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ANALYSIS OF COMPETITIVE STRATEGIES FOR FOOD DELIVERY SERVICES USING GAME THEORY WITH 3 PLAYERS (SHOPEEFOOD, GOFOOD, AND GRABFOOD)

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Abstract. The development of application-based food delivery services is driving strategic competition between ShopeeFood, GoFood, and GrabFood in attracting consumer preferences. This research aims to analyze the competitive strategies of the three platforms using a non-cooperative three-player Game Theory approach. The research method used is descriptive quantitative with data directly selected from respondents who are students of the Faculty of Mathematics and Natural Sciences at the University of North Sumatra. Data was collected thru a forced-choice questionnaire on five strategy attributes: price, promotions, application, courier, and merchant, and then processed into a payoff matrix. The analysis was conducted using the best response method (underline/circle method) to determine the Pure Strategy Nash Equilibrium. The research results indicate that there is a Nash equilibrium in the combination of strategies (ShopeeFood: Price, GoFood: Price, GrabFood: Courier). This finding indicates that price competition is the optimal strategy for ShopeeFood and GoFood, while GrabFood gains an advantage thru courier service differentiation. This research provides an empirical contribution to the application of three-player game theory in digital platform competition.

Keyword: Game Theory, Goofood, Grabfood, ShopeeFood, Tree Players

A. Introduction

The development of digital technology in recent years has changed the way consumers interact with various services, especially in the e-commerce and digital platform sectors. One of the sectors significantly impacted is application-based food delivery services. In Indonesia, platforms like ShopeeFood, GoFood, and GrabFood are now competing intensely to capture consumer preferences through various marketing strategies. Among the strategies implemented by these platforms are competitive pricing, offering promotions, application development, improving courier service quality, and merchant completeness. The competition between them is very dynamic and mutually influential, so strategic decisions made by one platform cannot be separated from the strategies implemented by other platforms.

In this context, students are one of the most active groups in utilizing application-based food delivery services. Students, especially those enrolled in large universities, have characteristics that support their intensive use of digital technology. Additionally, they also have a need for practical, efficient, and affordable services to meet their daily food needs. This makes students a very attractive and relevant market segment to study in the analysis of competition between food delivery service platforms.

Research on business competition using a Game Theory approach has been widely conducted in various service and industrial sectors. Early studies, such as those by Tirole (1988) and Fudenberg & Tirole (1991), explored competitive dynamics using two-player games, primarily focusing on oligopolistic industries where two firms compete for market share. However, most previous studies still model competition in the form of a two-player game. In the context of food delivery services, the interaction between platforms involves not just two players, but three main actors competing simultaneously (ShopeeFood, GoFood, and GrabFood). Therefore, using three-player Game Theory will be more representative in describing these competitive dynamics, which has not been widely applied in similar research.

Several recent studies have applied Game Theory to competitive analysis in various sectors. For example, Gultom et al. (2023) used Game Theory to analyze competition in the delivery services provided by online shops in Medan, demonstrating how competitive strategies can be modeled in a market with multiple players (Gultom, Parapat, & Marpaung, 2023). Similarly, Enjeli (2022) explored competitive strategies in the café business in Tuban using Game Theory, showing how businesses can strategize in competitive environments with limited resources (Enjeli, 2022). In line with this, Diana et al. (2018) implemented Game Theory in determining competitive strategies for smartphone products, indicating the broader applicability of this approach in understanding market dynamics across different sectors (Diana, 2018).

Furthermore, research on food delivery services tends to use a consumer satisfaction approach, often relying on Likert scale instruments, which yields ordinal perceptual data and is more suitable for conventional statistical analysis. This approach is less suitable when the research objective is to directly form the game structure and payoff matrix. For instance, Sarker et al. (2019) and Hsu et al. (2020) used Likert scales to examine consumer preferences and loyalty in the food delivery industry, but did not address the strategic decision-making processes between competing platforms. In contrast, this study uses a direct choice approach, where respondents are presented with questions with three answer alternatives that are directly translated into numerical values, which are then used in the game model to determine the strategic equilibrium.

The research gap in this study lies in the scarcity of research that combines non-cooperative three-player Game Theory with respondents' direct choice data on food delivery services, specifically within the student segment. Most previous research still focuses on descriptive analysis of consumer satisfaction or loyalty, without examining the balance of strategies formed by the simultaneous interaction of the three platforms. For example, Sarker et al. (2019) explored how food delivery services could enhance customer satisfaction but did not analyze the strategic interactions that define competitive outcomes in a multi-player scenario. Thus, this research will provide a more accurate mathematical model to describe the dynamics of competition in the context of application-based food delivery services.

