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# The Impact of ICT on Service Sector's Productivity and Employment in the Philippines

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| ARTICLE INFORMATION | ABSTRACT |
|---|---|
| | Various studies have been conducted among different countries to determine the relationship of ICT on productivity and employment, but the results vary among industries and firms. This research aims to examine the impact of ICT on the service sector productivity and employment in the Philippines through quantitative research methods. Findings on the relationship between ICT and Productivity show that all the independent variables have a linear relationship on the dependent variable while the findings on the relationship of ICT and Employment, only Labor Force Participation Rate shows a nonlinear relationship to the dependent variable. The researchers ought to impart knowledge about the opportunities and threats brought by ICT, which may guide the policymakers who formulate policies regarding the advancements brought by ICT. |

## 1. Introduction

Information and Communication Technology (ICT) is evident and used everywhere, making it an essential tool to easily access information and transform our way of communicating and engaging with people and various agencies. The Philippine Statistics Authority (PSA) categorizes ICT as a part of the "Information Economy" or IE that refers to industries that provide ICT products and services. In 2017, PSA stated the preliminary results of the Survey on Information and Communication Technology (SICT) for the Information Economy that almost 99% of the ICT sector uses computers and communication equipment in their business operations.

According to the Department of Trade and Industry, the rise of the service sector in the Philippines began in the 1990s, where an average of 52.4% of GDP comes from the sector's output. The country's initiative to prioritize and reallocate the investments to the industrial and service sectors because of its influence on the economy (Go et al., 2019). In 1992, the Philippines took advantage of the foreign companies' demand for IT support, software development and English-proficient workers that paved the way for the Business Process Outsourcing (BPO) industry.

In 2019, BPOs generated over $26 billion in the Philippine economy and provided 1.3 million jobs for the Filipinos from different foreign companies in travel and insurance, customer support and telehealth services (Thompson, 2020). An estimate of over 1.5 million freelance Filipino workers was given the opportunity to work from home if they have access to the internet through the outsourcing digital platforms that function as an "E-bay" of short-term jobs (Wood et al., 2019).

According to the International Trade Administration, the Philippines is one of the fastest-growing retail e-commerce markets online, and the most used online platforms are Lazada, Zalora, Shopee, Ebay and Kimstore. This online shopping trend contributes to the boost of the transportation and freight sector, which delivers the goods to the place of the consumer, changing the way consumers shop in stores and eventually replacing the in-store shopping trips (Kim et al., 2021). In 2019, there are almost 4 billion

internet users in the world, and approximately 76 million are Filipinos, despite the low internet penetration rate in the country. The modernization of applications enables ICT to play a bigger role in national productivity and employment opportunities, but poor ICT infrastructures hinder the speed of growth (Salvosa II, 2015).

The research focuses on determining the significance of ICT to the sector's productivity and employment. The objective of this study is to quantify the impact of ICT in the Philippines service sector by measuring its relationship with the service value added (% of GDP) and share of total employment employed in services. It also aims to help the government to formulate policies that can protect from the possible threats brought by ICT and support future technological investments in the Philippines.

## 2. Review of Related Literature
### 2.1 *ICT and Productivity*
Productivity, a key source of economic growth and competitiveness, is a way of improving the standard of living that depends on raising or increasing the number of output that a worker could make. It has an impact on socio-economic development at the different levels of the economy (national, organizational, and individual levels). Export and import in a country can also be used to identify its effect on the service sector's productivity. A study's findings showed that the export volume has a negative impact while the import volume was revealed to positively impact the sector's productivity (Nyamekye, 2015).

One of the factors that were said to affect the growth of a country, a sector or a firm's productivity is innovation (Chou, 2014). Technological innovations have many benefits for businesses, such as time and cost-effectiveness, better communication, and increased efficiency in controlling and processing output (Adewoye et al., 2011).

Based on different studies, ICT could be measured in various ways. In the study of Otoo and Song (2020), the ICT variables they used were Mobile cellular subscriptions, Fixed Broadband subscriptions, Internet users, and ICT index. This study has proved that these advancements have a strong relationship between both rich and poor countries' productivity and economic growth, but the gains are more visible in the poor countries than those in the rich countries, which makes the gains of these countries differ from each other.

