Jejak Vol 17 (1) (2024): 57-67 DOI: https://doi.org/10.15294/jejak.v17i1.5617

JEJAK

Journal of Economics and Policy

https://journal.unnes.ac.id/journals/jejak

Analysis of Bed Availability and COVID-19 Deaths Relationship in Jakarta

Refina Muthia Sundari[1]✉, Teguh Dartanto[2], Goldy F. Dharmawan[3]

[1,2,3]Faculty of Economics and Business, Universitas Indonesia, Depok, Indonesia

Permalink/DOI: https://doi.org/10.15294/jejak.v17i1.5617

Received: November 2023; Accepted: January 2024; Published: March 2024

Abstract

The surge in COVID-19 cases that hit Indonesia in May – July 2021 led to a decline in the capacity of the health system. It was reflected by an increase in the national Bed Occupancy Ratio (BOR) percentage of more than 60%, where DKI (Special Capital Region) Jakarta had the highest percentage of BOR among all provinces, reaching 85%. The death rate also soared at 256 deaths per day. The government responded this incident by continuing to increase the bed capacity, thus BOR percentage could be decreased in order to preventing a higher death rate. Therefore, this study was conducted to analyze how the impact of increasing bed capacity on deaths from COVID-19. This study estimates 511 time series data using the Ordinary Least Square (OLS) method. As the result, the addition bed capacity had a negative association with COVID-19 deaths. The increase in overall bed capacity, ICU bed capacity, and isolation bed capacity could reduce deaths of COVID-19 by 22.5%, 17.3% and 22.7%, respectively.

Key words : COVID-19, Death Rate, Bed Capacity, Government

How to Cite: Sundari, R. M., Dartanto, T., & Dharmawan, G.T. (2024). Analysis of Bed Availability and COVID-19 Deaths Relationship in Jakarta. *JEJAK, 17*(1). doi:https://doi.org/10.15294/jejak.v17i1.5617

✉ Corresponding author : Refina Muthia Sundari
Address: Jl. Pondok Kelapa IV A, Blok B9/26, Kel. Pondok Kelapa, Kec. Duren Sawit, Kota Jakarta Timur 13450
E-mail: refinamuthia@gmail.com

e-ISSN 2460-5123

INTRODUCTION

In May to July 2021, DKI Jakarta was the province with the highest COVID-19 positive cases which led to high mortality rate. The increase of positive cases was started after mudik tradition, where many people were going home to their hometown to celebrate Eid al-Fitr. This event intensified the mobility rate that enabled COVID-19 virus transmission. High mobility rate had been proven to be correlated with the rise of COVID-19 positive cases in many countries (Liaw, et al., 2021).

The surge of COVID-19 positive cases from May to July 2021 was followed by increaseing Bed Occupancy Ratio (BOR). On June 20th 2021, national BOR was 64% where those percentages had been exceeded BOR standard percentage, which is 60% (Ministry of Health of Republic of Indonesia, 2018). DKI Jakarta had the biggest BOR percentage compared to other provinces with 86% value on June 20th 2021. In the next month, DKI Jakarta was still the one of the provinces which had the greatest BOR percentage with 85% value on July 7th 2021. Meanwhile, the national BOR was reaching 76% value at the same period (Ministry of Health of Republic of Indonesia, 2021). Based on the trend of increasing BOR, the national government urged Ministry of Health and local government to immediately make effort to increase bed capacity for COVID-19 by 30% - 40% in city or district and provincial capital referral hospitals. The increase in bed capacity of COVID-19 was prioritized for areas with red zone status and having BOR percentage above 60% (Coordinating Ministry of Economics of Republic of Indonesia, 2021).

Beside the surge of positive cases, the increase in bed capacity urgency was driven by COVID-19 deaths increasing in May to July 2021. Death cases increased up to 12.2% or 5,067 deaths in May 2021. Those numbers were getting higher with 7,865 deaths in June 2021. COVID-19 deaths were getting worse in July 2021 as death numbers reached 35,274 deaths (Katadata, 2021). Local government and some civil society organizations also collected the data of death cases from self-isolation and non-hospitalized cases. On August 7th 2021, total deaths of COVID-19 from self-isolation and non-hospitalized cases were 3,013 deaths. DKI Jakarta, via Health Department, was the only local government which publish the death cases of COVID-19 compared to other provinces (*Lapor Covid-19*, 2021).