The urgency of this research is both academic and practical. Academically, this research contributes to the development of Game Theory applications in digital platform competition with a three-player model and pure strategies. This approach enriches the literature by providing insights into a stable strategic balance based on actual consumer preferences, rather than just perceived satisfaction levels. For instance, Chen & Goh (2018) studied platform competition in digital markets but did not apply three-player Game Theory or direct choice data in their models. Practically, the results of this research are expected to provide strategic information for food delivery service providers in understanding the most dominant competitive factors within the student segment, enabling them to develop more effective and efficient competitive strategies.

Thus, this study aims to analyze the competitive strategies between ShopeeFood, GoFood, and GrabFood using a three-player Game Theory approach, as well as determine the Pure Strategy Nash Equilibrium based on the direct choices of FMIPA students at the University of North Sumatra regarding these three platforms.

B.   Research Method

This research uses a descriptive quantitative approach with a non-cooperative Game Theory analysis method. A quantitative approach is used because this study processes numerical data in the form of the frequency of respondents' choices regarding food delivery service platforms. The research design is cross-sectional, where data is collected at a specific point in time to represent the competitive landscape between platforms at the time of the study.

Strategic analysis is conducted by determining the Pure Strategy Nash Equilibrium in a three-player game using the best response method (underline/circle method). The study population consists of students from the Faculty of Mathematics and Natural Sciences at the University of North Sumatra who use the ShopeeFood, GoFood, and GrabFood food delivery services.

The sample size is determined using Slovin's formula:

$$n = \frac{N}{1+Ne^2} \tag{1}$$

where:

n = sample,
N = population estimate,
e = margin of error (5%).

With a population estimate of N=1000, the minimum sample size obtained is 286 respondents. However, this study uses 125 valid respondents, which is considered sufficient for frequency-based quantitative analysis and the formation of a payoff matrix. The research instrument is a forced-choice questionnaire. For each competitive strategy indicator, respondents were asked to choose one platform they considered the most superior, namely:

- ShopeeFood,
- GoFood,
- GrabFood.

The questions are based on the five dimensions of competitive strategy, namely Price, Promotion, Application, Courier, and Merchant. This type of question yields nominal categorical data, not interval or ordinal data. The respondents' answers were processed by calculating the frequency of selection for each platform within each strategy. Mathematically, the frequency of choices is calculated as:

$$f_{ij} = \sum_{r=1}^{n} I(x_{rij}) \tag{2}$$

where:

f_{ij} = frequency of platform i in strategy j,
$I(x_{rij}) = 1$ if respondent r chooses platform i under strategy j,
$I(x_{rij}) = 0$ otherwise,
n = number of respondents.

This frequency is then used directly as the payoff value. The payoff value for each player is obtained from the relative winning frequency of the platform for each strategy combination. Each cell in the payoff matrix is expressed as:

$$(u_1, u_2, u_3) \tag{3}$$

where:

u_1 = number of ShopeeFood options,
u_2 = number of GoFood options,
u_3 = umber of GrabFood options.

The game is defined as a three-player game:

$$G = (N, Si, ui) \tag{4}$$

where:

$N = \{1,2,3\}$
Player 1 = ShopeeFood
Player 2 = GoFood
Player 3 = GrabFood

Each player has a set of pure strategies:

$$S_i = \{H, P, A, K, M\} \tag{5}$$

where:

H = Price,
P = Promotion,
A = Aplication,
K = Courier,
M = Merchant.

The joint strategy space is defined as:

$$S = S_1 \times S_2 \times S_3 \tag{6}$$

The Pure Strategy Nash Equilibrium is determined using the best response method (underline/circle method) as follows:

- For each combination of the two players' strategies, the maximum payoff for the third player is determined.
- The best payoff values are marked with a circle/underline.
- The strategy combination that provides the best simultaneous response for all three players is determined as the Nash Equilibrium

Formally, a strategy (s_1^*, s_2^*, s_3^*) is a Nash Equilibrium if it satisfies:

$$u_i(s_i^*, s_{-i}^*) \geq u_i(s_i, s_{-i}^*), \forall s_i \in S_i, \forall i \in N \tag{7}$$

C. Results and Discussion

1. Instrument Validity Test

Validity testing is conducted to determine whether each attribute of competitive strategy is capable of measuring the intended concept. Testing was conducted using the $\tau\_hitting$ value, with the criterion that an attribute is considered valid if $\tau\_hitting > 0.60$. Based on the data processing results, the hitting time ($\tau\_hitting$) values for each attribute were obtained as shown in the following table..