The study conducted in EU countries by Gruber et al. (2014) used the aggregate production function as the basis of their model and applied explanatory variables such as labour, capital, and the number of broadband lines, while the dependent variable used is real GDP to measure the growth of the economy. The study affirmed that the building infrastructures to expand the internet coverage and speed affects economic output, but the cost of the construction and operation was less high than the economic growth it brings to the countries.

Ageing labor capital with either high or low skilled labor was used to determine its impact on productivity in other countries' industries. ICT capital was also included as part of their study and revealed that there was a complementary effect with older workers and the ICT capital in industries with a large share of ICT in the capital stock. Other studies also found that ageing labour capital positively impacts productivity, especially those workers with high skill or educated, but it was not compatible with ICT capital. It was more interdependent with those low-skilled workers (Ilmakunnas & Miyakoshi, 2013; Lee et al., 2020).

Mobile ICT was used in studies as a proxy for the firms' ICT use. In research by Kim et al. (2021), ICT was measured by wired ICT and mobile ICT to know its effect on the GDP of developed and developing countries. As a result, the use of this mobile ICT has been proved to be significant to develop countries compared to developed countries because it is more convenient and cheaper than wired ICT. Bridging it to another study found that when mobile ICT is combined with extremely flexible work arrangements, firms can obtain larger productivity improvements. A positive result was found that concludes adopting ICT assists businesses' employees to systematically organize their work using trust-based work time arrangement or TBW (Viete & Erdsiek, 2020).

In the study by Lee & McKibbin (2018), measured the productivity of Asian countries, findings showed that the increase in the productivity of an economy would be critically based on beneficial factors such as having a better and strong human capital, investment rate and other economic factors in the economy that would help enhance the productivity in the service of the economy. If the productivity growth in a particular sector increases, then a country's GDP will rise and help build progress and continuous development in its economy. Same with the study was conducted by Pradhan et al. (2018) using ICT infrastructures such as Broadband and Internet Users, Labor Force Participation Rate, GDP per capita, and CPI has a positive long-run effect on the economic growth of the 20 countries studied.

Furthermore, in their retrospective report, Šniukienė and Sarkane (2014) used Fixed telephone and Mobile cellular subscriptions per 100 inhabitants as one of the indicators for ICT infrastructures and Internet users, Fixed Broadband Internet Subscriptions, and Mobile broadband subscriptions per 100 inhabitants as an indicator for ICT use while for the ICT production and trade on economic

growth, they used value-added as a measurement. Their study noted that results might differ depending on what the research uses as its data to determine the effect of ICT on productivity development.

## 2.2 *ICT and Employment*

To be able to sustain a competitive advantage, firms need to invest in ICT (Jung et al., 2019). Shifting from manual labour to mechanical work through ICT would widen opportunities to expand their product and service markets. Investing in technologies such as machinery would cost a great amount of expense for the company (Kılıçaslan & Töngür, 2018). In the study of Roy et al. (2017), the positive impact of innovation on employment holds true for high-tech manufacturing sectors.

One of the advantages of ICT adoption is the low price of products and services. The reduced price will not only increase its demand but also increase the demand for labor. Another is that machinery and computer equipment still require the aid of humans, which will offer jobs. Additional profit may be used for new products and services and thus, create employment opportunities (Vermeulen et al., 2018).

Even though ICT is perceived to give rise to unemployment, it still has compensation effects which later will be beneficial for the firm. In Africa, it was observed that the internet has no significant effect on employment due to the low rate of internet penetration. However, mobile phone penetration has a significant effect on employment as it provides jobs in the telecommunications sector for the people in their region. Developing countries need jobs, and developed countries will outsource and relocate their tasks to these underdeveloped nations (Goaied & Sassi, 2017).

Broadband is one of the advanced telecommunication technologies that permit the transmission of data at greater speed. Generally, it is being used by private sector firms in places where technology is commercially available such as urban areas. The effects of broadband internet expansion on labor market outcomes were studied using a fixed-effect model of employment and broadband access. One of the conclusions derived from the findings is that broadband expansion significantly affects the employment rate. The increase of the employment rate in the rural and isolated areas is substantially higher. Broadband technology complements the skilled labour, therefore, offering job opportunities for them. They are also being paid at a higher rate (Atasoy, 2013).

