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Forecasting of Indonesian Digital Economy based on Available New Start-up

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Abstract: Since the last 5 years, digital economy is growing steadily in Indonesia. Right now, the digital economy faces some potential problems and Covid-19 pandemic. This paper presents current data of the national Gross Domestic Product (GDP) and other GDPs (billion IDR) and the number of start-up, and predicts near some categories of future GDP and numbers of available new start-up for the next few years. The forecast will use Markov chain analysis. The results indicate that, while there are problems faced by the digital economy industry, the GDP and numbers of start-up are significantly increasing.

Index Terms: Digital economy; Start-up; Income forecast; Markov chain Method

1. Introduction

Currently, digital process runs extremely fast and and increasing significantly. In economic aspect, digital economy is getting popular because of information technology (IT) revolution in the world [1]. Before IT revolution, history of the world already noted 3 eras, such as: (1) agricultural society, (2) industry revolution and (3) petroleum exploration and corporation capitalism [2]. The 4th era, the digital economy, brings equality of opportunity and inclusive topography [3]. The concept of 4th era may have good spirit for the industry for having better collaboration and synergy [4]. This study will investigate the forecasting of Indonesian digital economy in Indonesia which is celebrated since industrial revolution 4.0

As pointed out by some researcher, the Indonesian government has a future target for the e-commerce transaction. In 2020, the target is to create 1,000 start-up companies with USD 10 Billion and to transact USD 130 Billion [5]. The target can be achieved by opening access for businesses, letting them join in, and strengthening the nation economy through digital infrastructure [2]. Other research on Micro and Small Business (MSB) indicated that e-commerce will potentially bring positive impact on national economic productivity [6]. The prediction of Indonesia Gross Domestic Product (GDP) showed positive trend using K-Nearest Neighbour Regression [7]. To show up the government target, we then explain it in table 1. Table 1 is the national GDP and some other GDPs that can be affected by digital economy activities at the end of the year in Indonesia.

Table 1 indicates that digital economy gives positive impact to the national GDP. From the table 1, there are always other ways to understand the growth of Indonesian digital economy by prediction of (1) start-up growth, (2) e-commerce transaction and (3) comparable e-commerce among countries [8]. To understand better digital economy, there are local company problems, such as: (1) acquisition by foreign companies, (2) online transaction regulation, and (3) consumer protection that need to be understood [9]. Besides that, other problem such as Covid-19 Pandemic, which can affect the digital economy negatively [10]. The pandemic is slowing down global economic growth because of lockdown [11]. There are China, USA, Italy, Spain, Malaysia and also Indonesia where lockdown is happening [12]. All the problems may affect GDP in Indonesia especially in table 1. So, there is a need of research to forecast near future of Indonesian digital economy.

Table 1. GDP at the end of the year (billion IDR) (BPS, 2019)

Year	*Information and communication GDP*	*Agriculture GDP*	*GDP of Processing Industry*	*National GDP*
2014	95,371.8	317,161.5	575,733.2	2,632,524.4
2015	104,933,3	338,702.9	621,183.2	2,839,900.7
2016	117,419.6	370,868.2	648,249.1	3,065,187.4
2017	132,789.7	390,416.2	696,767.6	3,335,902.1
2018	137,321.4	502,153.4	730,697.2	3,535,084.4

The present study, researchers highlight the near future forecasts of digital economy in Indonesia. The second section describes digital economy and the Markov chain. The following section tells the research method and analysis results and discusses our forecasts. The last section puts conclusion and future research.

2. Literature Review

2.1 Digital Economic

The digital economy is an aspect utilizing IT and digital communication [13]. The economy also evolves based on market growth [14]. The growth of digital economy in South East Asia is affected by the big data, mobile internet, artificial intelligence, Internet of Things and cloud technology. Indonesia is a country which has huge potential market for digital economy industry. The opportunity in Indonesia was proven by USD 27 billion that was being transacted in 2018 [15].