Relationship between bed capacity and deaths in COVID-19 pandemics had been explained in some previous studies. Globally, limited bed capacity led to higher deaths of COVID-19 and economic loss (Sussman, 2020). Janke et al. (2020) also found the similar result in smaller scope, which confirmed areas with the greater availability of intensive care unit (ICU) and surgical bed capacity, and nurse was able to decrease COVID-19 deaths compared with other areas. Another study also stated that limited bed capacity and bed supply cause more positive cases, deaths, and longer COVID-19 pandemic outbreak (Zhou et al., 2020). The study which was conducted by Prabowo (2021) also recommends DKI Jakarta government to increase isolation bed and ICU bed capacity for COVID-19 patients in order to reduce the death cases in DKI Jakarta.

Although some retrospective studies had been conducted in other countries, similar study which specifically analyze relationship between bed capacity and COVID-19 deaths has not been done yet in Indonesia, particularly in DKI Jakarta. In health economics perspective, the government has significant role to make an efficient resource allocation (Mankiw, 2017). Health Department in DKI Jakarta had increased isolation bed and ICU bed capacity for COVID-19 to anticipate the surge of positive cases and decrease BOR percentage. If BOR percentage is able to decreased by the government, it will prevent higher COVID-19 death.

Even though those policy was in line with previous study results and recommendation, yet its effectiveness to reduce COVID-19 death is unknown. Therefore, the policy needs to be evaluated to discover the impact of increase in bed capacity to COVID-19 death in DKI Jakarta. The result of this study is expected to provide policy recommendation based on data or evidence-based policy. Thereby, DKI Jakarta government will be able to implement more effective policy to handle COVID-19 pandemic and other health crises in the future.

METHOD

This study used time series daily data to see the relationship between bed capacity and COVID-19 death. To discover the relationship between two variables, Ordinary Least Square (OLS) was used as estimation method. Time series data was collected from DKI Jakarta Health Department on March 1st 2020 - October 22th

2021 and Google Mobility Report. Furthermore, the data obtained was processed using Microsoft Excel and Eviews software.

Analyzed data consist of dependent variable, independent variables, and control variables. Dependent variable in this study was daily death and main independent variables were total bed capacity, ICU, and isolation bed capacity. Meanwhile, other independent variables consist of COVID-19 positive cases, hospitalized patients, and previous daily death numbers. As for control variables, this research used numbers of first stage vaccination, vaccination dummy, mobility trend value of retail and recreation and workplaces. For vaccination dummy, period after vaccination implementation was worth (1) and (0) for period before vaccine implementation.

Table 1. Summary of Variables

Variable	Definition	Unit	Source
Dependent Variable			
daily_death	Daily death	Daily	DKI Health Department
Independent Variables			
bed_cap	Total bed capacity	Daily	DKI Health Department
bed_cap_icu	ICU bed capacity	Daily	DKI Health Department
bed_cap_iso	Isolation bed capacity	Daily	DKI Health Department
daily_inf	COVID-19 positive cases	Daily	DKI Health Department
Dirawatrs	Hospitalized patients	Daily	DKI Health Department
$daily\_death_{(t-i)}$	Previous daily death numbers	Daily	DKI Health Department
Control Variables			
vacc_total_1	Numbers of first stage vaccination	Daily	DKI Health Department
Dumvacc	Vaccination dummy (1) and (0)	Daily	DKI Health Department
ret_and_rec	Indoor mobility trend such as restaurant, café, mall, museum, amusement park, library, and cinema.	Daily	Google Mobility Report
Workplaces	Workplaces mobility trend	Daily	Google Mobility Report