Zhu et al. (2020) concluded that the increasing number of employments in China is attributable to the increased turnover of sales in their old products (price effect of process innovation) and the improved production efficiency (productivity effect of product innovation) of new products is proven to be the reason for the delay in the growth of employment. Moreover, there is a need to expand the labor structure to somehow lessen the impact of technological innovation on labour demand.

Since the 19th century, unemployment has been a growing concern due to the birth of ICT (Pantea et al., 2014; Bessen, 2018; Piva and Vivarelli, 2018). Workers will be substituted because they will have difficulty keeping up with the machinery (Acemoglu and Restrepo, 2018).

The service sector in India comprises 58% of its total GDP, which is apparently more than half and greater than the other sectors such as agriculture and manufacturing sectors. Over the years, there has been a significant change in the GDP growth rate of India, but the increase in the employment rate is insignificant. One evident reason is the technological change in the service sector. Labourers were displaced by the additional unit of capital, which resulted in a rise in their productivity rate. There was a surplus of labour because, during the post-reform phase, other sectors were also challenged by ICT adoption (Behera, 2019).

The independent variable is Internet Subscribers measured by Fixed broadband internet subscribers (per 100 people) and Employment as the dependent variable were used to test the effect of technology on employment in a study conducted in 2016. Data used was a panel of 23 countries with a period of 15 years. Since this is panel data, fixed data regression analysis was used. The results revealed that there is a negative effect on service employment in Latin America. Internet users can now access multiple services using their mobile phones, which limits human aid. Therefore, resulting in unemployment (Murillo, 2016).

To determine the impact of ICT on Employment in Rwanda, the study utilized time series data analysis with a period of 30 years. The ICT indicators are mobile cellular subscriptions and the number of internet penetration, and the employment variable is measured by the labor force. The negative effect of internet penetration shows that it minimizes the rate of youth unemployment, while the positive effect of mobile cellular subscriptions means that it contributes to the increase in the employability of youth in their region (Faustin and Gallican, n.d.).

## 2.3 *Statement of Hypothesis*

H1: The share of the total population who are internet users has no significant impact on the Service Sector Productivity.
H2: Mobile cellular subscriptions (per 100 people) have no significant impact on the Service Sector Productivity.

H3:  Employment in services (% of total employment) has no significant impact on the Service Sector Productivity.

H4: Mobile cellular subscriptions (per 100 people) have no significant impact on the Service Sector Employment.

H5: Labor force participation rate has no significant impact on the Service Sector Employment. H6: Service value added (% of GDP) has a negative relationship with the service sector employment.

### 2.4 Theoretical Framework

In line with our objective, the Solow-Swan Growth model (1957) serves as a guide in determining the impact of ICT on productivity. Since the production function was used to explain the relationship of inputs to the outputs, this follows one of the assumptions of this model, which states that capital and labor are the same production technology that all firms in the economy are using to produce output. The theory simplifies that the relationship between capital and labor affects economic productivity. The production function is stated as:

Y= AF(K, L)

Where:

Y= is represented as the level of output or the GDP

K= is represented as the level of capital

L= is represented as the level of Labor

A= is represented as the determinant of the level of Technology

As for the relationship of ICT and employment, the study used the same theoretical approach as that of the study of Pantea et al. (2014), Roy et al. (2018), Jung et al. (2019), and Acemoglu and Restrepo (2018) which is the substitution and complementary effect on labor and capital. Roy et al. (2018) defined "complementary effect" as Technology-led growth that helps in generating employment while "substitution effect" means that capital replaces labor to increase productivity.

