factors to guarantee a sustainable increase in real gross domestic product per capita in the long run .

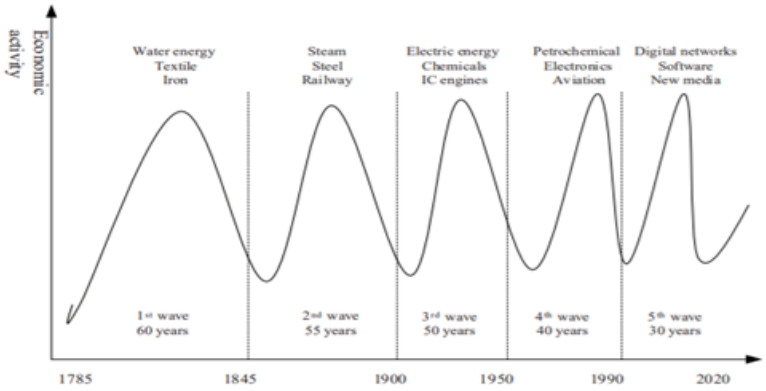
According to the neoclassical growth model of Solow (1956) and Swan (1956), an economy's long-run growth rate is determined exclusively by the rate of technological progress, which was considered as an exogenous variable, consequently economic growth is predominantly a result of external forces. But the biggest drawback of neoclassical growth theory is a failure to respond to the question of how technological changes occur. **(Gupta, M,2015)**

The endogenous growth theory has tried to overcome this shortcoming by building macroeconomic models out of microeconomic foundations. In these theories, technological progress came to be regarded as an endogenous factor of economic growth, generated by internal causes **(Sredojević, et al, 2016).** For the first time, Romer (1987) and Lucas (1988) advanced the hypothesis on the endogenous nature of the most important technological innovations, based on investment in technological development and in human capital. **(Sharipov, I. ,2015).**

At the dawn of the industrial era, Today's world has achieved unprecedented technological innovation advances. First came the development of a connected economy, characterized by mass take-up of the Internet and the roll-out of broadband networks. Schumpeter

explained this phenomenon through his
waves of innovation (Figure1) .

**Figure 1: Schumpeter's long waves of innovation**




**Source : Jovanović, M., et al , (2018)**

Currently, we are living in the 5th wave of innovation, where the economy transformed to digitalized one whose production and consumption models are based on the incorporation of digital technologies in all economic, social and environmental dimensions. **(Jovanović, M., et al ,2018)**

Since the onset of the fifth wave of innovation, we can distinguish three eras of digital economy: Firstly "Digitization" where the analog items are converted into digital versions (i.e. electronic version of paper documents); secondly "Digitalization" ,where digital technologies are used to change business models, create revenue, improve business and value- producing

opportunities; and finally " Digital transformation" ,where digital technologies are used to change all business aspects. **(I-scoop, 2016)**

Therefore, the introduction and use of digital technologies in economic processes increases productivity and allows you to participate in global value chains. Digitalization contributes to increased efficiency by reducing transaction costs, eliminating information asymmetry, using economies of scale and network effects .

Eventually, Technological progress causes production efficiency differences among departments and impels the flow of production elements into industry divisions with high productivity. This process creates a flow of elements across departments and promotes the transformation and upgrade of the industrial structure which is known as structural change phenomena. **(Zhou, et al,2021)**

Hence, it is necessary to identify the structural change, which shows shifts in the way the economy is operating and allocating its scarce resources. Furthermore, it implies that resource allocation must change in favor of economic sectors that are more productive and characterized with the ability to maximize economic (or social) welfare.

For developing countries economic growth must be derived by structural changes. Following recent development theories, the required long run growth rates are fostered by

structural changes that is primarily derived by the relevant technical progress. It can also be argued that successful structural changes in developing countries are the ones that induces technology and innovation by the availability of technology infrastructure. If this happened, the main conclusion about the digitalization – structural changes nexus is simultaneous .

## 2. literature review

- **(BONDAREV, 2021)**

This study developed an endogenous growth model in which doubly differentiated research and development is the engine of growth. The authors note that the model includes dynamic structural changes and heterogeneous changes in knowledge.

- **(BYE et al., 2021)**

They argued that the promotion of economic growth and the transition to a more knowledge-based industrial structure will be at the forefront in the coming decades. Researchers are studying how more, and better human capital can contribute to knowledge accumulation and structural change through a dynamic endogenous growth model, with Norway as a numerical example.

- **(ROMÁN et al., 2021)**

They have found that growing interest in diversifying the economy, improving technology and specializing production again puts structural change at the center of economic development theory. The authors seek to fill this gap by using a

synthetic indicator that reflects the dynamics of structural changes in the long run and allows to identify various patterns of development

- **(SHEVANDRIN et al., 2020)**

Their study is based on the quantitative assessment and identification of the relationship between economic growth and structural and technological changes in the economies of the regions, which allows us to conclude about the quality of the observed economic growth or factors of economic downturn. According to the research of scientists, it is concluded that there is no positive impact of structural changes on economic growth in the regions.

- **(DÁVILA-FERNÁNDEZ et al., 2020)**

They investigate and analyze the interaction of structural and institutional changes. Emphasis is placed on the sharp contrast between societies. Using Tearwall's law as a connecting bridge, the authors present empirical evidence regarding the attitude and production structure for a sample of 20 Latin American and 14 Asian countries.

- **(SONI et al., 2020)**

They made empirical analysis of the nature and causes of structural changes in the Indian economy shows that industry and the economy are driven by the services sector, and the growth and dominance of the sector are influenced by external factors such as foreign direct investment.