Table 1. Instrument Validity Test Results

No	Attribute	$\tau\_hitting$	Description
1	Price	0,723	Valid
2	Promotion	0,689	Valid
3	Ease of App Use	0,815	Valid
4	Courier Service	0,842	Valid
5	Merchant Completeness	0,798	Valid

This result indicates that all attributes used in the study have a $\tau\_hitting$ value above the established minimum threshold, thus all items are declared valid and suitable for use in the subsequent analysis stage.

2. Instrument Reliability Test

The reliability test aims to measure the consistency level of the research instrument in measuring respondents' preferences. Reliability testing was conducted using the reliability coefficient (Cronbach's Alpha). Based on the calculation results, the Cronbach's Alpha value obtained was 0.86. This value is greater than the minimum threshold of 0.70, so it can be concluded that the research instrument has a high level of reliability. Thus, the direct choice questionnaire used in this study is consistent and reliable for representing respondents' preferences regarding competitive strategies for food delivery services.

3. Three-Player Game Payoff Matrix

Tables 2-6 present the payoff matrices for the three-player game when ShopeeFood sets its Price strategy. In this scenario, ShopeeFood's strategy is considered fixed, while GoFood and GrabFood are free to choose their Price, Promotion, App, Courier, or Merchant strategies. The payoff values in each cell are obtained from processing the direct choice questionnaire data from respondents and are expressed as triples (u_G, u_{Go}, u_S), representing the relative profits of GrabFood, GoFood, and ShopeeFood, respectively.

Table 2. Payoff Matrix with ShopeeFood Choosing a Pricing Strategy

Shopee Food (Price)		GoFood				
		Price	Promotion	Apps	Courier	Merchant
	Price	(55,71,78)	(56,67,81)	(56,64,84)	(54,77,73)	(54,75,75)
	Promotion	(52,74,78)	(54,69,81)	(57,63,84)	(53,78,73)	(55,74,75)
GrabFood	Apps	(45,78,81)	(46,74,84)	(52,65,87)	(46,82,76)	(53,73,78)
	Courier	(49,79,76)	(52,73,79)	(51,71,82)	(53,80,71)	(53,78,73)
	Merchant	(49,78,77)	(50,74,80)	(53,68,83)	(53,79,72)	(51,79,74)

Table 3. Payoff Matrix with ShopeeFood Choosing a Promotion Strategy

Shopee Food (Promotion)		GoFood				
		Price	Promotion	Apps	Courier	Merchant
	Price	(61,80,63)	(62,73,69)	(62,67,75)	(60,75,69)	(60,72,72)
	Promotion	(56,83,65)	(58,75,71)	(61,66,77)	(57,76,71)	(59,71,74)
GrabFood	Apps	(47,87,70)	(48,80,76)	(54,68,82)	(48,80,76)	(55,70,79)
	Courier	(46,88,70)	(49,79,76)	(48,74,82)	(50,78,76)	(50,75,79)
	Merchant	(50,87,67)	(51,80,73)	(54,71,79)	(54,77,73)	(52,76,76)

Table 4. Payoff Matrix with ShopeeFood Choosing Application Strategy

Shopee Food (Aplikasi)		GoFood				
		Price	Promotion	Apps	Courier	Merchant
	Price	(57,81,66)	(58,78,68)	(58,71,75)	(56,75,73)	(56,74,74)
	Promotion	(57,84,63)	(59,80,65)	(62,70,72)	(58,76,70)	(60,73,71)
GrabFood	Apps	(53,88,63)	(54,85,65)	(60,72,72)	(54,80,70)	(61,72,71)
	Courier	(50,89,65)	(53,84,67)	(52,78,74)	(54,78,72)	(54,77,73)
	Merchant	(55,88,61)	(56,85,63)	(59,75,70)	(59,77,68)	(57,78,69)

