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GAME THEORY APPLICATION ON ONLINE TRANSPORTATION COMPANY AND DRIVER INCOME LEVELS DURING THE PANDEMIC

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Abstract. *Online motorcycle taxi drivers are a group of people who are economically affected by the Covid-19 pandemic. This study aimed to provide a balanced choice strategy for drivers and companies. Game theory was applied to conflict of interest situations as a research method. Choices for online transportation companies and drivers are analyzed and arranged in a payoff table until they reach the saddle point. Simulation software as an illustration of a balanced model. This research resulted in driver diligence and incentive strategies as optimal strategies for drivers and companies. If drivers improve performance by choosing a driver diligence strategy, the driver's expectations of getting incentives will be more realistic. Meanwhile, for the company, when the driver's diligence increases, the choice of providing incentives will provide balanced benefits as well.*

Keywords: *drivers, game theory, linear programming, online transportation companies, strategies payoff table*

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1. INTRODUCTION

Drivers are a group of people directly affected economically due to the COVID-19 pandemic. It is a severe problem that requires immediate treatment. However, suppose it is not immediately handled. In that case, it could cause a domino effect, considering the number of drivers that has soared in line with the development of more efficient online transportation via Android [1]. Plus, of course, the physical distancing policy initiated by the government will significantly affect the driver's income level [2-3].

Following the contract agreement with the transportation company, the driver's position is a partner for the company. Therefore, it automatically releases the company's responsibility for all risks that may arise during online transportation services [3]. However, drivers still have to bear various obligations to the company based on the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 12 of 2019.

Based on interviews with drivers who are members of the FOSDOR-MS community in May 2020, they said that achieving targets with the lure of bonuses is often difficult to maintain performance. The difficulty of maintaining performance is partly due to an application system error, which results in the receipt of a double order, resulting in cancellation. Performance appraisal will decrease when cancelation occurs, and bonuses that fail to be received while working hours throughout the day will not be considered [4].

Especially in the current COVID-19 pandemic, it seems as if the fate of drivers depends on the company. Although drivers have become one of the community groups affected by the effects of the pandemic, the relationship with partner status forces drivers not to sue the company to provide the same guarantee rights as employees in general [5]. However, unfortunately, the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 12 of 2019, the company still cuts 20% of the tariff received by the driver, which is his daily income.

However, the presence of online transportation companies in Indonesia has helped the government provide job opportunities. GO-JEK and Grab are the two largest online transportation companies in Indonesia. Go-Jek has a vision and mission that contains the hope of helping stabilize the Indonesian economy and helping realize a more dignified Indonesia. Of course, companies need drivers' services and vice versa. Drivers need facilities from the company [6].

The interdependence between the two has unexpectedly led to a conflict of interest, which has several times invited demonstrations from the driver's side. For example, a controversy occurred in 2015 in Jakarta when hundreds of Go-Jek drivers accused PT Go-Jek Indonesia of violating Law Number 13 of 2003 concerning employment [7]. Drivers allege that PT Go-Jek Indonesia is not responsible for the rights of drivers who have been working partners.

The Employment Agreement is regulated by Law Number 13 of 2003 concerning Manpower. The definition of the employment agreement itself in the law is explained in Article 1, number 14. It says that a "work agreement" is an agreement between a worker or laborer and an entrepreneur or employer that contains the working conditions, rights, and obligations of the parties [8]. Then it is also emphasized in Article 1, number 15 that "the work agreement is the basis for the employment relationship." The relationship between the entrepreneur and the worker or laborer is based on a work agreement with elements of work, wages, and orders. Furthermore, in the civil partnership agreement in Article 1618 of the Civil Code, it is stated that the subject of a civil partnership is two or more people who promise to put something (money/business/goods) into the company to obtain mutual benefits. Furthermore, more specifically, contract law on online road transportation business law [9].