- **(RAMSTETTER, 2019)**

The aim of the study is to assess the extent to which foreign direct investment in developing countries is associated with structural changes in the Asia-Pacific region.

- **TRESHCHEVSKY et al., 2018)**

The purpose of the article is to identify promising areas of structural change in the regions based on economic and statistical analysis. The authors propose for each group of municipalities promising areas of structural change in the economic and social spheres .

- **(ZABELINA et al., 2016)**

The examine the structural changes in the Russian and Chinese regions involved in cross-border cooperation processes. The authors conclude that the possible impact of cross-border relations on the dynamics of sectoral changes in the regions of Russia, while the Chinese provinces are less dependent on this factor.

- **(SAVELIEV, 2013)**

The author of the article analyzes the regions, which allows to determine the factors of their competitiveness and assess how effectively they are used. According to the research results, standard strategies for modernization and increasing the competitiveness of regions are proposed.

- **(VAYSMAN et al., 2013)**

Scientists propose a forecast of structural changes in the economy, which is planned to be implemented in two areas: in the traditional sector of the economy and the knowledge-based economy. The method was developed to determine the first forecast field, the approbation of which confirmed the probable downward trend in traditional sectors of the economy.

## 3-Statement of the problem:

In the new economy, knowledge, skills and innovation are key inputs in the production function. Unlike traditional economies in which capital and natural resources represent key drivers of economic growth, the new economy entails building knowledge and innovation capabilities with a view to enhance productivity value-added of the board economic sectors (industrial, agricultural and services).

Unfortunately, up until today, most of the new literature on the impact of digitalization has focused largely on the industrialized countries of the Global North only, while the impacts on developing countries are under-researched. However, there is reason to believe that a separate analysis of the impact on developing countries is necessary, since the impacts of digitalization differ significantly according to the level of industrialization and income per capita. However, the envisioned impacts of digitalization are rarely grounded in theoretical or

empirical evidence, and it is still unclear how digitalization will affect structural change.

In accordance with the above, the research problem can be formulated in the form of set of questions:

- What are the main drivers of the variables under consideration (i.e digital transformation and structural change)?
- How far the technological innovation (digitalization)and the productivity of the board sectors related in developing nations?

## 4.Objectives

Main objective: - This study pursues to analysis the relationship between digital transformation and structural changes by answering the mentioned earlier questions.

Following research sub-objectives would facilitate the achievement of this main:

1. Highlighting the context of structural change and digital transformation.
2. Conducting an analysis of the structuralist methodology, certain trends in the developing countries' economic structure.
3. Providing recommendation to the policymakers in terms of the acceleration of the growth rates by identifying the sectors' value added.

## 5.Hypothesis

## It is hypothesized that:

Digital transformation influences the process of structural change through its contribution to technology-driven productivity and share of employment in the board sectors (industrial, agriculture and service) of the economy in developing economies.

## 6. Methodology

The literature on structural change considers technology as an engine of value added for each sector as a percentage of GDP and job transfers among economic sectors (**Freire, 2021),** moreover, the phenomenon of digital transformation will be proxied using the dimensions of digital economy and society index (DESI) . According to the availability of data for our sample of countries, a set of data called human capital, connectivity and business digitalization which examines the level of technological advancement.

Consequently, this Study seeks to analysis the trends of the digital economy and structural changes whether value added or employment over the period (1998-2022) in our three primary sectors for a sample of five countries **(India, Egypt, Indonesia, Brazil, Philippine).** The methodology of sample selection is that these are the countries with the largest population among the panel, as proved by(Leukhina & Turnovsky, 2016) .Whereas the

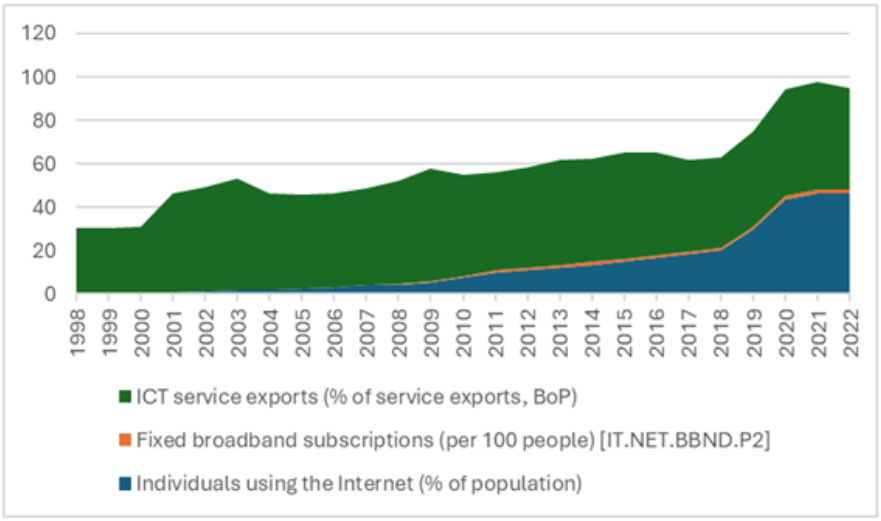
rapid population growth characterizing the eighteenth and nineteenth centuries was likely an important contributor to the process of structural change.

