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MEASURING THE EFFICIENCY OF CONTENT DISTRIBUTION NETWORK (CDN) IMPLEMENTATION IN INDONESIA'S TELCO WITH DATA ENVELOPMENT ANALYSIS (DEA)

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Abstract *− This paper aim is to evaluate the efficiency of content distribution network (CDN) implementation in Internet Service Provider Network (ISP). The Data Envelopment Analysis (DEA) with BCC model will be used to calculate the technical efficiency. This study will use 1 input which is total server installed and 2 outputs which are the traffic generated and server distribution as the main variable to measure the technical efficiency. All the required data is collected from one of Telco player in Indonesia. Currently, several content owners / CDN players have collaborated using different business models towards ISP, therefore an evaluation is needed to assess the existing cooperation model, which one is the most efficient as a reference to be used in collaborating with content owner players who will work together.The data taken is secondary data obtained from internal company data, which is related to traffic generated by CDN and the distribution of the server installation. The results of the study are expected to be used as an evaluation and reference for existing business models and for future reference in choosing a business model in establishing future collaborations with content owners/CDN owners.*

Keywords: *Data Envelope Analysis (DEA), Content Delivery Network (CDN), Internet Service Provider (ISP), Efficiency*

INTRODUCTION

Internet traffic especially in Indonesia significantly growth for more than 15% year on year since 2013 (We are Social Report Digital, 2022) this is because the demands of bandwidth from internet of things (IoT) and also the new content that the over the top (OTT) player brought in to Indonesia with requirement of high definition video graphical that hunger on more bandwidth usage.

Huge population with active internet user is being one of interest thing for the OTT player to come and deploy their content in Indonesia. Content Delivery Network (CDN) is one of technology on how the OTT player deploy and distribute their content on destinate location. OTT will put their server to serve the content to the nearest location to the user. This design will maximize the latency of the content towards clients and on the other hand ISP as the service owner of the internet get benefit from localize content that CDN did so they don't need to fetch the content from the global internet exchange which mean cost efficiency for internet service provider (ISP) not to deploy new subsea cable or point of present to pick up the content on global internet exchange.

Currently there are a number of business models that being used by ISP in dealing with content aggregator / content owner. There is free settlement model business which mean the content owner didn't pay anything to the ISP for the colocation and supporting facilities of the CDN servers. No revenue generated from this free settlement scheme between the ISP and content owner. As the indirect payment that received is the ISP get the content being localize so they can save their international bandwidth / capacity, saving international bandwidth means saving company capital expenditure (CAPEX) to not deploy another subsea cable to pick up the content in other country because the content is already in their local network with CDN technology. in this free settlement case the Telco company are only being dumb pipe for the content owner. The other model business is federation model whereby the ISP can generate revenue from the traffic that generated by the content owner.

the efficiency measurement of the CDN implementation inside Telco local network is main goal goal of this study moreover from the calculation of the efficiency using DEA we can know which CDN server installation that still have room for improvement to be maximize so the ISP can get maximal benefit from it.

METHODS

There are currently 6 CDN partners who have collaborated with the local ISP in Indonesia (Tabel 1). All the necessary data were collected from dedicated dashboard of each CDN partner under one of the ISP account in Indonesia.

Tabel 1 List of CDN Partners

DMU	**Variabel Input**	**Variabel *Output***	
	Cap *port*	**Max *Traffic recorded* (Gbps)**	***Distribution***
Google	7130	4188	27
Facebook	4700	3470	20
Netflix	3600	459	12
Akamai	3300	2589	7
Edgio	300	105	1
ZenLayer	600	392	4

Source: Telco Reports (2023) of 6 CDN Partners

This study measure the technical efficiency of the list CDN partners with using data envelopment analysis method (DEA). The study of Riko, Kristian and Gayuh (2020), it took

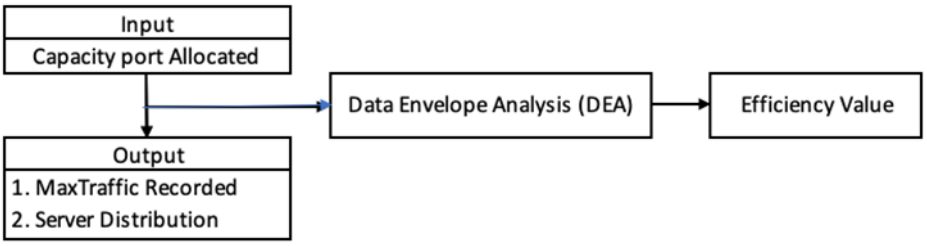
data traffic and subscriber as the output while the input are using financial number such as total asset, opex and capex. Input and output in this research are used based on the type of input and output in prior studies in the same field but adapted to the research object.