### 2.5 Simulacra
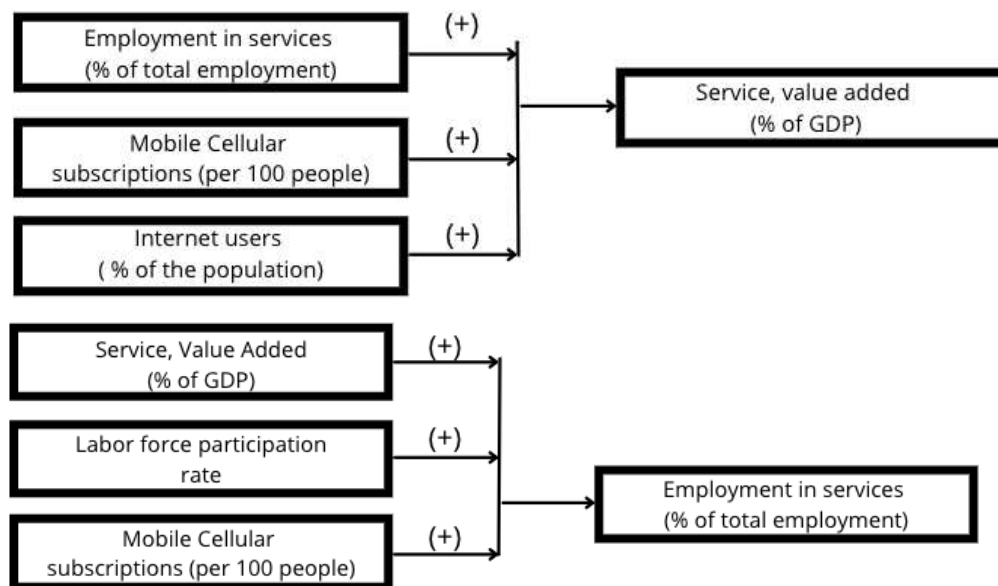


### 3. Research Method

#### 3.1 Research Design

This study utilized the quantitative method of research to quantify and analyze the impact of ICT on the service sector productivity and employment. Nyamekye (2016) employed the same research design in explaining the relationship between its research variables. To further examine the degree of relationship between the variables, a correlational approach is used, as the studies by Adewoye et al. (2011); Šniukienéa and Sarkane (2014); Atasoy (2013); Zhu et al. (2020); Viete and Erdsiek (2020).

#### 3.2 Data

Secondary data from World Bank Data were used covering the period from 1960 to 2020 in the Philippines' service sector. The researchers came up with two models: one for the service sector's productivity and another one for the service sector's

employment. The Variance Inflation Factor (VIF) application was also made to measure the fitness of the variables used in the model.

### 3.3 Models

In the study of Kim et al. (2021) and Chou et al. (2014), the use of a production function that indicates the relationship of inputs to the outputs will be the basis of the models derived by the researchers. The model is stated as:

$$Y = f(l, k_{ICT})$$

The production function shows that the output (Y) is derived from the inputs of Labor (l) and ICT capital (k). The regression model 1 is shown below:

$$Service\ Value\ Added\ (\%\ of\ GDP) = \beta_0 + \beta_1 Labor + \beta_2 Internet\ User + \beta_3 Mobile\ Users + e$$

The study of Gruber et al. (2014), Kim et al. (2021), and Otoo and Song (2020) used GDP as a measurement for national productivity relating it to the ICT capital, but since the study focuses on the service sector productivity, the measurement will be the Service Value Added (% of GDP). It is also the same variable used by Lee and Mckibbin (2018) in measuring the sector's productivity. The data used for the explanatory variables are the ICT proxies' Mobile cellular subscriptions (per 100 people) and Internet Users (per 100 people). As a proxy for Total Labor Employment, the Employment in Services (% of total employment) will be used. (ε) is an error term that stands for the variables that are not mentioned in the model.

The regression model 2 shown below was derived from the study conducted by Faustin and Gallican (n.d.) and Pantea et al. (2014), which also assessed the impact of ICT on employment.

$$Service\ sector\ (\%\ of\ Total\ Employment) = \beta_0 + \beta_1 LFP + \beta_2 Service\ Value\ Added\ (\%\ of\ GDP) + Mobile\ Users + e.$$

The explanatory variables are the ICT proxy, namely Mobile cellular subscriptions (per 100 people), Labor Force Participation Rate and Service Value Added (% of GDP). The study of Faustin and Gallican (n.d.) made use of the population as the proxy for labour force variable, but in this study, the researchers opted to use Labor Force Participation Rate (LFP) in accordance with the study of Pradhan et al. (2014). As for the dependent variable, the study used the Employment in Services (% of total employment) to assess the relationship between the sector's employment and the aggregate ICT capital. Again, the use of (ε) is an error term that stands for variables not mentioned in the model.