## 7. Digital transformation and structural change Nexus in developing countries.

### 7.1 India

Enterprise's globalization, economic liberalization, the worldwide internet boom of the 1990s, and the current digital revolution, which began in early 2000, contributed to propelling India's technology services industry forward. As shown in figure 4 the digital transformation indicators for Indian economy have authenticated an uncredible strides since the last decade which attributed to "Digital India" project launched by the Indian government, a significant reform aimed at accelerating digitalization. The project has a total cost of approximately 14 billion USD (or Rs. 1 lakh crores) and aims to transform the country into a knowledge economy by providing individuals with simple access to technology, infrastructure, and government services**. (Ahluwalia, 2023)**

**Figure 2 Digital transformation indicators for India**



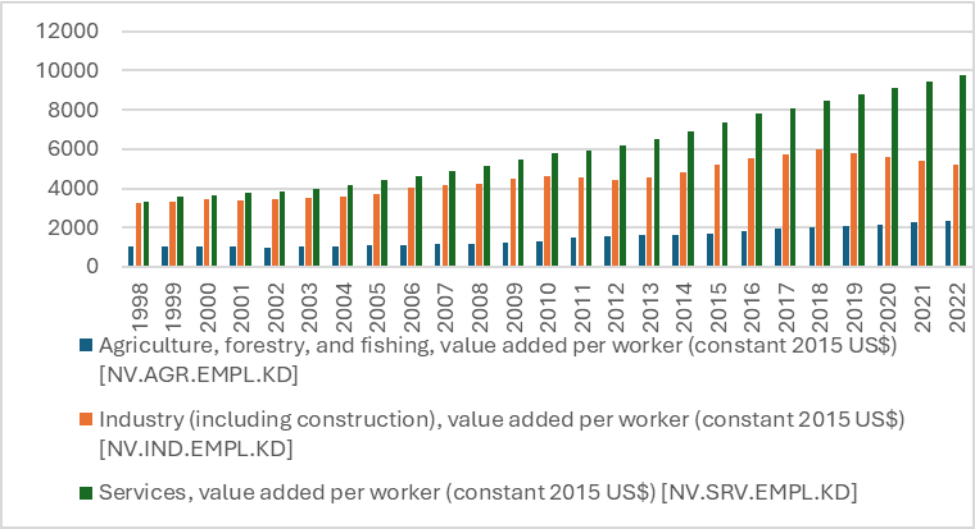

**Source: drawn by the author using data from WDI.**

The Communications and IT Ministry aimed to generate $1 trillion in business prospects by having a significant impact on the IT/ITES, electronic, manufacturing, and telecom industries. The "Digital India" program has tried to give high-speed Internet to the average man and make all government services available to the public.

Furthermore In 2009, the "Aadhaar Scheme" was established to incorporate all citizens through the distribution of biometric identification cards. Initiatives were also made to present immediate advantages (such as unemployment compensation, subsidies, public utilities, and so on) using ICT to eliminate intermediaries, bypass informality, identify cybercrime,

control the security of borders, and foster electronic commerce, allowing the government to effectively pursue redistributive policies, preserve security, and present efficient public services. **(G. Gupta & Basole, 2020)**

**Figure 3 Sectoral value added for India.**

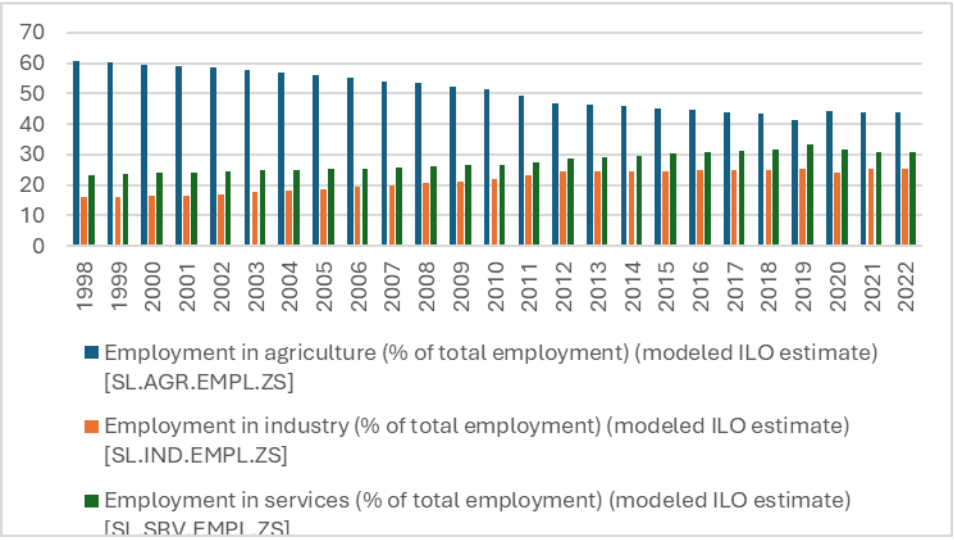



**Source: drawn by the author using data from WDI.**

While regarding the structural changes' indicators in figures 5,6 , they raise the following: Agriculture's share of value added and employment continues to quite decline, besides the manufacturing sector has not expanded as predicted in contrast service sector have witnessed accelerated growth in value added and gradual in employment. All of these contributions highlight the services-led

nature of growth in the Indian economy because of digital transformation. **(Ray & Kar, 2022)**