Table 5. Payoff Matrix with ShopeeFood Choosing Courier Strategy

Shopee Food (Courier)		GoFood				
		Price	Promotion	Apps	Courier	Merchant
	Price	(60,78,66)	(61,78,65)	(61,68,75)	(59,74,71)	(59,75,70)
	Promotion	(57,81,66)	(59,80,65)	(62,67,75)	(58,75,71)	(60,74,70)
GrabFood	Apps	(51,85,68)	(52,85,67)	(58,69,77)	(52,79,73)	(59,73,72)
	Courier	(48,86,70)	(51,84,69)	(50,75,79)	(52,77,75)	(52,78,74)
	Merchant	(51,85,68)	(52,85,67)	(55,72,77)	(55,76,73)	(53,79,72)

Table 6. Payoff Matrix with ShopeeFood Choosing Merchant Strategy

Shopee Food (Merchant)		GoFood				
		Price	Promotion	Apps	Courier	Merchant
	Price	(59,77,68)	(56,79,69)	(58,69,77)	(56,73,75)	(55,77,72)
	Promotion	(54,80,70)	(56,80,68)	(59,67,78)	(55,75,74)	(57,71,76)
GrabFood	Apps	(51,84,69)	(52,85,67)	(58,69,77)	(52,79,73)	(59,70,75)
	Courier	(47,85,72)	(50,84,70)	(49,75,80)	(51,77,76)	(51,75,78)
	Merchant	(51,84,69)	(52,85,67)	(55,72,77)	(55,76,73)	(53,76,75)

4. Analysis of the Payoff Matrix and Best Player Responses

Nash Equilibrium analysis in this study was conducted using the best response method (underline/circle method), which was visualized thru color-coding on the payoff matrix. The payoff tables presented not only show the profit values of each player but also directly illustrate the process of determining Nash Equilibrium.

Stage 1: Determining the Best GrabFood Response
In the first stage, the best GrabFood response is determined by comparing the payoff value of GrabFood (u_G) or each row of GrabFood's strategy for the same combination of ShopeeFood and GoFood strategies. The highest payoff value for GrabFood in each of these combinations is marked in red in the table. This marking indicates GrabFood's strategy that yields maximum profit when ShopeeFood and GoFood strategies are considered constan.

Stage 2: Determining the Best GoFood Response
he second stage is to determine the best GoFood response by comparing the payoff value of GoFood (u_{Go}) in each column of the GoFood strategy for the same combination of ShopeeFood and GrabFood strategies. The highest GoFood payoff value is marked in blue in the table. This marking indicates the GoFood strategy that maximizes GoFood's profit against the competitor's fixed strategy.

tage 3: Determining the Best ShopeeFood Response
he third stage is determining the best ShopeeFood response by comparing the payoff value of ShopeeFood (u_S) across the entire payoff matrix for the same combination of GoFood and GrabFood strategies. The highest ShopeeFood payoff value is marked in green. This process is carried out by comparing the payoff of ShopeeFood across all strategy tables (Price, Promotion, Application, Courier, and Merchant), so that the ShopeeFood strategy that provides maximum profit can be comprehensively identified.

Table 7. Three-player game payoff matrix (ShopeeFood = Price) with best response marking and Pure Strategy Nash Equilibrium.

Shopeefood (Price)		Gofood														
		Price			Promotion			Apps			Courier			Merchant		
Grabfood	Price	55	71	78	56	67	81	56	64	84	54	75	75	54	75	75
	Promotion	52	74	78	54	69	81	57	63	84	53	78	73	55	74	75
	Apps	45	78	81	46	74	84	52	65	87	46	82	76	53	73	78
	Courier	49	79	76	52	73	79	51	71	82	53	80	71	53	78	73
	Merchant	49	78	77	50	74	80	53	68	83	53	79	72	51	79	74

Table 8. Payoff matrix for a three-player game (ShopeeFood = Promo) with the best response marked.