## 4. Results and Discussions

As mentioned above, this research aims to measure the growth of ICT in the Philippines, the growth of productivity and employment in the service sector, and determine the relationship of ICT to the service sector's productivity and employment.

The secondary data gathered was from the World Bank Database and had a data range of 61 years from 1960 to 2020, of the Philippine service sector. To answer the following objectives, the researchers used these variables as a proxy to quantify the ICT in this study: Mobile Cellular Subscriptions (per 100 people) and the Internet User (% of the population). On the other hand, the proxy variables used to measure the Service Sector are Employment in Services (% of total employment), Employed in the Service Sector to quantify the labor or the employment generation of the sector and the Service Value Added (% of GDP) to quantify the output generated by the sector.

### 4.1 Results

The major issue in the gathered data is that there are missing values. The reason behind the incomplete data is that the internet in the Philippines was established in 1994. If the researchers push through with multiple linear regression, it will violate its important assumptions and will also result in a high variation.

To address this issue, Multiple Data Imputation was performed to fill in the missing data points across the variables in line with the study of Phillips and Chen (2011), Breitweiser and Wick (2015) and Hassan et al. (2019). In the said process, the underlying pattern must be found within the non-missing data points under consideration in this study. These missing data points must be addressed to avoid the high bias that these absent observations may incur, thus invalidating the results of the analysis if it will be carried over.

| | Missing | | Number of | Mean | Standard Deviation |
|---|---|---|---|---|---|
| | N | Percent | Samples | | |
| **Employment in Services (% of total employment)** | 32 | 52.5% | 29 | 48.76 | 5.370 |
| **Internet User (per 100 people)** | 31 | 50.8% | 30 | 16.53 | 21.287 |
| **Labor Force Participation Rate** | 19 | 31.1% | 42 | 60.40 | 8.031 |
| **Mobile Cellular Subscription (per 100 people)** | 13 | 21.3% | 48 | 32.10 | 46.245 |

*Table 1. Variable Summary*

The values from Table 1 indicate that the missing data points across 61 observations from the original data set. For Employment in Services (% of total employment) and Internet Users (per 100 people), more than 50% of the missing data points can cause unwanted bias on the regression model if not addressed.

Using the Mersenne Twister Algorithm on SPSS, the missing data points were imputed on five different iterations to identify which of these generated data points will best fit the pattern based on the non-missing data points. This also includes the adjustment of data points to balance out the missing cases in the imputation. Although these generated data points are not guaranteed to be the actual values of the missing data points, they are random numbers that were based on the pattern of progression of the non-missing data points. Afterwards, all five iterations were tested out for Multiple Linear Regression to examine if the imputed values were suitable in constructing the regression model.

| Variable | Mean | Std. Deviation | N |
|---|---|---|---|
| Employment in Services (% of the total employment) | 48.76 | 5.370 | 29 |
| Mobile Cellular Subscription (per 100 people) | 53.14 | 49.317 | 29 |
| Internet User (per 100 people) | 17.10 | 21.430 | 29 |
| Labor Force Participation Rate | 62.66 | 2.288 | 29 |
| Service Value Added (% of GDP) | 52.76 | 4.808 | 29 |

*Table 2. Descriptive Statistics of the Original Data*

| Variable | Mean | Std. Deviation | N |
|---|---|---|---|
| Employment in Services (% of the total employment) | 42.17 | 7.527 | 61 |
| Mobile Cellular Subscription (per 100 people) | 23.21 | 48.977 | 61 |
| Internet User (per 100 people) | -10.05 | 35.440 | 61 |
| Labor Force Participation Rate | 59.22 | 8.145 | 61 |
| Service Value Added (% of GDP) | 45.52 | 7.989 | 61 |

*Table 3. Descriptive Statistics of the First Iteration*

Tables 2 and 3 show the difference between descriptive statistics before and after data imputation. The sample data increased from 29 to 61 observations with the use of the Mersenne Twister Algorithm on SPSS.