The following is the econometric models which were estimated in this study:

$$\Delta ldaily\_death_{(t)} = \beta_0 + \beta_1 ldaily\_death_{(t-i)} + \beta_2 lbed\_cap_{(t-7)} + \beta_3 ldaily\_inf_{(t-7)} + \beta_4 ldirawatrs_{(t-7)} + \beta_5 lvacc\_total\_1_{(t)} + \beta_6 ret\_and\_rec_{(t-i)} + \beta_7 workplaces_{(t-i)} + \varepsilon_{(t)} \quad (1)$$

$$\Delta ldaily\_death_{(t)} = \beta_0 + \beta_1 ldaily\_death_{(t-i)} + \beta_2 lbed\_cap\_icu_{(t-7)} + \beta_3 ldaily\_inf_{(t-7)} + \beta_4 ldirawatrs_{(t-7)} + \beta_5 lvacc\_total\_1_{(t)} + \beta_6 ret\_and\_rec_{(t-i)} + \beta_7 workplaces_{(t-i)} + \varepsilon_{(t)} \quad (2)$$

$$\Delta ldaily\_death_{(t)} = \beta_0 + \beta_1 ldaily\_death_{(t-i)} + \beta_2 lbed\_cap\_iso_{(t-7)} + \beta_3 ldaily\_inf_{(t-7)} + \beta_4 ldirawatrs_{(t-7)} + \beta_5 lvacc\_total\_1_{(t)} + \beta_6 ret\_and\_rec_{(t-i)} + \beta_7 workplaces_{(t-i)} + \varepsilon_{(t)} \quad (3)$$

$$\Delta ldaily\_death_{(t)} = \beta_0 + dumvacc + \beta_1 ldaily\_death_{(t-i)} + \beta_2 lbed\_cap_{(t-7)} + \beta_3 ldaily\_inf_{(t-7)} + \beta_4 ldirawatrs_{(t-7)} + \beta_5 ret\_and\_rec_{(t-i)} + \beta_6 workplaces_{(t-i)} + \varepsilon_{(t)} \quad (4)$$

$$\Delta ldaily\_death_{(t)} = \beta_0 + dumvacc + \beta_1 ldaily\_death_{(t-i)} + \beta_2 lbed\_cap\_icu_{(t-7)} + \beta_3 ldaily\_inf_{(t-7)} + \beta_4 ldirawatrs_{(t-7)} + \beta_5 ret\_and\_rec_{(t-i)} + \beta_6 workplaces_{(t-i)} + \varepsilon_{(t)} \quad (5)$$

$$\Delta ldaily\_death_{(t)} = \beta_0 + dumvacc + \beta_1 ldaily\_death_{(t-i)} + \beta_2 lbed\_cap\_icu_{(t-7)} + \beta_3 ldaily\_inf_{(t-7)} + \beta_4 ldirawatrs_{(t-7)} + \beta_5 ret\_and\_rec_{(t-i)} + \beta_6 workplaces_{(t-i)} + \varepsilon_{(t)} \quad (6)$$

Where are β_0 is Constanta; β is Regre-ssion coef; (t) is Period (day); and (t-i) is *Lag* (i = 1, 2, 3,...7).

RESULTS AND DISCUSSION

Estimation results from 1st model, 2nd model, and 3rd model with the first stage vaccination control showed negative association between bed availability and daily death. The 1st model showed that increase of total bed capacity at previous 7 days was able to decrease daily death until 22.5%. While on the 2nd model, if there was increase of ICU bed capacity at previous 7 days, so there will be decrease of daily death up to 17.3%. On the 3rd model, the increase of isolation bed capacity at previous 7 days was able to decrease daily death until 22.7%. Among three models, second model, with ICU bed capacity, had the lowest daily death percentage.