Tabel 2 Variable Details and Definition

Variable	Measurement Units	Definition and Measurement
Input Variable	Allocated port	Router Port that have been allocated by the Telco as gateway point for the CDN server
Output Variable	Maximum Traffic	The highest peak traffic that ever recorded so far. More traffic produced so it's more efficient.
	Server Distribution	Total server distribution in all Telco point of presence (PoP) all around Indonesia.The most efficient is the distributed

Source: Author

The variable tested used in this research is the port capacity used as an uplink server, while the output variable is the inbound traffic generated by the CDN server to serve internet customers as well as the distribution of installations from the CDN server itself. This input and output variable data is taken from the latest data for the 2023 period.



Source: Author

This research began with the current phenomenon of technology and information development. Rapid development has led to digital transformation in various activities. A spike in data usage also occurred during the COVID-19 pandemic because many activities carried out at home require internet connectivity. ISPs as internet service providers are required to be able to meet increasingly high data needs. However, on the other hand, investment costs for networks are very expensive so operators must be able to run their companies as efficiently as possible. Therefore, this research is a study that calculates the technical efficiency value obtained by operators / ISPs for OTTs who bring CDN technology into the ISP's internal network. The variables chosen to assess efficiency are operational variables consisting of the number of DMU ports, server distribution and the maximum value of traffic used by customers. So this study is used the DEA model with output-orientation to calculate the technical efficiency of the listed CDN partners of the Telco in Indonesia, as there are two output and one input variable. From data in table 1, we can get the ratio output against input are as below.

Tabel 3 The Ratio of Output

Ratio	Trafic Eff (X)	Distribution Eff (Y)
Google	5,750350631	3,786816269
Facebook	5,063829787	4,255319149
Netflix	1,275	3,333333333
Akamai	8,757575758	2,121212121
Edgio	3,5	3,333333333

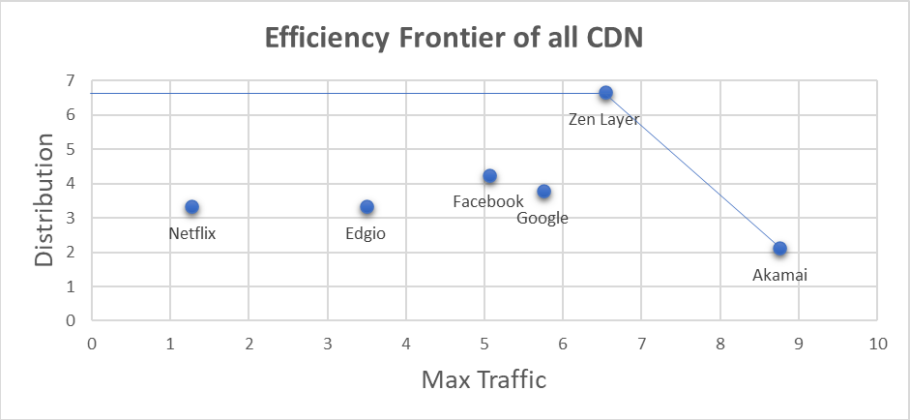
Ratio	Trafic Eff (X)	Distribution Eff (Y)
Zenlayer	6,533333333	6,666666667

Source: Author

RESULT AND DISCUSSION

From the data that we have in table 3, we try to map it into cartesian diagram figure 1. We can see that there are 2 DMUs that are on the efficiency frontier (efficiency curve), namely CDN Zen Layer and Akamai. As we are using output-oriented method to measure the efficiency frontier so that the graph will be created as concave graph which is escape away from the origin point axis (x,y) of the cartesian diagram and the outer boundary of the graph are the 2 outermost DMUs and we call it as efficiency benchmark and it create an efficiency frontier for other DMUs inside the frontiers. For the other DMUs that are below the Zenlayer and Akamai CDN efficiency curve so that is classified as inefficient DMUs.