Multicollinearity diagnostics was also performed by measuring the Variance Inflation Factor (VIF) to select the suitable independent variables for predicting the variances on the dependent variable. The acceptable level or the threshold for VIF is less than or equal to 5; thus, the lower the VIF, which has the best combination of independent variables, the better. In this process, all five iterations went through this process to see which of the following iterations has a proper combination to the dependent variable that shows a little to no multicollinearity or auto collinearity correlation.

| | Under Standardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Tolerance | VIF |
| Constant | 4.485 | 1.314 | | 3.413 | 0.001 | | |
| Employment in Services (% of total employment) | 1.003 | 0.033 | 0.881 | 30.799 | .000 | 0.243 | 4.114 |
| Internet User (per 100 people) | 0.074 | 0.004 | 0.374 | 18.996 | .000 | 0.513 | 1.949 |
| Mobile Cellular Subscription (per 100 people) | -0.039 | 0.005 | -0.211 | -7.594 | .000 | 0.257 | 3.890 |

*Table 4. Collinearity Statistics of the third iteration with the least VIFs for Model 1*

| | Under Standardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Tolerance | VIF |
| Constant | 15.328 | 0.677 | | 22.655 | .000 | | |
| Service Value Added (% of GDP) | 0.900 | 0.020 | 1.016 | 43.976 | .000 | 0.224 | 4.456 |
| Mobile Cellular Subscription (per 100 people) | 0.014 | 0.003 | 0.084 | 4.086 | .000 | 0.283 | 3.534 |
| Labor Force Participation rate | -.236 | 0.013 | -0.264 | -18.195 | .000 | 0.569 | 1.758 |

*Table 5. Collinearity Statistics of the third iteration with the least VIFs for Model 2*

Based on the diagnostic tests performed to assess the multicollinearity and autocorrelation (high linear relationship across independent variables within a regression model), the data set did not satisfy these two assumptions due to high VIF values and low collinearity tolerance. Therefore, to address this, the regression model underwent a stepwise elimination method across all five iterations of datasets, including the original data set to counteract this issue and to choose the most suitable combination of independent variables that would give the lowest VIF values possible. As a result, the third iteration of both models has the least VIF of independent variables in relation to the dependent variable, which is shown in Table 4 for Model 1 while Table 5 for Model 2.

### 4.1.1 ICT and Service sector's Productivity

| | Dependent Variable | Independent Variables | | |
|---|---|---|---|---|
| | **Service Value Added (% of GDP)** | **Mobile Cellular Subscription (per 100 people)** | **Internet users (per 100 people)** | **Employment in Services (% of total employment)** |
| **Service Value Added (% of GDP)** | 1.000 | 0.806 | 0.895 | 0.980 |
| **Coefficient** | | -0.211 | 0.374 | 0.881 |
| **Sig. p-value** | | .000 | .000 | .000 |

*Table 6. Pearson Correlation Coefficient of the Service Value Added (% of GDP) to the Mobile Cellular Subscription (per 100 people), Internet Users (% of the population), and Employment in Services (% of total employment).*

Table 6 shows the negative relationship between Mobile Cellular Subscription (per 100 people) and Service Value Added (% of GDP). In contrast to the positive relationship of Internet users (per 100 people) and Employment in Services (% of total employment) to the Service Value Added (% of GDP).

| | |
|---|---|
| **R** | 0.980 |
| **R square** | 0.961 |
| **Adjusted R Square** | 0.960 |
| **Std. Error of the Estimate** | 1.599 |

*Table 7. Model Summary of ICT and Service Sector's Productivity*

Table 7 shows the R-squared with 96.1% of the total variation in the Service Value Added (% of GDP) can be determined by the independent variables, namely Employment in Services (% of total employment), Internet Users (per 100 people) and Mobile Cellular Subscriptions (per 100 people).

| **Model** | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| **1** | Regression | 3679.030 | 1 | 3679.030 | 1439.810 | .000 |
| | Residual | 150.758 | 59 | 2.555 | | |
| | Total | 3829.788 | 60 | | | |
| | a. **Dependent variable:** *Services Value Added (% of GDP)* | | | | | |
| | b. **Predictors:** (*(Constant), Employment in Services (% of total employment), Internet User (per 100 people), Mobile Cellular Subscription (per 100 people)* | | | | | |

*Table 8. ANOVA (f- test)*

Table 8 shows an f-ratio of 1439.810. This means that the model is statistically significant and that there is a high variation between its regression coefficients and residuals. It can also explain the variation on the dependent variable on a high level.