Those spectacular amounts make Google to predict 10 years later. In next 10 years, the amount transaction will reach USD 100 billion [5]. For the purpose of our study, we examine some definitions about digital economic. The supporting factors for achieving the development are technology implementer and human resources to run the technology. In August 2019, Bank of Indonesia said the digital economy will be able to give 10% GDP in 2025 [16]. In addition, the digital economy creates many entrepreneurs. The digital economy gives many opportunities for e-commerce, financial technology (Fintech), agriculture, transportation and et cetera [17]. The digital economy growth can be seen by the numbers of internet access. There are 4 start-up companies in South East Asia which already reach Unicorn status [1]. Figure 1 explains basic concept of the digital economy.

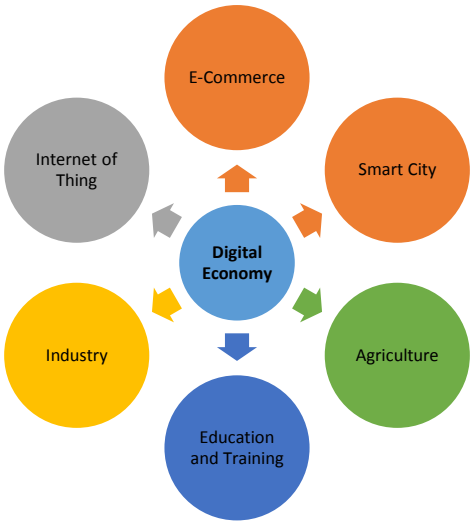

Fig. 1. Concept of Digital Economy [18]

Based on figure 1. Stated that the digital economy continues developing, Indonesia has broad potential penetration of IT user increased [19]. *Infact,* Indonesian government in the era of President Joko Widodo target Indonesia to be the greatest power of the digital economy in ASEAN in 2020 with e-commerce transaction value projections reached 130 million USD [20]. Components of a digital economy that are first identified time is the technology industry, information and communication (ICT), e-commerce activities, and distribution digital goods and services. Mainly, digital economy has significant aspect on Indonesian economic, because digital economic interconnect in the some aspects such as E-comerce, smart city, agricultural, education and training, industry, and internet.

2.2 Start-Up of E-Commerce

Start-up company is a company finding a suitable business model in the middle of extreme uncertainty [18]. The e-commerce business model is classified into some models based on market target [2]. The e-commerce scopes are (1) marketing service, (2) distribution and (3) buying and selling activities which the services are going through internet. The e-commerce can be defined a combination to have online transaction of goods and services [6]. Business model classification of e-commerce can be seen in table 2.

Table 2. Business model classification of e-commerce start-up

Business Model	*Explanation*	*E-commerce type*	*Example Platform*
Business to Business (B2B)	Selling product or service from B2B	Shopping mall platform	Mataharimall.com
Business to Customer (B2C)	Direct selling of services or goods to customers	Online shop, transportation application	Go-jek, Grab, Shopee, Tokopedia, Bukalapak
Customer to Customer (C2C)	Direct selling of goods and services from customer to other customers	Social media utilization for online selling	Facebook, Instagram, Twitter
Customer to Business (C2B)	Application or website creation to run the business	Social business platform	Kitabisa.com

2.3 Prediction Analysis of Digital Economy by Markov Chain

In the last 5 years, the growth of e-commerce is significantly increasing because of new way of shopping. Consumer do not need to meet seller for buying a needed goods [21]. The Markov Chain, a tool to predict growth, is a useful calculation to predict the digital economy growth [22]. The Markov Chain is a calculation method to model every system and also business process [23]. The Markov Chain forecasts the changes over time in the future with dynamic variable [24]. The Markov Chain calculation is a descriptive way to have probability information about the future [24].