The conflict of interest between online transportation companies and such complicated and prolonged drivers has become a social problem. This study aimed to analyze the position of partners between online transportation companies and drivers so that they can run in a balanced and fair manner using the game theory method. Game theory is a mathematical model that tends to be applied in situations of conflict of interest [10]. Alternative strategy choices for online transportation companies and drivers were analyzed and arranged in a payoff table to reach a saddle point with a linear programming solution using a simplex table [11-12]. Furthermore, it is equipped with a software simulation to illustrate a balanced regulatory model between online transportation companies and drivers based on the optimal choice of strategy. For online transportation companies, the results of this study are expected to be considered for balanced regulatory management.

2. RESEARCH METHOD

The identification of research variables was conducted through interviews. This stage was carried out to find the alternative options to balance the benefits for drivers and online transportation companies. Based on interviews conducted with drivers who are members of the FOSDOR-MS community, several things can be considered alternative strategies. The strategy is summarized into six options, namely: setting a standard price per km, the distance from the nearest driver to the destination of the order, consideration for the driver's diligence, accident and/or health insurance, assessment, and reward for driver loyalty, a clear and balanced incentive structure. As shown in Table 1, variable X is used for drivers as row players and variable Y for online transportation companies as column players, as shown in Table 1.

Table 1. Game Variables

Variabel	Player	
	Driver	Firm
Standard price	X_1	Y_1
Nearest drivers	X_2	X_2
Driver diligence	X_3	Y_3
Insurance	X_4	Y_4
Driver loyalty	X_5	Y_5
Incentive	X_6	Y_6

Testing the validity in Table 2 using SPSS Software with n = 29, degrees of freedom (df) = n - 2 = 27 and significant level 5% so r_{tabel} = 0.36.

Table 2. The Test of Validity of the Questionnaire

Variable	*r* count	*r* table	Interpretation
Standard price	0.709	0.367	Valid
Nearest drivers	0.565	0.367	Valid
Driver diligence	0.564	0.367	Valid
Insurance	0.536	0.367	Valid
Driver loyalty	0.759	0.367	Valid
Incentive	0.768	0.367	Valid

The data reliability test was conducted to determine the level of confidence in the results, namely the consistency of respondents' answers from time to time. From Table 3, it is stated that each strategy choice is reliable because the value obtained is $\alpha > 0.60$.

Table 3. Data Reliability

Variable	$\propto$	Interpretation
Standard price	0.638	Reliabel
Nearest drivers	0.705	Reliabel
Driver diligence	0.722	Reliable
Insurance	0.710	Reliable
Driver loyalty	0.616	Reliable
Incentive	0.616	Reliable

Furthermore, the acquisition value matrix is formed from the results of the respondents' answers by reducing the value of the row player respondents to the column player respondent values. Table 4 is a matrix of the overall acquisition value, and it can be seen that there are dominance values in both rows and columns.

Table 4. Earning Value Matrix

Driver	Company

	Y_1	Y_1	Y_1	Y_1	Y_1	Y_1
X_1	-16	-28	22	4	-2	8
X_2	14	0	6	-12	18	20
X_3	-6	-38	-2	-20	-12	34
X_4	-8	-2	22	-6	24	28
X_5	4	-10	14	-24	-10	14
X_6	-2	-22	18	-10	-24	-28

Drivers who use the maximin rule, namely maximizing the minimum profit, get a score of -8. Meanwhile, online transportation companies use the minimax rule to minimize the maximum loss, obtaining a value of 0. Furthermore, to reduce the size of the matrix to make it simpler and more efficient, a dominance strategy was used so that analytical methods could be carried out to achieve the optimal strategy.

Because the equilibrium point is not reached using a pure strategy, a mixed strategy was carried out using a linear program with a simplex solution. The linear program must guarantee a positive game value (V). For that reason, all elements of the game matrix are added with a value of k = 38 as the absolute value of the smallest element.

3. RESULTS AND DISCUSSION

The driver used the variable x as the maximizing player with the expected value of maximizing the minimum profit with the inequality sign ≥. The online transportation company uses the variable y as the minimizing player with the expected value of minimizing the minimum loss with the inequality sign ≤. The profits earned by drivers can outweigh the value of the game if the online transportation company uses a weak strategy. Meanwhile, the losses incurred by transportation companies can exceed the value of the game if drivers use weak strategies. Expected values for drivers and online companies are calculated using a linear program, respectively.