Table 2. Estimation Results with OLS

Variables	Dependent Variable: Daily Death (Vaccination Number Control)			Dependent Variable: Daily Death (Vaccination Dummy Control)		
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Independent Variables:						
lbed_cap(-7)	**-0.225****			**-0.221****		
	(0.107)			(0.106)		
lbed_cap_icu(-7)		**-0.173****			**-0.170****	
		(0.077)			(0.076)	
lbed_cap_iso(-7)			**-0.227****			**-0.224****
			(0.111)			(0.110)
ldaily_inf(-7)	**0.213*****	**0.214*****	**0.212*****	**0.211*****	**0.212*****	**0.211*****
	(0.060)	(0.059)	(0.060)	(0.060)	(0.059)	(0.060)
ldirawatrs(-7)	**0.162****	**0.158****	**0.162****	**0.162****	**0.158****	**0.162****
	(0.068)	(0.067)	(0.068)	(0.068)	(0.067)	(0.068)
ldaily_death(-1)	**0.213*****	**0.211*****	**0.213*****	**0.213*****	**0.212*****	**0.213*****
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
ldaily_death(-2)	**0.109****	**0.107****	**0.109****	**0.109****	**0.107****	**0.109****
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
ldaily_death(-3)	**0.067**	**0.066**	**0.067**	**0.067**	**0.066**	**0.067**
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
Control Variables:						
lvacc_total_1	**0.007**	**0.007**	**0.007**			
	(0.012)	(0.011)	(0.011)			
Dummy Vaksin				**0.045**	**0.041**	**0.044**
				(0.078)	(0.076)	(0.078)
ret_and_rec(-1)	**-0.004**	**-0.004**	**-0.004**	**-0.004**	**-0.003**	**-0.004**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ret_and_rec(-2)	**-0.014***	**-0.014***	**-0.014****	**-0.014***	**-0.014***	**-0.014***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
ret_and_rec(-3)	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
workplaces(-1)	**-0.000**	**0.000**	**-0.000**	**-0.000**	**5.70E-05**	**-0.000**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
workplaces(-2)	**0.000**	**0.001**	**0.000**	**0.000**	**0.000**	**0.000**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
workplaces(-3)	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**	**0.003**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Constanta	**0.358**	**-0.337**	**0.334**	**0.330**	**-0.356**	**0.309**
	(0.785)	(0.488)	(0.788)	(0.778)	(0.484)	(0.781)
Observations	511	511	511	511	511	511
R-Squared	0.718	0.718	0.718	0.718	0.718	0.718

Note: Level of confidence 99% (***), 95% (**), 90%(*), **the value in brackets is the robust standard error**

Source: Author, 2021

Other independent variables, such as the number of COVID-19 positive cases and hospitalized patient at previous 7 days, as well as death at previous 1 day and 2 days had positive association with daily death on all three models. On the 1st, 2nd, and 3rd model, the increase of previous 7 days COVID-19 positive cases leads to death number enhancement up to 21.3%, 21.4%, and 21.2% respectively. Meanwhile, the increase of previous 7 days hospitalized patients was able to enhance daily death numbers until 16.2%, 15.8%, and 16.2%. Previous 1 day and 2 days death numbers also increase daily death on each model up to 21.3% and 10.9%; 21.1% and 10.7%, as well as 21.3% and 10.9% respectively.

Moreover, first stage vaccination as control variable showed statistically insignificant estimation results on all three models. Beside first stage vaccination variable, retail and recreation and workplaces mobility trend show almost no association on each model. However, there was negative association between previous 2 days retail and recreation mobility trend and daily death with percentage of 1.4%.

Estimation results from 4th model, 5th model, and 6th model with vaccination dummy control were not much different to 1st model, 2nd model, and 3rd model. There was negative association between bed availability and daily death on each model. On the 4th model, the increase of previous 7 days total bed capacity was able to reduce daily death until 22.1%. Then, on the 5th model, previous 7 days ICU bed capacity addition will lead to daily death reduction up to 17%. While on the 6th model, the increase of previous 7 days isolation bed capacity had potential to decrease daily death with percentage of 22.4%. The 5th model had the lowest percentage of daily death reduction compared to fourth and sixth model.

Similar to 1st, 2nd, and 3rd model, other main independent variables such as previous 7 days COVID-19 positive cases, previous 7 days hospitalized patient numbers, and previous 1 day and 2 days death also had positive association with daily death on 4th model, 5th model, and 6th model. On each model, previous 7 days COVID-19 positive cases and hospitalized patient numbers were able to increase daily death until 21.1% and 16.2%; 21.2% and 15.8%; as well as 21.1% and 16.2% respectively. Meanwhile, previous 1 day and 2 days death numbers also had implication to daily death escalation on each model up to 21.3% and 10.9%; 21.1% and 10.7%. as well as 21.3% and 10.9%.