**Figure 4 Sectors employment level for India.**



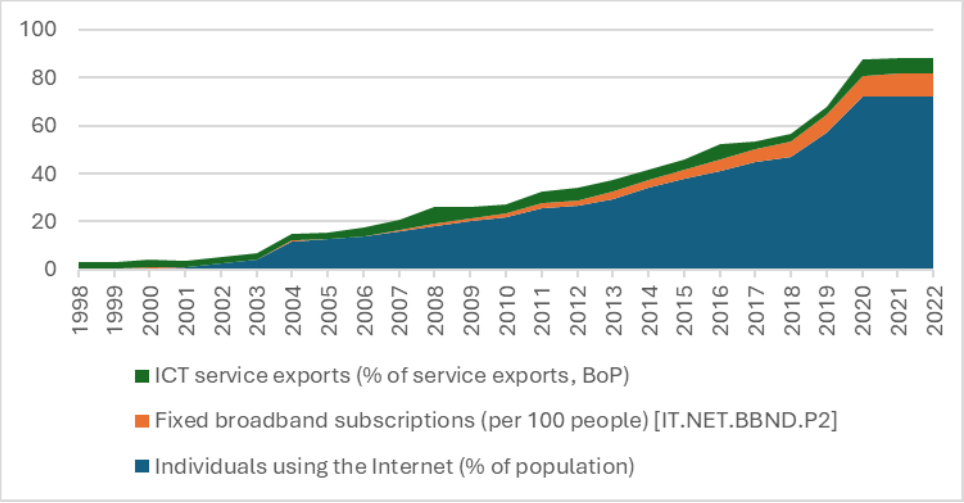

**Source: drawn by the author using data from WDI.**

## 7.2 Egypt

Egypt has made significant investments in ICT infrastructure and infostructure since the mid-1980s, recognizing it as a crucial component for development. Early on in the route, Egypt adopted a statewide strategy for handling national difficulties like as debt, illiteracy, bad infrastructure, and structural reforms. ICT was viewed as an essential tool for strategy conception, development, and implementation as shown

in figure 7 ,In 1985, Egypt's government founded the Information and Decision Support Center (IDSC), a cabinet-affiliated think tank. The goal was to use a supply-push method to develop and implement large-scale informatics projects to boost socioeconomic growth through cutting-edge ICTs. **(Raymond et al., 2020).**

**Figure 5 Digital transformation indicators for Egypt**.




**Source: drawn by the author using data from WDI.**

Between 1985 and 1995, a government-private sector cooperation significantly improved Egypt's information infrastructure by establishing several informatics projects in public and private organizations aimed at socioeconomic growth.

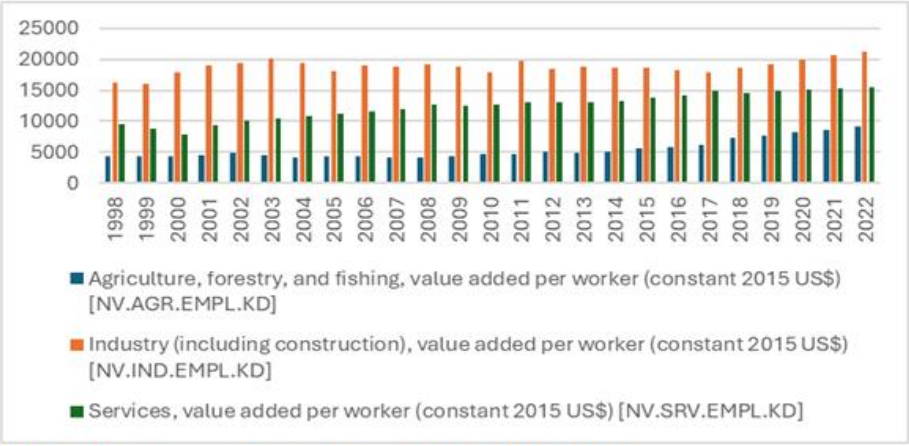
In 1999, ICT was highlighted as a top policy priority,

prompting the establishment of a new cabinet office: the Ministry of Communications and Information Technology (MCIT).

In 2017, the MCIT launched Digital Egypt, a 2030 ICT strategy aimed at supporting the sector's growth and contributing to both economic and socioeconomic growth. The strategy includes initiatives like MSMEs development and human capital capacity-building. In 2020, Egypt ranked 72nd in the UN Global Knowledge Index, up from 82nd in 2019. It also ranked 23rd in technical and vocational training and 74th in ICT, compared to 78th in 2019. **(UNDP,2020).**

In November 2019, Egypt's government formed the National Council for Artificial Intelligence (AI), a collaboration between government, academia, and the corporate sector to research AI potential and their impact on various economic sectors. Egypt secured over USD 1 billion in 2020 for digital transformation, with USD 3.19 billion assigned to support the private sector, particularly MSMEs, in digitalizing their operations (Ministry of International Cooperation, 2021). Improving broadband access is a crucial component of digital transformation, creating new economic and social benefits. **(Kamel, 2021)**

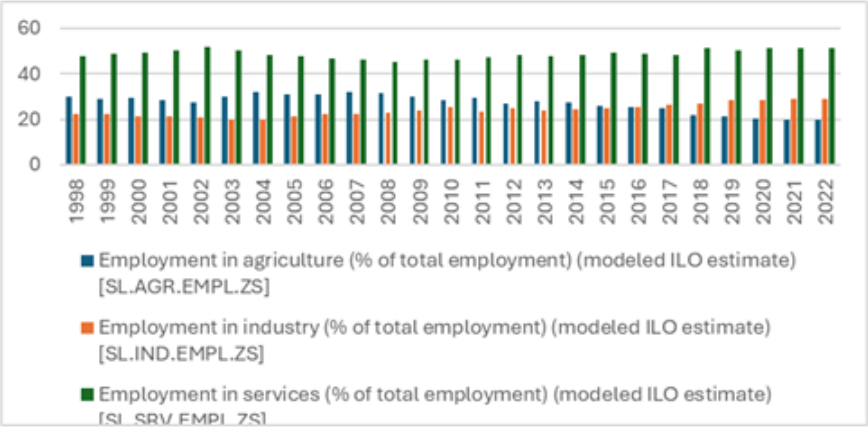
**Figure 6 Sectoral value added for Egypt.**