3.1. Expected Value for Driver and Company

Purpose function:

$$Min\ Z = \frac{1}{v} = \sum_{i=1}^{6} x_1 + x_2 + x_3 + x_4 + x_5 + x_6 \tag{1}$$

Constraint function:

$$22x_1 + 52x_2 + 32x_3 + 30x_4 + 42x_5 + 36x_6 \geq 1 \tag{2}$$

$$108x_1 + 38x_2 + 0x_3 + 36x_4 + 28x_5 + 16x_6 \geq 1 \tag{3}$$

$$60x_1 + 44x_2 + 3236 + 60x_4 + 52x_5 + 56x_6 \geq 1 \tag{4}$$

$$42x_1 + 26x_2 + 18x_3 + 32x_4 + 14x_5 + 2x_6 \geq 1 \tag{5}$$

$$36x_1 + 56x_2 + 26x_3 + 62x_4 + 28x_5 + 14x_6 \geq 1 \tag{6}$$

$$46x_1 + 58x_2 + 72x_3 + 66x_4 + 52x_5 + 10x_6 \geq 1 \tag{7}$$

$$x_1, x_2, x_3, x_4, x_5 x_6 \geq 0 \tag{8}$$

The results of the iteration using QM 5.0 Software for six new rows based on the values of the objective function and constraint function equations (1) - (8) obtained the optimal profit expectation value for the driver as shown in Table 6.

Table. 6 New Simple Tables Driver Games with Online Transport Companies

Minimize	X1	X2	X3	X4	X5	X6		*NK*	Dual
	1	1	1	1	1	1			
Constraint 1	22	10	60	42	36	46	≥	1	0
Constraint 2	52	38	44	26	56	58	≥	1	0
Constraint 3	32	0	36	18	26	72	≥	1	-0.0125

Constraint 4	30	36	60	32	62	66	≥	1	0
Minimize	**X1**	**X2**	**X3**	**X4**	**X5**	**X6**		*NK*	**Dual**
	1	**1**	**1**	**1**	**1**	**1**			
Constraint 5	42	28	52	14	28	52	≥	1	0
Constraint 6	36	16	56	2	14	10	≥	1	-0.0098
Solution	**0**	**0**	**0.0168**	**0**	**0**	**0.0054**		**0.0223**	

Based on the New Simplex Table, the optimal strategy choices for drivers are the 3rd and 6th constraints, namely the driver diligence strategy x_3 and incentive strategy x_6 as follows:

$$x_3 = 0.0168$$
$$x_6 = 0.0054$$
$$x_1 = x = x_4 = x_5 = 0$$
$$Z = 0.0223$$
Because $Z = \frac{1}{v}, y_{i1} = \frac{x_i}{v}$

So, $V = \frac{1}{v} = \frac{1}{0.0223} = 44.84$
$$\overline{x_1} = x_1 \times V = 0 \times 44.84 = 0$$
$$\overline{x_2} = x_2 \times V = 0 \times 44.84 = 0$$
$$\overline{x_3} = x_3 \times V = 0.0168 \times 44.84 = 0.753$$
$$\overline{x_4} = x_4 \times V = 0 \times 44.84 = 0$$
$$\overline{x_5} = x_5 \times V = 0 \times 44.84 = 0$$
$$\overline{x_6} = x_6 \times V = 0.0054 \times 44.84 = 0.242$$

The probability for the driver diligence strategy is 0.753 and the probability for the incentive strategy is 0.242. The optimal game value is:
$$V = 44{,}84 - 38 = 6{,}86$$
The optimal loss expectation value for the company as shown in Table 7 was obtained by iteration using QM 5.0 Software for six new rows based on the same objective function and constraint functions so that the game is balanced for both parties, namely from equation (1) – (8).