Vaccination dummy as control variable on 4th model, 5th model, and 6th model showed statistically insignificant estimation results. Moreover, retail and recreation and workplaces mobility trend also showed almost no association on each model, except in previous 2 days retail and recreation mobility trend. Previous 2 days retail and recreation mobility trend showed negative association to daily death with the percentage of 1.4% on each model.

Estimation results from all models showed negative association between bed availability and daily death. It means bed capacity which was always added by the government was able to reduce COVID-19 deaths in DKI Jakarta. This result was consistent to some previous study results that stated bed availability had negative relationship with the COVID-19 deaths (Sussman, 2020; Janke et al., 2020).

Based on the results, increase of total bed capacity at previous 7 days was able to decrease daily death until 22.5%. Total bed capacity is the sum of ICU and isolation bed. If each bed capacity is compared, isolation bed capacity had higher percentage in reducing death than ICU bed capacity. Increase of isolation bed capacity at previous 7 days leads to lower daily death up to 22.7%, while increase of ICU bed capacity at previous 7 days was only able to decrease COVID-19 death until 17.3%. This result might be caused by increase of isolation bed capacity is more than ICU bed capacity. Until October 22nd 2021, total number of isolation bed capacity reached 11,773 or approximately 87% of total bed capacity.

Accordance to previous study at one of COVID-19 reference hospitals in DKI Jakarta, which was Wisma Atlet Kemayoran Emergency Hospital, approximately 31.5% of all hospitalized patients were patients with moderate symptom (Susanto et al., 2021). Meanwhile, based on WHO global data publication, the percentage of each COVID-19 patients with mild to moderate symptom was 40% respectively. Therefore, isolation bed availability in DKI Jakarta health facilities is important to accommodate patients with moderate symptom.

Beside COVID-19 patient's level of symptom, duration of bed supply in order to fulfill the isolation bed demand will affect patient success in their recovery. Based on previous study, the average duration of care for non-ICU COVID-19 patients in hospital is 10 days before fully recovered (Wang et al., 2020). This study result was similar to Wang's study where addition of isolation bed capacity at previous 7 days could increase the chance for COVID-19 patients with moderate symptom to get treatment faster so they recover quickly. It certainly will lower the death risk among COVID-19 patients.

Even though ICU bed capacity had the smallest percentage in reducing death among other bed categories, but its percentage had significant impact to decrease COVID-19 death since ICU bed percentage is only 12% of all bed availability. It means ICU bed availability is effective to prevent higher death rate in DKI Jakarta. It was consistent to the study result which was conducted by Sen-Crowe et al. (2021) that showed ICU bed capacity is more effective to reduce COVID-19 death. Besides, ICU bed capacity is one of country healthcare indicators in pandemic handling (Jensen dan Molina, 2020). Then, similar to isolation bed capacity, addition of ICU bed capacity at previous 7 days made COVID-19 patients to get intensive care faster since the average duration of care for ICU COVID-19 patients in hospital is 13.25 days before recovered (Wang et al., 2020).

Opposite to bed availability, the number of COVID-19 positive cases and hospitalized patients at previous 7 days, as well as death at previous 1 day and 2 days showed positive association to COVID-19 death. The number of COVID-19 positive cases at previous 7 days had strong association to death where the increase of COVID-19 positive cases will lead to higher deaths up to 21% in DKI Jakarta. It was caused by fast virus transmission from one individual to others. In addition, it can be caused by undetected infections due to limited access to healthcare, infected individuals who do not show the COVID-19 symptoms (OTG) or have mild symptoms so they do not take COVID-19 testing, testing capacity limitation which prioritize infected individuals with moderate to severe symptoms, and so on (WHO, 2020). As its implication, uncontrollable virus transmission happened quickly and it was transmitted to susceptible individuals, such as individuals with comorbid and elderly. It was also related to the number of hospitalized patients at previous 7 days since most of hospitalized patients were infected individuals with moderate to severe symptoms (Satgas COVID-19, 2021). Finally, when most of COVID-19 patients had moderate to severe symptoms, healthcare capacity was not able to provide proper healthcare service to the patients which leads to higher death numbers.