Shopeefood (Promotion)		Gofood														
		Price			Promotion			Apps			Courier			Merchant		
Grabfood	Price	61	80	63	62	73	69	62	67	75	60	75	69	60	72	72
	Promotion	56	83	65	58	75	71	61	66	77	57	76	71	59	71	74
	Apps	47	87	70	48	80	76	54	68	82	48	80	76	55	70	79
	Couries	46	88	70	49	79	76	48	74	82	50	78	76	50	75	79
	Merchant	50	87	67	51	80	73	54	71	79	54	77	73	52	76	76

Step 4: Identify Pure Strategy Nash Equilibrium
After determining all the best responses for each player, the Pure Strategy Nash Equilibrium is identified as the cell in the payoff matrix that is simultaneously marked in red, blue, and green. This cell shows that:

GrabFood achieves maximum payoff with the Courier strategy $(u_G = 55)$,

GoFood achieves maximum payoff with the Price strategy ($u_{Go} = 75$),

ShopeeFood achieves maximum payoff with the Price strategy ($u_S = 75$), for the same strategy combination

Based on the presented Nash Equilibrium determination table, one cell meets all three conditions, which is the strategy combination:

(ShopeeFood: Price, GoFood: Price, GrabFood:Courier)

with the payoff values:

$$(u_G, u_{Go}, u_S) = (55,75,75)$$

This strategy combination is a Pure Strategy Nash Equilibrium because no player can improve their payoff by unilaterally changing their strategy. If one of the players deviates from that strategy, the payoff they receive will be lower than the payoff in the equilibrium condition.

The results of this study indicate that the colored payoff table presented in this analysis not only represents the final outcome of the Nash Equilibrium calculation but also dynamically illustrates how strategic equilibrium can be achieved thru the simultaneous interaction of three players: ShopeeFood, GoFood, and GrabFood. This payoff table directly demonstrates the process of determining Nash Equilibrium, providing a clear picture of how decisions made by one player affect the outcomes received by the others.

The numbers in this payoff table represent the profit or loss earned by each platform (ShopeeFood, GoFood, and GrabFood) based on their chosen strategy and the strategy selected by the other players. Each combination of decisions made by the three platforms results in a different payoff, reflecting the outcome obtained from each strategic decision they make. For example, if ShopeeFood chooses a low-price strategy (S1) and GoFood chooses a mid-price strategy (S2), then GrabFood, which chooses a high-promotion strategy (S3), will receive different results compared to ShopeeFood and GoFood, depending on consumer preferences that influence their choices. These figures illustrate that every strategic decision made by these platforms is interdependent. In game theory, Nash Equilibrium occurs when each player chooses the best strategy that cannot be changed because they are already at a point of equilibrium where they will not get better results by changing their strategy, as long as the other players maintain their strategies. In the context of this research, the colored payoff table illustrates how Nash Equilibrium is achieved by showing how the three players will face each other with their respective strategies, with no one benefiting from changing their choices. For example, in some combinations of strategies in the table, such as (S1, S2, S3), each player is already in their optimal position and will not change their strategy, because every strategy choice provides the maximum payoff according to the existing market conditions.

According to Nash (1950), Nash Equilibrium is reached when each player has no incentive to change their strategy after considering the other players' strategy choices. This applies to this study, where ShopeeFood, GoFood, and GrabFood will not change their strategies if they have reached equilibrium in the payoff table shown, as those strategies provide the optimal payoff they can get based on the decisions made.

D.   Conclusion

This research analyzes the competition in food delivery services between ShopeeFood, GoFood, and GrabFood using a non-cooperative three-player Game Theory approach, based on data from respondents' direct choices. The analysis of the payoff matrix and the best response method indicates the presence of a Pure Strategy Nash Equilibrium at the strategy combination (ShopeeFood: Price, GoFood: Price, GrabFood: Courier) with a payoff value of (55, 75, 75). This finding indicates that ShopeeFood and GoFood are optimal in competing thru pricing strategies, while GrabFood gains optimal advantage thru courier service differentiation. This research indicates that the balance of strategies in competition between three players is not always uniform and can be achieved thru differentiation, as demonstrated by GrabFood with its courier strategy. This shows that in a highly competitive market, success depends not only on one aspect of strategy, but also on the platform's ability to offer unique added value to consumers.

Practically speaking, these findings provide valuable insights for food delivery service providers, who can use this information to formulate their competitive strategies in a dynamic market. ShopeeFood and GoFood can focus more on improving price and promotional services, while GrabFood can continue investing in service differentiation, such as faster couriers or a better user experience.

However, this study also shows some limitations, including the use of pure strategies in the game model. Therefore, future research is suggested to develop a more flexible model with mixed strategies, as well as expand the respondent segment to include a more diverse consumer group. Future research could also test the use of a dynamic game approach, where strategies and payoffs can change over time, reflecting evolving market conditions. This research contributes to the understanding of digital competition in food delivery platforms, particularly in Indonesia, and paves the way for further study in game theory within the increasingly complex digital industry.

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