**Source: drawn by the author using data from WDI.**

Regarding the contribution of sectors value added and employment figures 8,9, Over the past decade Egypt's economy has tilted towards away from agriculture and manufacturing toward services pursuing a trend that has been developing over the past three decades. However, the decline in the employment share of low-productivity sectors in Egypt has been slow. Over 50 per cent of employed Egyptians still worked in agriculture or in the public sector in 2010. The largest rise in the share of jobs over the decade was in construction, an unproductive sector already burdened by a lack of modernization and an abundance of unskilled workers but supported by large energy subsidies reducing the cost of building materials, notably cement. Meanwhile, the employment share of private sector services and industrial manufacturing had almost stagnated, sharply contrasting with other emerging economies.**(Morsy et al., 2014).**

**Figure 7 Sectors employment level for Egypt**




**Source: drawn by the author using data from WDI.**

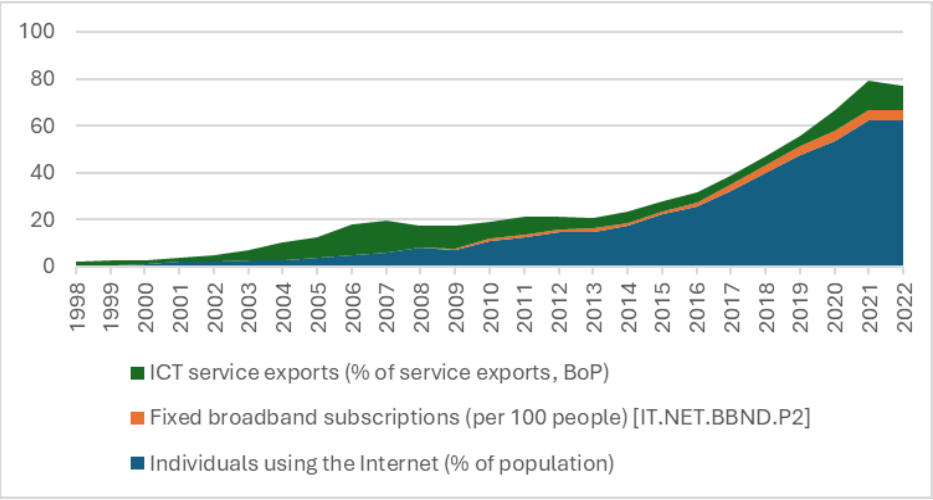
## 7.3 Indonesia

Digital transformation has a special role to play in Indonesia due to of the nation's unique of socio-economic and geographic characteristics. Indonesia's youth are leading the revolution of the ICTs sector in Indonesia, the average age of the population is 24, in addition to 60% of the population being under 39.

Since 1990 with the privatization vision ICTs sector that generated $17 billion in FDI, Mobile telecommunications coverage jumped from 3% in 1999 to over 100% in 2013, By 2014 There were more than 70 million users. Since mobile networks are more widely available than fixed lines, most Indonesian Internet users access the Internet using mobile

devices that contribute around 62% of population in 2022 as shown in figure 10 **(Tabor & Yoon, 2015).**

**Figure 8 digital transformation indicators for Indonesia**

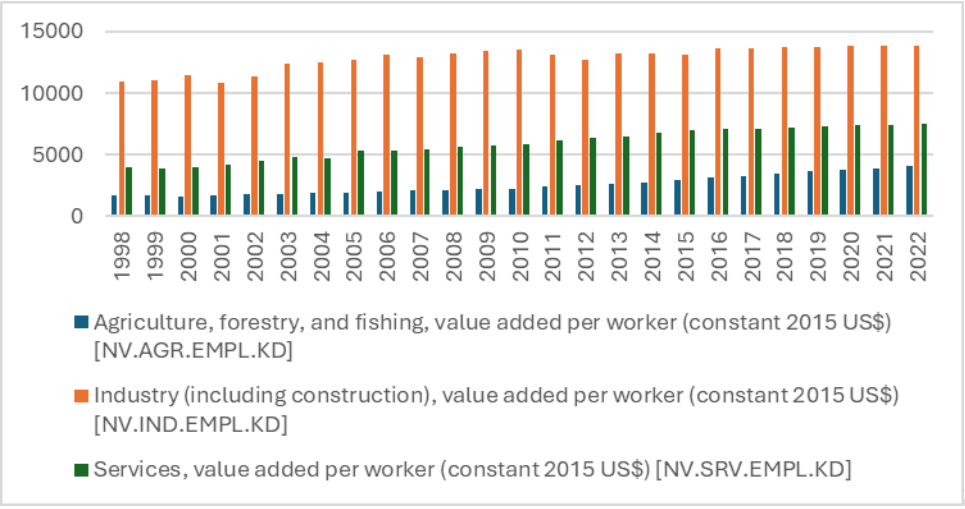



**Source: drawn by the author using data from WDI.**

In 2015 the public sector launched a Broadband Plan (IBP) by a $27 billion which is implemented during the period (2015 - 2019) in order to enhance the ICT infrastructure, that make Fixed broadband subscriptions rise up from 1.5 to 4.5 per 100 people during the period (2015-2022).