### *4.1.2 ICT and Service sector's Employment*

| | Dependent Variable | Independent Variables | | |
|---|---|---|---|---|
| **Correlation** | **Employment in Service (% of total employment)** | **Service Value Added (% of GDP)** | **Labor Force Participation Rate** | **Mobile Cellular Subscription (per 100 people)** |
| **Employment in Service (% of total employment)** | 1.000 | 0.980 | 0.251 | 0.874 |
| **Coefficient** | | 1.016 | -0.264 | 0.084 |
| **Sig. p-value** | | .000 | 0.026 | 0.000 |

*Table 9. Pearson Correlation Coefficient of the Employment in Service (% of total employment) to the Mobile Cellular Subscription (per 100 people), Service Value Added (% of GDP), and Labor Force Participation Rate.*

Table 9 shows the relationship between the Employment in Service (% of total employment) to the independent variables. The Service Value Added (% of GDP) and Mobile Cellular Subscription (per 100 people) have a positive linear relationship between the dependent variable Employment in Service (% of total employment). In contrast to the Labor Force Participation Rate that shows no linear relationship between Employment in Services (% of total employment).

| | |
|---|---|
| **R** | 0.960 |
| **R square** | 0.922 |
| **Adjusted R Square** | 0.921 |
| **Std. Error of the Estimate** | 1.985 |

*Table 10. Model summary of ICT and Service Sector's Employment*

Table 10 shows the R-squared with 92.2% of the total variation in the Employment in services (% of total employment) can be determined by the independent variables, namely Service Value Added (% of GDP), Labor Force Participation Rate and Mobile Cellular Subscriptions (per 100 people)

| **Model** | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| **2** | Regression | 3265.898 | 1 | 3265.898 | 1439.810 | .000 |
| | Residual | 133.8298 | 59 | 2.268 | | |
| | Total | 3399.726 | 60 | | | |
| c. | **Dependent variable:** Employment in Services (% of total employment) | | | | | |
| d. | **Predictors:** (Constant), Services Value Added (% of GDP), Internet user (per 100 people), Mobile Cellular Subscription (per 100 people) | | | | | |

*Table 11. ANOVA (F-test)*

Table 11 shows an f-ratio of 1439.810. This means that the model is statistically significant and that there is a high variation between its regression coefficients and residuals. It can also explain the variation on the dependent variable on a high level.

**4.2 Discussions**
*4.2.1 Impact of ICT on Service Sector's Productivity*
Hypothesis 1 states that Internet users (per 100 people) have no significant impact on the Service Sector Productivity. The results show that the Internet users (per 100 people) have a positive linear relationship with dependent variable agreeing with the study of Šniukienėa and Sarkane (2014) that Mobile Cellular subscription (per 100 people) and Internet users (per 100 people) have different impacts on productivity depending on the research sample, data range, as well as the countries involved. Therefore, the null hypothesis is rejected.

Connecting with the inference between the Mobile Cellular subscription (per 100 people) and Internet users (per 100 people), hypothesis 2 states that Mobile cellular subscriptions (per 100 people) have no significant impact on the Service Sector Productivity. The results show that the Mobile cellular subscriptions (per 100 people) have a negative linear relationship. Therefore, the null hypothesis is rejected. This result contradicts the research of Viete & Erdsiek (2020) that have found a positive result for the researchers that revealed that adopting mobile phones in association with highly flexi-time could lead to higher productivity improvements for firms. With this, it can be inferred that although mobile cellular phones are used, other devices that use the Internet are much preferred in the service sector, which explains the positive correlation between Internet users (per 100 people) and Service Value Added (% of GDP).

Hypothesis 3 states that Employment in services (% of total employment) has no significant impact on the Service Sector Productivity. Findings show that Employment in Services (% of total employment) have a positive linear relationship with Service Value Added (% of GDP). In contrast with the result, a study by Behera (2019) has found out that the employment rate is insignificant with the GDP growth rate in India because of technological change over the years. But a similar study was revealed in Ilmakunnas & Miyakoshi (2013) and Lee et al. (2020) that ageing labor capital does have a positive effect on productivity, especially those workers with high skills and who are more educated. This proves that as the country continues to develop in the next few years, employment will also grow at the same rate for ICT help, giving away new opportunities to other people and helping employees work more efficiently. Therefore, the null hypothesis is rejected.