The calculation is started by deciding probability state and n. n is the numbers of state. n1, n2, n3 and et cetera indicate probability in the state of 1, 2 and n. The next step is to determine transition probability matrix [25]. Commonly, matrix is useful to determine first state and state movement [26]. The following step is matrix calculation to have Steady State condition in S for stable distribution [27]. Steady State also can be called irreducible state in the Markov chain [11]. Equation (1) is the Markov Chain formula with random variable n1, n2, n3...nm. The Markov Chain model can be depicted diagrammatically of state transition showing transition.

3. Research Method

3.1 Data Analysis by Markov Chain

Figure 2 shows our data analysis process with the Markov Chain. This also gives us holistic view to analyze industries which contribute more in the Indonesian digital economy. First step, we define industries in digital economy (e-commerce, fintech, game, agriculture, et cetera) and GDP which impacted by industries (information and communication, agriculture, processing et cetera). After that, we analyze both datasets with Markov chain analysis. The results of analysis can be used for comparison analysis. The purpose of comparison is to have connection between industries and the GDP. Hence, we report the results.

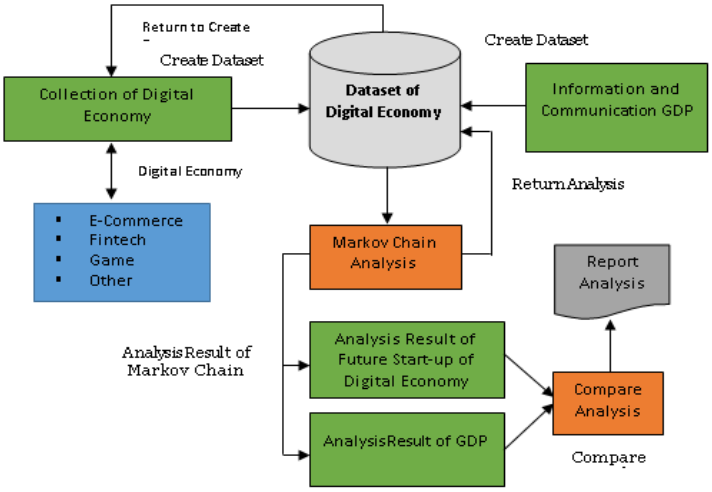

Fig.2. Dataset processing in the Digital Economy

3.2 Data Source for the Study

Table 1 is our sample data source. The other data source used for the study is the number of start-ups in the digital economy. Table 3 displays the number of start-ups in the digital economy from 2015-2018.

Table 3. The number of start-ups in the digital economy [15]

Year	*E-Commerce*	*Fintech*	*Game*	*Other*
2015	193	26	47	251
2016	239	35	49	331
2017	276	39	53	408
2018	286	39	53	426

3.3 Markov Chain Processing Study

Markov chain process is an analysis process from 1 state to other state [24]. The process will analyze future event mathematically [8].

3.3.1 Transitional Matrix

Transitional state is a changes state in the following period [23]. The transition is a random process that can be stated as probability. Transitional probability can be used to determine probability in the following period [26]. Transitional matrix is written as P in equation (1).

$$\mathrm{P} = \left[P_{ij}\right]_{N\ x\ N} = \begin{bmatrix} P_{11} & P_{12} & \dots & P_{1N} \\ P_{21} & P_{22} & \dots & P_{2N} \\ \dots & \dots & \dots & \dots \\ P_{N1} & P_{N2} & \dots & P_{NN} \end{bmatrix} \quad (1)$$

P = $\left[P_{ij}\right]$ is transitional matrix of probability N x N in Discrete Time Markov Chains (DTCM) $\{X_n,\ n \geq 0\}$ in state space S = $\{1,\ 2, \dots, N\}$. The formula can be $P_{ij} \geq$ i, j ≤ N and $\sum_j^N = 1\ P_{ij}$ = 1, 1 ≤ i ≤ N. The transitional n-step is written with equation Chapman-Kolmogorov to be equation (2).