Based on estimation results, death at previous 1 day and 2 days had positive association to daily death. Each variable showed increasing daily death percentage up to 21% and 10%. It means death at the previous 1 day and 2 days had potential to increase death on the next day. According to Bappenas, the increase of death on the next day can be caused by some factors such a the increase in inpatient and critical care needs, limited critical inpatient care, and lack of information on facilities availability in hospital (BAPPENAS, 2020).

Meanwhile, vaccination numbers as control variable did not show association with the daily death. This estimation results did not fit with the theory and results from previous studies, where vaccination is effective in preventing infection, virus transmission, and death from COVID-19 (WHO, 2021; Xu et al., 2021; Sheikh, Robertson, dan Taylor, 2021). Mobility trend as control variable in this study also did not show any association with daily death and not fit to previous study, where mobility trend such as retail and recreation as well as workplaces had association with the COVID-19 death (Irini, et al., 2021).

This research still used variables that are limited to the healthcare capacity scope and did not involve other potential variables which can influence COVID-19 death, such as age and gender. Besides, health workers variables were also not included as analysis unit which had an impact on COVID-19 death considering some previous studies involved health workers variables and bed capacity to see the its association with the COVID-19 death (Janke et al., 2020). The results of this study also did not fully describe the actual phenomenon that occurs in DKI Jakarta. It was because not only DKI Jakarta citizens who take advantage of healthcare in DKI Jakarta, but other citizens outside DKI Jakarta, like Bogor, Depok, Tangerang, and Bekasi, also use provided healthcare facilities.

CONCLUSION

This study analyzed the impact of one of the government policies – the increase of bed capacity to death rate as the government evaluation in handling COVID-19 pandemic. The analysis in this study used time series data with daily units which source from DKI Jakarta Health Department and Google Mobility Report. Ordinary Least Square (OLS) was used as estimation method in this study. The results of this study showed that the increase of bed capacity had negative association with COVID-19 death in DKI Jakarta. Based on the study results, the addition of all bed capacity had potential to decrease COVID-19 death up to 22.5%. Meanwhile the increase of ICU and isolation bed capacity were able to reduce COVID-19 death with the percentage of 17.3% and 22.7% respectively. Furthermore, the increase of COVID-19 positive cases, hospitalized patients in the hospital, as well as death at the previous 1 day and 2 days lead to higher COVID-19 death.

DKI Jakarta government's effort to fulfill bed availability in healthcare facilities was proven to decrease COVID-19 death rate effectively. As an improvement, DKI Jakarta government could consider the addition of ICU bed capacity and its complementary facilities to prevent higher COVID-19 death. It was because ICU bed capacity had significant impact to decrease the COVID-19 death with lower number of bed compare to isolation bed capacity. Moreover, the prevention of COVID-19 virus transmission in society should be more improved, such as increasing vaccination rate, maintaining physical distancing, implementing cleaning and disinfection, and encouraging personal protection. Hopefully, government commitment and implementation in increasing bed capacity and preventing virus transmission could reduce COVID-19 death in DKI Jakarta.

ACKNOWLEDMENT

This study was supported by Department of Economics Planning and Development Policy, Faculty of Economics and Business, Universitas Indonesia. I thank Mr. Teguh Dartanto, Ph.D, the Dean of the Faculty of Economics and Business, Universitas Indonesia, as co-author and supervisor for his guidance on this study that greatly improved the manuscript. I also thank Mr. Goldy Fariz Dharmawan, Policy and Research Analyst for the Secretary-General at Ministry of Education, Culture, Research, and Technology as co-author for his insights and comments. I would like to show my gratitude to Mr. M. Halley Yudhistira, Ph.D, Head of Economics Planning and Development Policy Department, and Dr. Hera Susanti, S.E, M.Sc, lecturer at Departement of Economics Planning and Development Policy for the reviews and insights of this paper. Last but not least, I am also immensely grateful to academic staffs at the Department of Economics Planning and Development Policy, my colleague, and my beloved ones for their support in this study.

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