*4.2.2 Impact of ICT on Service Sector's Employment*
Hypothesis 4 states that the Mobile Cellular Subscriptions (per 100 people) has no significant impact on the Service Sector Employment. The above result agrees with the study of Goaied & Sassi (2017) that the use of mobile phones yields jobs in the telecommunications sector for the people living in the Sub-Saharan African countries. This contradicts the study of Murillo (2016) that Mobile Cellular Subscriptions (per 100 people) has a negative effect on Employment in Service (% of total employment) in Latin American countries. This implies that as you increase the Mobile Cellular Subscriptions, the quantity of output generated by the service sector will also increase. Therefore, the null hypothesis is rejected. It can be inferred that the effect of Mobile Cellular Subscriptions varies depending on the country's level of development.

Hypothesis 5 states that the Labor Force Participation Rate has no significant impact on the Service Sector Employment. The result of this study revealed that there is a negative relationship between Labor Force Participation Rate and Employment in Services (% of total employment). This complements the result of the study of Behera (2019) conducted in India, which stated that despite the increase in their unemployment rate due to technological development, there is a significant change in the country's GDP growth. Therefore, the null hypothesis is accepted. This goes to show that a decrease in Labor Force Participation Rate does not necessarily mean that it will directly affect the country's growth positively because not all people who are part of the labor force are employed and will be employed under the service sector.

Hypothesis 6 states that Service Value Added (% of GDP) has a negative relationship with the Service Sector Employment. Findings revealed a positive relationship between the two variables. This can be supported by the study of Faustin and Gallican (n.d.) that GDP has a positive effect on employment in Rwanda. Therefore, the null hypothesis is rejected. From this, it can be inferred that investing in ICT infrastructure in the service sector is a great help in increasing employment since more than 50% of the GDP comes from this sector. This can also be justified by the study of Kılıçaslan and Töngür (2018) and Vermeulen et al. (2018) that improvement and expansion of the firms due to large profits requires investment in capital and labor hence an increase in job opportunities.

**5. Conclusion and Policy Implications**
This research aims to determine the impact of ICT on the Philippines service sector productivity and employment. Due to insufficient data, multiple data imputation was performed to fill in the missing values. Based on the various tests, the researchers have concluded the following:

The ICT proxy measured by the Internet User (per 100 people) positively affected the sector's productivity, which rejects the null hypothesis. In contrast, the Mobile Cellular Subscription, which is also an ICT proxy, shows a negative correlation to the Service Value Added (% of GDP). In conclusion, the primary ICT used in the service sector is not merely mobile cellular phones but other devices that can be used to access the internet. In comparison, Mobile Cellular Subscription (per 100 people) is statistically significant to the growth of Service Sector Employment, proving that ICT complements employment in the Service Sector of the Philippines. Productivity measured by Service Value Added (% of GDP) also played a role in the growth of employment that added value to the conclusion that technological advancements such as ICT create job opportunities and are not a substitute for labor.

Findings from recent studies with different subject countries still could not come up with a definite answer on how ICT could impact productivity and employment. Since it varies among countries, this research aims to fill in the gap regarding the impact of ICT on the Philippines service sector's productivity and employment. Although the study has its limitations on the data availability since the ICT in the Philippines is still in the early stages. The study focused mainly on services because it is the most significant contributor to the GDP of the Philippines, and knowing how ICT stimulates it can help the country improve it further.

Based on the outcomes, the Philippines should be investing in internet penetration as it shows that the number of internet users impacts the growth of Service Value Added (% of GDP). It is also evident that employment in the Philippines thrives and complements labor, which induces productivity with higher ICT usage. In addition, connectivity is vital in the productivity and employment of the sector. This research reiterates the sole purpose of the Philippine Republic Act No. 10844. The Department of Information and Communication Technology (DICT) should improve and strengthen the accessibility of internet connectivity in all public places all around the country. There should be no place in the Philippines left behind as the internet now becomes necessary in everyday living.

The researchers recommend focusing on a specific firm or industry and considering other methods of gathering data to have a more precise result on the impact of ICT on productivity and employment.

**Conflicts of Interest**: The authors declare no conflict of interest.

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