$$P_{i,j}^{(n+m)} = \sum_k^N = 1\ P_{i,k}^{(n)} P_{k,j}^{(m)} \quad (2)$$

Formula (2), then can be stated to be $P^{(n+m)} = P^{(n)}$ x $P^{(m)}$ and $P^{(n+1)} = P^{(n)}$ x P. For n = 0, we have equation (3), (4) and (5).

$$P^{(1)} = P^{(0)} \text{ x P} \quad (3)$$

$$P^{(2)} = P^{(1)} \text{ x P} = P^{(0)} \text{ x P x P} = P^{(0)} \text{ x } P^2 \quad (4)$$

$$P^{(n)} = P^{(n-1)} \text{ x P} = \dots = P^{(0)} \text{ x } P^n \quad (5)$$

We have equation (6) from recursive formula (3), (4) and (5).

$$P^{(n+1)} = P^{(0)} \text{ x } P^{n+1} \quad (6)$$

$$X_1 = \begin{bmatrix} A & B & C \end{bmatrix} \text{ x } \begin{bmatrix} a & b & c \\ d & f & f \\ g & h & i \end{bmatrix} \quad (7)$$

3.3.2 Initial State Matrix

Steady state chance is future transition which does not depend on initial state. The steady state chance already reaches stable position [28]. So, there is no changes in the future [24]. Basically, the steady state is to observe the following state for reaching stable position. So, n-step means a lot for steady state [11]. To determine next step, we have to multiply initial state and is written as formula $X_1 = X_0$ x P.

From equation (8), we then get:

$$\begin{matrix} \begin{bmatrix} A\ x\ a = Aa & A\ x\ b = Ab & A\ x\ c = Ac \\ B\ x\ d = +Bd & B\ x\ e = +Be & B\ x\ f = +Bf \\ O\ x\ g = Og & O\ x\ h = Oh & O\ x\ i = Oi \end{bmatrix} \\ \text{D} \qquad\qquad \text{E} \qquad\qquad \text{F} \end{matrix}$$

DEF is the next state. X1 =1, when DEF is added, the value must be 1. To determine next step and become state 2, the formula is $X_2 = X_1$ x P.

$$X_2 = [D \quad E \quad F] \text{ x} \begin{bmatrix} a & b & c \\ d & f & f \\ g & h & i \end{bmatrix} \tag{8}$$

From equation (8), we then get:

$$\begin{matrix} \begin{bmatrix} D\ x\ a = Da & D\ x\ b = Db & D\ x\ c = Sc \\ Ex\ d = +Ed & E\ x\ e = +Ee & E\ x\ f = +Ef \\ Fx\ g = Fg & F\ x\ h = Fh & F\ x\ i = Fi \end{bmatrix} \\ \text{M} \qquad\qquad \text{N} \qquad\qquad \text{O} \end{matrix}$$

GHI is the next state. X2 = 1, when GHI is added, the value must be 1. To determine next step and become state 3, initial state is $X_0 = [M \quad N \quad O]$.

3.3.3 Transition Probability Matrix (TPM)

Matrix whose every element is a value of the probability of transition from one State to another or the State itself. TPM element is approached by using the proportion of movement between States in the entire observation period Markov chain can be said a regular transitional matrix where transition P is a collection of some P value with positive entry [11]. From table 3, we then define state (s) for calculation in transitional probability matrix, s1 = growth in 2015, s2 = growth in 2016, s3 = growth in 2017 and s4= growth in 2018. We have 4x4 transitional matrix.