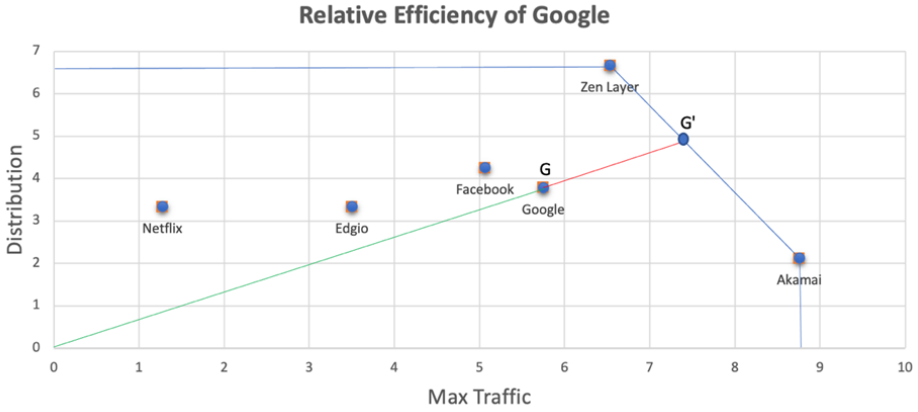
Figure 1. Cartesian Diagram of Efficiency Frontier



Source : Author

Relative technical efficiency is the value point that must be achieved by the DMU in this case the inefficient DMUs under the efficiency frontier (Google, Facebook, Edgio and Netflix) in order to get the efficient title. This relatively technical efficiency point is the result of a linear programming calculation with comparing the efficient DMUs which are Zen Layer and Akamai as a benchmark for others inefficient DMUs to reach the efficiency frontier point based on the efficiency frontier in Figure 1. The intersection or cut point between the inefficiency DMUs with efficiency frontier based on the cartesian diagram in figure 1 is called as the relative technical efficiency and it's applied to all DMUs that located under the efficiency frontier, please refer to figure 2.

Figure 2 : Relative Efficiency of DMU's Google



Source: Author

From figure 2 we can see that Google's efficiency value (G) is below the efficiency frontier with Zen layer CDN and Akamai as benchmarks. The relative technical efficiency value of Google's is obtained from the ratio of point G to point G' of the cartesian diagram so that we can get the Google's relative efficiency= 〖G/G'〗^. Linear programming is used to find out the value of the G'. With using linear programming we got the intersection point of the axis (x,y) of all the inefficient DMUs with the efficiency frontier as below.

Tabel 4 Efficiency axis (x,y) of the inefficiency DMUs towards the efficiency frontier

Koordinat Efisien	**Trafic Eff (x)**	**Distribution Eff (y)**
Google	7,38	4,78
Facebook	6,8	5,7
Netflix	2,4	6,6
Edgio	6,6	6,2

Source: Author

The coordinates axis (x,y) of point G' above are obtained using a linear equation to get the intersection point between 2 straight lines, the line that is on the efficiency curve or efficiency frontier between the Zen Layer and Akamai DMU points with the line between the center of cartesian diagram (0,0) axis point through the coordinates of each DMU which is below the efficiency curve, while the distance between points G and G' is the technical efficiency value. The technical efficiency value is the changes that required by each inefficient DMUs to reach the relative efficient level towards the efficiency frontier.

Discussion

Data Envelopment Analysis (DEA) with output-oriented is used to measure the relative technical efficiency of the listed CDN Partner. The study found that Akamai (8.7 , 2.1) and Zen Layer (6.5 , 6.6) are being the most efficient DMU and the other 4 CDN partners are found out as inefficient as it's located under the efficiency frontier that made by Akamai and Zen layer. The finding also imply that each DMUs need improvement on certain value to reach the relative technical efficient value towards the efficiency frontier. The highest improvement need to be made by Edgio with 3,1 follow by Facebook with 1,73 and Google with 1,62 and the last one is Netflix 1,13.

CONCLUSION

This study measures the relative technical efficiency of the CDN installation in one of Telco in Indonesia. The relative technical efficiency of the DMU was determined using an output-oriented DEA model. There are 2 output, such as maximum traffic and server distribution and and 1 input, such as router port allocation.

The DEA measurement result showing us that the management of CDN traffic in the Telco internal network is still inefficient. 2 DMUs from 6 DMUs were found on efficient condition (located on the efficiency frontier), namely the Akamai and Zen Layer DMUs while the other 4 DMUs relative efficiency score is inefficient, namely the Google, Facebook, Netflix & Edgio DMUs. Opportunity for improvement (OFI) to increase company efficiency in term of CDN e implementation can be immediately carried out based on the results of the calculations that have been carried out. The efficiency measurement with using the DEA method can be used as one of the procedure to consider future decisions regarding collaboration with other CDN players / owners based on the traffic that they brought in.

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