As we shown in figure 11,12 from the variations in productivity between the sectors that create and lose jobs, the researcher found that labor productivity growth has mainly been driven by within-sector progress, rather than structural change

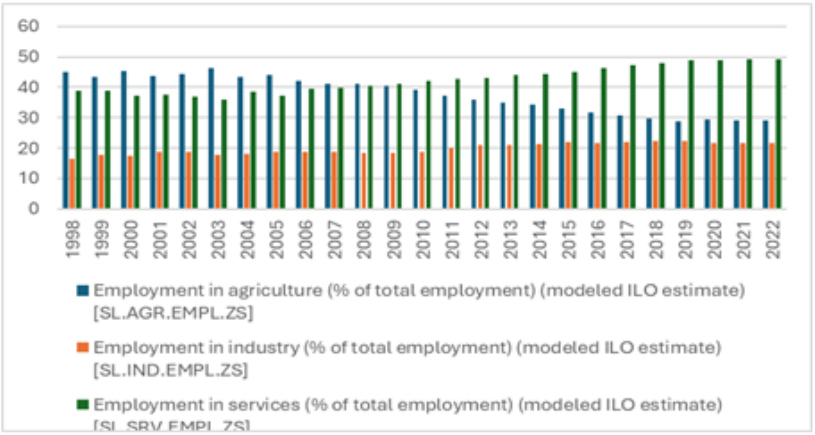
**Figure 9 sectors value added for Indonesia.**




**Source: drawn by the author using data from WDI.**

That makes the share of workers in the service sector rise rather than agriculture and industry sectors. This is because the majority of newly created jobs have been in low-value services, which are not significantly more productive than the industries that are losing workers (mostly agriculture).**(Gil Sander & Shen Yoong, 2020).**

**Figure 10: sectors employment level for Indonesia**




**Source: drawn by the author using data from WDI.**

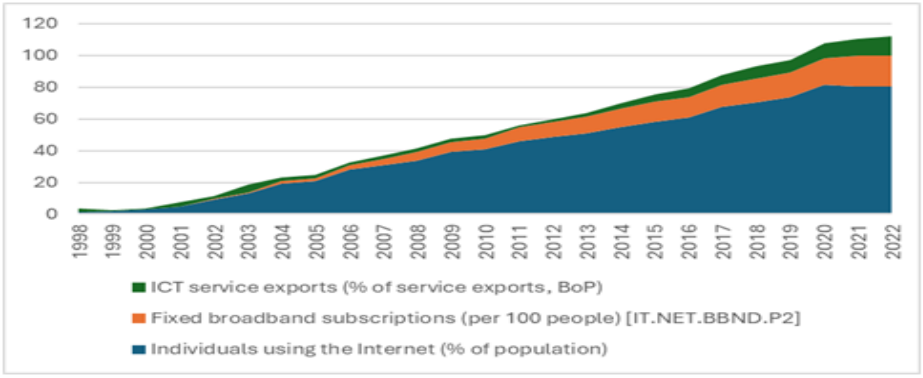
## 7.4 Brazil

Brazil has introduced new policies to promote technology and innovation during the past decade (see figure 13). During the analyzed period, the first breakthrough in Brazilian innovation policy was the establishment of the so-called Sectoral Funds. These funds were established in 1999 by taxes and donations from several economic sectors, including oil and gas, telecommunications, energy, and so on, with each sectoral fund having its own unique source of revenue. Brazil's sectoral funding sources were supplemented with a tax on foreign technology acquisition, known as CIDE-tecnologia. This tax applies to any technological contract, including technical

assistance and licensing, where Brazilian companies acquire technology from non-residents.

A more current scheme of tax incentives to encourage corporations to invest in R&D was implemented in 2005, with the enactment of the so-called "Lei do Bem" (Law no 11,196/05). The Lei do Bem marked a substantial improvement in corporate strategy by establishing a particular tax break that could be applied automatically to R&D investments. The Innovation Law and the Lei do Bem were both implemented during President Lula's first term as part of the new industrial policy (Industrial, Technological, and Foreign Trade Policy - PITCE) that was unveiled in 2003. **(Wigginton & Matsubayashi, 2019)**

**Figure 11 digital transformation indicators for Brazil**




**Source: drawn by the author using data from WDI.**

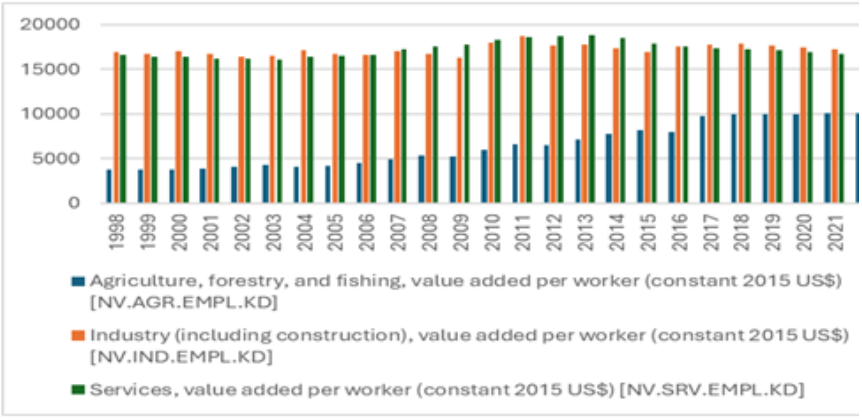
Within the scope of the Greater Brazil Plan (launched in 2010), FINEP and the Brazilian National Development Bank

(BNDES) launched the Innovate Company Program in 2013. This was a massive public line of credit with subsidized interest, which focused on innovation projects rather than just R&D.