$$\text{P} = \begin{bmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{bmatrix} \text{x} \begin{bmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{bmatrix} \tag{9}$$

$$\text{P2= P x P=} \begin{bmatrix} aa & bb & cc & dd \\ ee & ff & gg & hh \\ ii & jj & kk & ll \\ mm & nn & oo & pp \end{bmatrix} \text{x} \begin{bmatrix} aa & bb & cc & dd \\ ee & ff & gg & hh \\ ii & jj & kk & ll \\ mm & nn & oo & pp \end{bmatrix} \tag{10}$$

$$\text{P4=P2 x P2=} \begin{bmatrix} aa2 & bb2 & cc2 & dd2 \\ ee2 & ff2 & gg2 & hh2 \\ ii2 & jj2 & kk2 & ll2 \\ mm2 & nn2 & oo2 & pp2 \end{bmatrix} \text{x} \begin{bmatrix} aa2 & bb2 & cc2 & dd2 \\ ee2 & ff2 & gg2 & hh2 \\ ii2 & jj2 & kk2 & ll2 \\ mm2 & nn2 & oo2 & pp2 \end{bmatrix} \tag{11}$$

$$\text{P8= P4 x P4=} \begin{bmatrix} aa4 & bb4 & cc4 & dd4 \\ ee4 & ff4 & gg4 & hh4 \\ ii4 & jj4 & kk4 & ll4 \\ mm4 & nn4 & oo4 & pp4 \end{bmatrix} \text{x} \begin{bmatrix} aa4 & bb4 & cc4 & dd4 \\ ee4 & ff4 & gg4 & hh4 \\ ii4 & jj4 & kk4 & ll4 \\ mm4 & nn4 & oo4 & pp4 \end{bmatrix} \tag{12}$$

The way to get a stable condition is to multiply the probability matrix P x P is raised to P2, P4, P8 and so on with a higher lift so that each row of the matrix converges to a row vector which is the steady state condition. Determining steady state conditions in this study was carried out by the method of lifting the transition probability matrix P, which aims to get the value of elements in one column will converge towards the same value by raising the transition probability matrix with an enlarged rank.

4. Results and Discussion

4.1 Analysis Result of the Number of Companies

We will show the analysis of the number companies as the first result in this paper, in order to state the predicted future trend of the number of total companies was achieved by utilizing the data from table 3 and Markov Chain

analysis. Forecasting also applied on telecommunications [11]. Figure 3 depicts the growth of the number of companies at the end of the year.

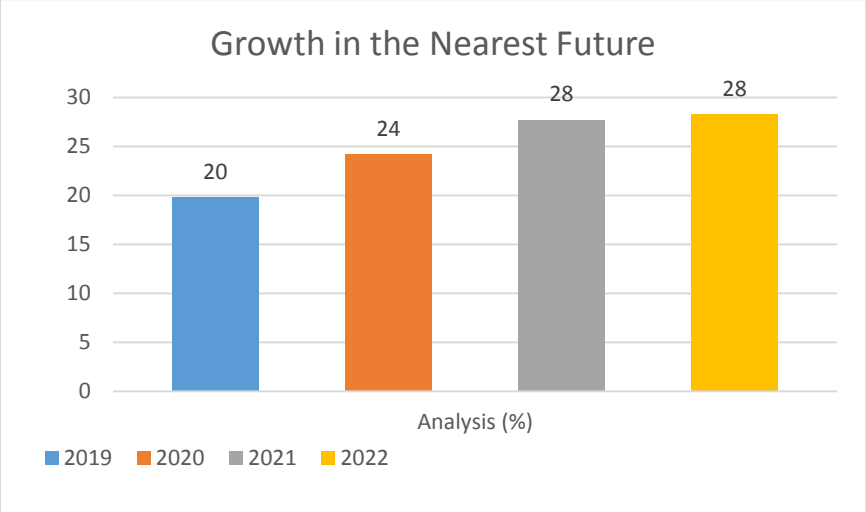

Fig. 3. Growth of the number of total companies from 2019 to 2022

Figure 3 shows the growth of the number of total companies from 2019 to 2022. In 2019, the growth will be 20%. In 2020, the growth will be 24%. In 2021 and 2022, the growth will be 28%. From each growth, we then analyze the number of total companies at the end of the year 2019 to 2022.