Table. 7 The Game Optimization Solution of Online Transportation Company with Drivers

Minimize	Y1	Y2	Y3	Y4	Y5	Y6		RHS	Dual
	1	1	1	1	1	1			
Constraint 1	22	52	32	30	42	36	≤	1	0
Constraint 2	10	38	0	36	28	16	≤	1	0
Constraint 3	60	44	36	60	52	56	≤	1	-0.0168
Constraint 4	42	26	60	32	14	2	≤	1	0
Constraint 5	36	56	32	62	28	14	≤	1	0
Constraint 6	46	58	72	66	52	10	≤	1	-0.0054
Solution	0	0	0.0125	0	0	0.0054		0.0223	

The optimal strategy choice for the company is the 3rd and 6th constraints, namely the driver diligence strategy y_3 and incentive strategy y_6.

$$y_3 = 0.0168$$
$$y_6 = 0.0054$$
$$y_1 = y = y_4 = y_5 = 0$$
$$Z = 0.0223$$
Because $Z = \frac{1}{v}, y_{i1} = \frac{y_i}{v}$

So, $V = \frac{1}{v} = \frac{1}{0.0223} = 44.84$
$$\overline{y_1} = y_1 \times V = 0 \times 44.84 = 0$$
$$\overline{y_2} = y_2 \times V = 0 \times 44.84 = 0$$
$$\overline{y_3} = y_3 \times V = 0.0168 \times 44.84 = 0.753$$
$$\overline{y_4} = y_4 \times V = 0 \times 44.84 = 0$$
$$\overline{y_5} = y_5 \times V = 0 \times 44.84 = 0$$

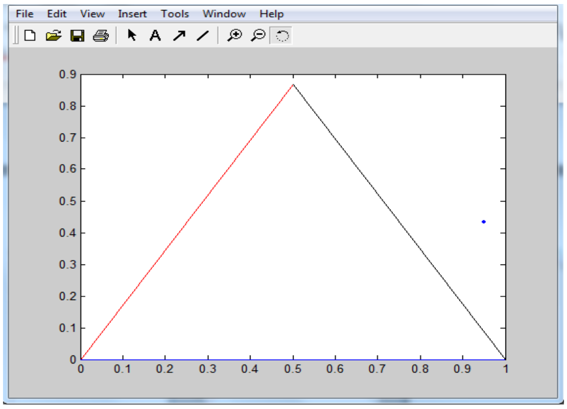
$$\overline{y_6} = y_6 \times V = 0.0054 \times 44.84 = 0.242$$

The probability for the driver diligence strategy is 0.560 and the probability for the incentive strategy is 0.439. The optimal game value is:

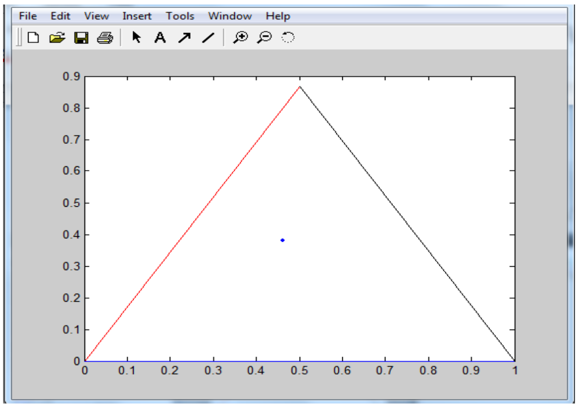
$$V = 44{,}84 - 38 = 6{,}86$$

3.2. Matlab simulation for optimal solution

The chosen optimal strategy is presented in a simulation using Matlab Software with magnitudes of n: 29 and z: 0.0223, ε: 0.05, dan μ: 0. Simulation for the diligence driver strategy in Figure 1 (a) with the equilibrium point for opportunities of 0.560 for transportation companies online and 0.753 for the driver is reached at the point (0.96 ; 045) marked with a small blue circle. Meanwhile, for the incentive strategy in Figure 1 (b) the equilibrium point for opportunities of 0.439 for online transportation companies and 0.242 for drivers is reached around the point (0.45 ; 04) marked with a small blue circle.