In 2014, the federal government launched two bold initiatives: i) the Knowledge Platform Program and ii) the Brazilian Industrial Innovation and Research Corporation (Empresa Brasileira de Pesquisa e Inovação Industrial, EMBRAPII). **(Lara & Prado, 2023)**

As we can see in figures 14 ,15 In general, for the two scenarios, services contribute more to the decline in gross production and value added, owing to their bigger part of the Brazilian economy. The same holds true for employment and aggregate payroll, as services are usually more labor-intensive than manufacturing.

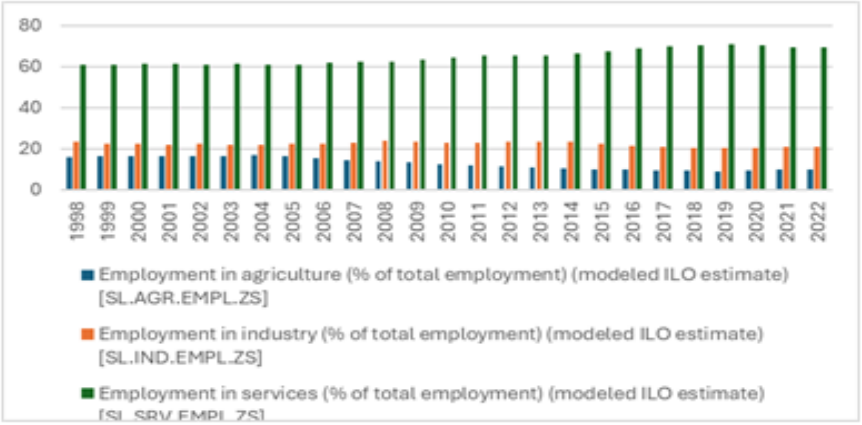
**Figure 12 sectors value added for Brazil**




**Source: drawn by the author using data from WDI.**

Imports, on the other hand, have a bigger manufacturing impact since manufacturing subsectors demand imported commodities in greater proportions**.(Rodrigues-Silveira, 2023)**

**Figure 13 sectors employment level for Brazil.**

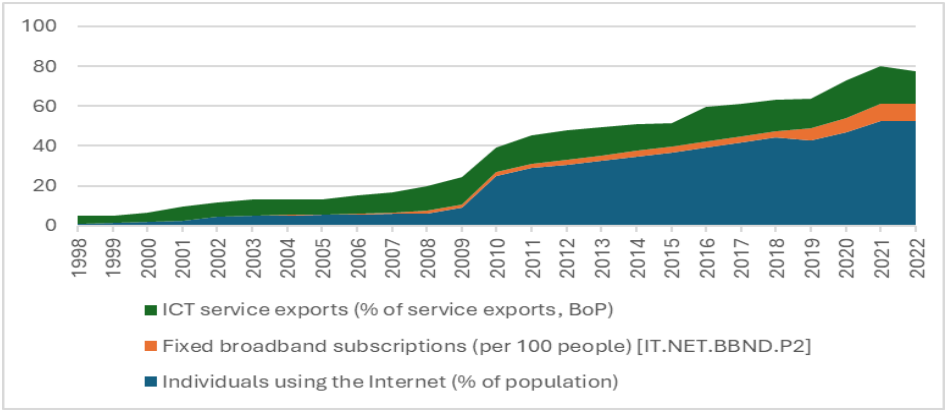



**Source: drawn by the author using data from WDI.**

## 7.4 Philippine

As we shown in Figure 16 that the level of development of ICTs in Philippine trend to rise particularly the period after 2010 due to Philippines Digital Strategy (2011-2016) to enhance the infrastructure od ICTs and create prosperous society where everyone has reliable and secure information access in the society, In addition to the global trend towards the digital economy.

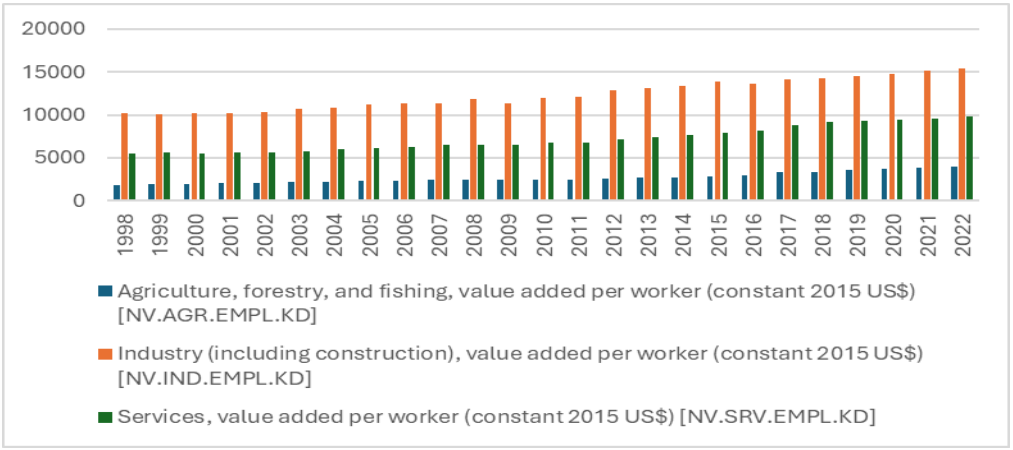
**Figure 14 :digital transformation indicators for Philippine.**




**Source: drawn by the author using data from WDI.**

According to academic studies in World Bank, that every 10% increase Fixed broadband subscriptions boosts Gross Domestic Product by an average of 1.3%, and every 10% rise in mobile density with a 0.7% rise in GDP.