The rapid technological developments that occur affect business behavior and global economic conditions, so that the digital economy is born. Now the internet world has developed so rapidly that the banking, fintech, and even financial industries such as insurance have also moved on the internet platform [29], [30]. We believe that debt ratio can improve firm's profitability when debt is managed by the company as efficiently as possible to generate profits. But when a company takes too much debt and it cannot manage it well, it will come to a point where it pays too much interests on debt, thus substracting its profits.

Table 4 exhibits the number of total companies at the end of the year from 2019 to 2022. Figure 5 presents this result graphically.

Table 4. Trend of the number of start-up at the end of year

Year	*E-Commerce*	*Fintech*	*Game*	*Other*
2019	231	31	56	301
2020	297	43	61	397
2021	352	50	68	521
2022	367	50	68	546

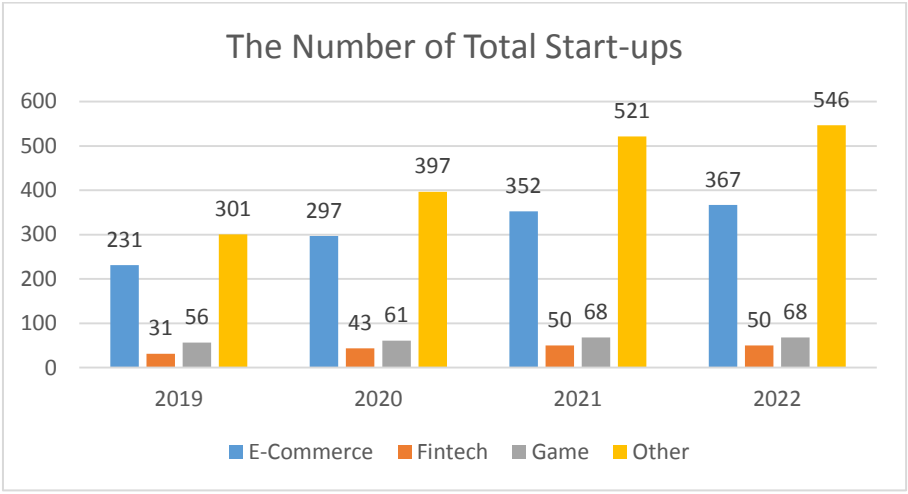

Fig. 4. The number of total start-ups from 2019 to 2022

Figure 4 presents the number of total start-ups from 2019 to 2022. 2 industries in digital economy (e-commerce, and other) have the positive trend from 2019 to 2022. Meanwhile, 2 industries (fintech and game) show positive trend from 2019 to 2020. Otherwise, stable trend is shown from 2021 to 2022 for fintech and game industries.

4.1 Analysis Result of National GDP

Based on table 1 (national GDP for the digital economy), a predicted future trend of the national GDP was achieved by utilizing the data and equations Markov Chain. Figure 5 depicts the growth of national GDP at the end of the year.