(a)



(b)

Figure 1. Selected Strategy Simulation

The combined simulation of the driver diligence strategy and the incentive strategy is shown in the simulation in Figure 2. The equilibrium point is reached around the point (0.95 ; 06) marked with a small blue circle.

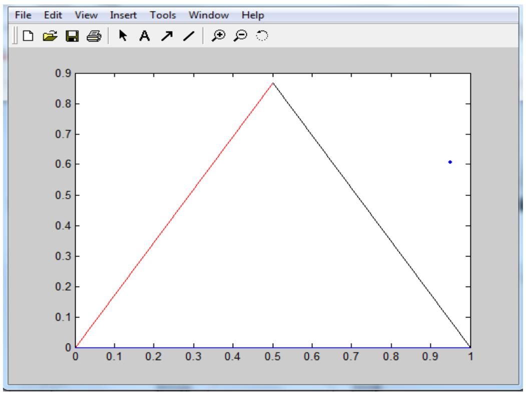


Figure 2. Simulation of Driver and Incentive diligence Strategy

3.3. Discussion

Conflicts of interest between online transportation companies and drivers are discussed in this study with the future goal of analyzing the position of partners between online transportation companies and drivers so that it can run in a balanced and fair manner. Our primary focus is choosing the optimal strategy that balances the benefits for both players by assuming a data error of 3%. The game theory that we apply to a matrix containing strategy choices is based on situation analysis from interviews with drivers who are members of the FOSDOR-MS community and a literature study from several references [13-14]. Fox, W. P. [15] uses game theory to prove optimal strategy selection in military decisions, choosing two or more strategies for each player. Meanwhile, [11] uses a linear program with an excel solver solution in the number zero game. This study only focuses on choosing the optimal strategy from the players with a choice of two strategies using a simplex table solution linear program. One of the main benefits of our game is that it acts as an initiation for preliminary research in the arrangement of future online transportation contracts. The game theory approach with clustering for wireless sensor networks [16] is applied in this study by grouping strategy options based on interview results and reference analysis. The results of this study provide a choice of driver diligence strategies and incentive strategies so it is hoped that further research can be carried out to reposition a power of attorney, as has been done by Pieter E. L. [17]. Game theory was used for the first time in this study to balance the partners' positions between drivers and online transportation companies during the COVID-19 pandemic with a simulation of choosing the optimal strategy. The Matlab simulation in Figure 3 shows that the profit level of the driver can increase with an opportunity of 0.95. At the same time, the company's loss rate decreases with an opportunity of 0.6. However, this study does not consider online transportation laws and regulations, and it also ignores competition among online transportation companies, and does not consider the judgments of consumers who use online transportation services.

4. CONCLUSION

This study's results obtained: (1) the game value was 6.87 as the equilibrium point. The optimal strategies for drivers and online transportation companies are the driver diligence strategy and the incentive strategy. It explains that the choice of driver diligence strategy and incentive strategy is a variable that will provide balanced benefits for both players, namely online transportation companies and drivers. The significant comparison of opportunities between the choice of driver diligence strategy and incentive strategy is not very significant for online transportation companies, which is only the difference between 0.560 and 0.439. However, it is pretty different for drivers, namely the difference between 0.753 and 0.242. It means that if the driver improves performance by choosing a driver diligence strategy, the driver's expectations of obtaining incentives will be more realistic. Meanwhile, when the diligence of drivers increases, the choice of providing incentives will provide balanced advantages and benefits for online transportation companies. (2) Based on the Matlab simulation for the diligence driver strategy, Figure 1 (a) and the Matlab simulation for the incentive strategy, Figure 1 (b) have a consistent shape as well as when a combined simulation of the two, Figure 2. It shows that when the game is repeated with choices of driver diligence strategy and incentive strategy, it will provide balanced benefits for online transportation companies and drivers. (3) Failure to select an insurance strategy indicates an imbalance in the partnership contract, in which the driver bears the entire overmatch. It is not following the Manpower Law, which regulates the terms of work, rights, and obligations between employers and workers. This problem is expected to be continued in subsequent research with a more complex scientific scope.

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