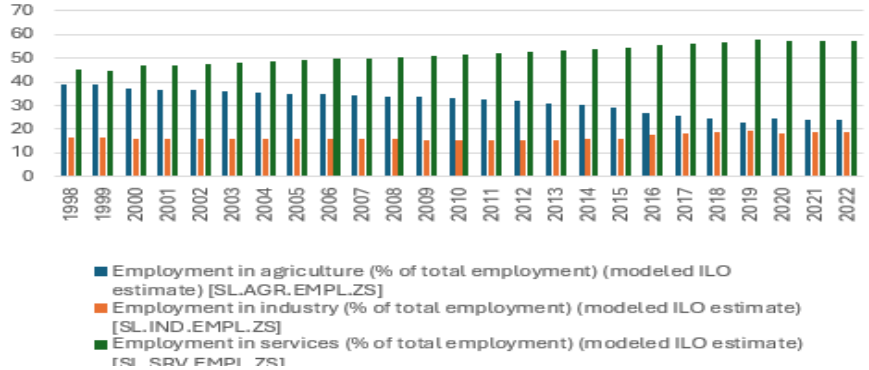
**Figure 15 : sectors value added for Philippine.**




**Source: drawn by the author using data from WDI.**

Furthermore, the Philippines Government in 2013 launched a new program in ICT that called "Smarter Philippines'' that is focused mainly on a few vital industries, and it used as a tool to enhance the priority sectors in Philippine**.(ICT, 2016)**

**Figure 16 : sectors employment level for Philippine**




**Source: drawn by the author using data from WDI.**

As we shown in Figure 17,18that the value added per worker in the industry sector has exceeded that of the agriculture and service sectors, although the sector's share in total employment declined compared to the share of the service sector that contributed to 57% in total employment in Philippines in 2022 that is more than the shares of agriculture and industry sectors combined. In similar vein Structural change does not contribute as much to labour productivity in Philippines as in regional peers such as Indonesia because of smaller reallocations, finally, the gains of labour productivity in industry sector overall were not significantly impacted, it contributes a small impact to the level of employment in this sector.(**Mikael Mitra, 2013).**

## 8.Conclustion

The main objective of this study was to investigate the process of structural transformation of developing countries. Therefore, it has been hypothesized that technological upgrading (digital transformation) of the primary sectors contributes to the structural change through two main venues 1) the contribution of value-added to the economy and 2) the re-organization of the share of the employment in the primary sectors of the economy (structural change).

Our results show that, for **value added**, digital transformation proxies of people using the internet, fixed broadband and ICT exports have a positive and significant

impact on the three sectors and, hence, on structural changes in the sample economies.

Regarding **employment**, the results indicate that digital consumption, digital production, network chains, and multinational industries provide new employment opportunities and possibilities except for the share of employment in the traditional service sector in developing countries where division of labor is not easily realized. In the manufacturing industry, a product can be processed in different parts of the world and then combined into one piece. However, the service industry is unable to create this type of division of labor given that it requires human-to-human services. Therefore, in the traditional service industry the service provider and receiver must be in the same place at the same time.

## 9. Policy Implications

A number of policy implications emerge from the main findings of this thesis. First and foremost, our findings acknowledge that structural change through digital transformation should be given a prime importance as a policy goal as it has an essential role in achieving high productivity growth. it also helps achieve more diversity in the economic structure change. So, this study offers the following policy implications for developing countries to enhance their efforts toward digital transformation in order to achieve economic development and structural change.

Regarding the interaction among sectors, economic diversification by shifting from agriculture to industry and services which can be achieved through investment in technology and training, and by creating favorable policies for industrial growth, so the lack of economic diversification and specializing in resource exports could crowd out other tradable sectors, which would ultimately have negative externalities on the economy through supporting long-term sustainable development by spreading risk across various sectors.

Regarding human capacity building and education development, the developing nations need to focus on improving the quality of education at all levels to build a skilled workforce that can adapt to new technologies and economic opportunities. In addition to Enhance access and connectivity, foster effective use of digital technologies, and improve digital skills among citizens and businesses.

Concerning the digital transformation, they have to develop digital infrastructure to support the growth of the ICT sector and enable e-governance and digital services in order to support economic activities and attract foreign direct investment. Besides supporting innovation, foster a culture of innovation through research and development initiatives. facilitate technology transfer operations and adoption to enhance productivity and competitiveness.

As a general requirement for the developing nations, leverage global partnerships engage in international trade and cooperation to access new markets and technologies. In addition to, learning from the experience of leading countries while implementation policies that are suitable their own requirements and local context.

For the institutional framework, reform public institutions to become more efficient, transparent, and accountable. Legal and Regulatory Frameworks: Establish legal and regulatory frameworks that support business development, protect property rights, and encourage foreign direct investment and fair competition. Similarly, Public-private partnerships (PPPs) play an important role in structural change and development in developing countries, particularly large-scale projects that require a large amount of financing.

Strengthening the linkages between booming domestic industries and the rest of the economy would be one important step in this direction. When these industries have limited scope to strengthen such linkages and spillovers, however, direct interventions might be required to diversify the economy towards sectors that have higher potential to diffuse technological learning across the whole productive structure.

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