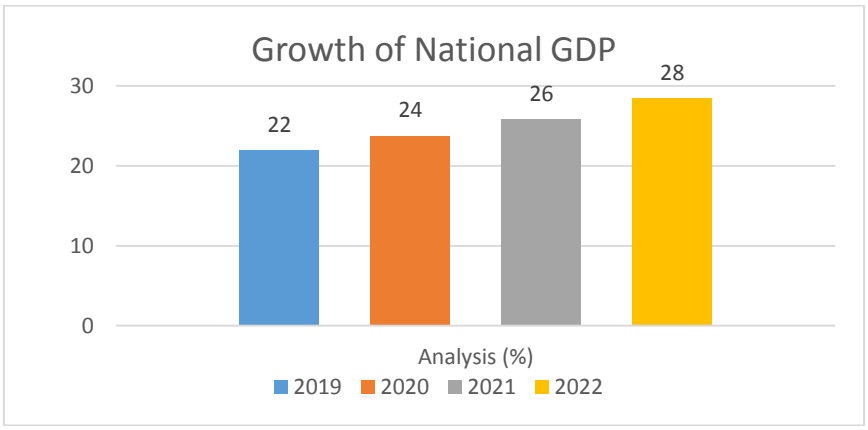

Fig. 5. Growth of national GDP from 2019 to 2022

Figure 5 shows the growth of national GDP from 2019 to 2022. In 2019, the growth will be 22%. In 2020, the growth will be 24%. In 2021, the growth will be 26%. In 2022, the growth will be 28%. From each growth, we then analyze national GDP at the end of the year 2019 to 2022. Table 5 depicts national GDP at the end of the year from 2019 to 2022. The data from table 5 is displayed graphically in Figure 6.

Table 5. Trend of the number of start-up at the end of year

Year	*Information and communication GDP*	*Agriculture GDP*	*GDP of Processing Industry*	*National GDP*
2019	127,992	413,134	757,690	3,463,976
2020	145,330	459,024	802,339	3,738,770
2021	167,067	491,195	876,625	4,197,004
2022	176,377	644,973	938,517	4,540,510

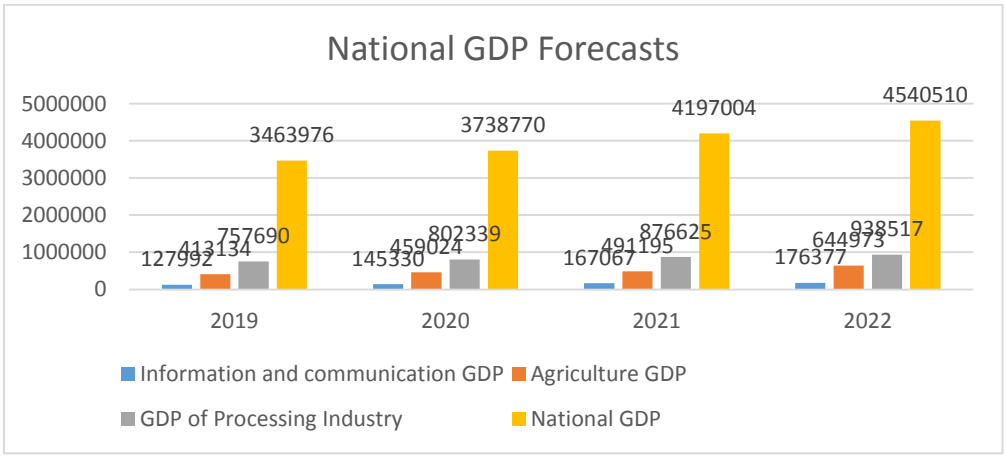

Fig. 6. National GDP from 2019 to 2022

Figure 6 presents national from 2019 to 2022. 3 industries impacted by the digital economy (information and communication, agriculture, and processing) are uptrend. For information and communication, there is a significant increment by 37.8% between 2019 and 2022. In addition, the biggest uptrend occurs for agriculture, an increase by 56.1% between 2019 and 2022. The lowest uptrend is on processing industry by 23.8% between 2019 and 2022.

Finally, digital economy denotes mostly to the recent and significantly unrealized changes of various segment of the economies by computer-assisted digitization of data. The authors were thus focusing on showcasing that something other than initial informative ideologues are considered.

5. Conclusions

This study has shown the application of Markov Chain for forecasting analysis. The results show the positive trend for national GDP and the number of start-ups in the following year. We have compared national GDP and the number of start-ups in Indonesia. The result indicates that the growing number of start-ups bring positive trend on national GDP.

Based on the results, this study has some limitation such as, the newer organizing data can be done, this research just invents the construction start-up. Otherwise, the vision of Jokowi to internationalize the digital economy as a component of foreign policy and to exploit technology and innovation as latent unlimited resources for future prosperity and development faces significant obstacles. Accordingly, the digital economy and tech sectors through a more integrative approach.

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