PRISONERS DILEMMA MODEL ON STREET VENDORS IN BENGKULU CITY

Eka Dewi Anggraini[1], Yusnida[2], Benardin[3]

[1,2,3] Faculty of Economic and Business Universitas Bengkulu

Coresponding: *ekadewia@unib.ac.id

Abstract

The existence of Street Vendors (PKL) in Bengkulu City also contributes to the community's economy. The large number of street vendors illustrates a conflict of interest where the actions of one trader have an impact on the income of other traders. In game theory, this condition is in line with the prisoner dilemma theory which explains the occurrence of a conflict between two prisoners who want to get a lighter sentence but the duration of the sentence is determined by the confession given by the two prisoners in separate places. When the two players interact, then actions that benefit one player are not advantageous to the other. If all players do the best strategy for them, then the result will end up in a worse situation for both of them.

This study tests the prisoner's dilemma theory to prove whether with the best strategy the reward will be better or worse for both parties? The data used is primary data from 90 respondents who sell food and beverages in Bengkulu City. The data collected includes information on demographic variables, business characteristics, and sales characteristics. The results of the study prove that the prisoner's dilemma theorem applies to street vendors in Bengkulu City. Cooperative strategies are not able to provide maximum rewards for street vendors. However, non-cooperative strategies further worsen the results received. Therefore, the strategy to obtain maximum rewards is not only determined by internal conditions, but also external conditions. Internal conditions are factors controlled by street vendors such as food taste, packaging, price, and selection of selling locations. Meanwhile, external factors are conditions of uncertainty that cannot be controlled by street vendors, such as taste, weather, and the number of consumers.

Keywords: *street vendors, prisoners dilemma, cooperative, non cooperative*

INTRODUCTION

The presence of street vendors in the economic court is considered creative and transformative because it is able to improve individual and collective welfare and contribute to the economic level of the community (Giraldo, Tello, and Rayburn, 2020). They sell food on the streets and move around carrying their goods in locations with a high concentration of pedestrians (Forkuor, Akuoko, and Yeboah, 2017). According to Roever (2014), the presence of street vendors participates in providing easy access to various goods and services in public spaces. They also play a role in generating demand for formal and informal suppliers, creating jobs, and generating revenue for local governments (Roever, 2014).

In Bengkulu City, the characteristics of street vendors include types of merchandise consisting of fast food and beverages, vegetables, basic necessities, fish, fruits, chicken, meat, and fruits. The trading location uses sidewalks and road bodies, there are waste wastes scattered at the selling location, and selling using motorbikes and without using motorbikes. Some trading locations are permanent or permanent and some are not permanent or go around. Meanwhile, some capital comes from cooperative loans, own capital, and capital from parents (Antoro, 2022).

Although in many countries street vendors have a positive impact on the state and households, Mramba (2015) found that the negative impacts of street vendors include causing congestion, health and safety risks, tax evasion, and poor sales of merchandise. According to Ilona and Chediel (2021), street vendors are among the most vulnerable groups in the informal economy because they experience limitations in accessing markets, training, credit, and other economic resources. They also operate in an uncertain work environment and are often displaced and relocated, resulting in a lack of focus on earning a living (Roever and Skinner, 2016). Behind that, street vendors are very observant in taking advantage of opportunities and considering strategic locations in the form of remaining public spaces such as sidewalks and road shoulders, as well as settlements and educational places (Handoyo and Wijayanti, 2021) so that it is easy to get a large number of consumers. Because there are more consumers, street vendors' income is increasing.

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The characteristic of this market is competition for consumers so that the actions of one trader tend to affect other traders. The advantage in this market is that it encourages innovation in product development due to the fierce competition between companies. The company expects more profits and seeks to suppress competition by developing innovation. The price given can be directly accepted by consumers because of the fierce competition, so there is a relationship between them.

Because if the first trader does a strategy to get customers, then the second trader also does a strategy with the same goal without communicating with each other and each trader does not care about the strategy used by other traders. What is the effect on market results? According to the prisoners dilemma. theory, when all players do the best strategy for them, then the result will end up in a worse situation for both of them. In this study, a test will be carried out to determine whether this postulate applies to street vendors in Bengkulu City, with the research title Model Prisoners dilemma street vendors in Bengkulu City. (Calibri, 12)

LITERATURE REVIEW

Game theory is an important study of strategies applied in mathematics, economics and business to model the behavior patterns of interacting players. Game theory analyzes the way in which two or more parties, interacting in an arena such as a market, act in choosing an action or strategy that together affects all participants (Samuelson, 2010). Economists use game theory as a tool to analyze the economy of competition, economic phenomena such as bargaining, design mechanisms, auctions, voting theory, experimental economics, political

economy, economic behavior, and so on. This theory is applied to give and concoct various strategies in the business world. This theory offers tools capable of solving strategy problems. A business strategy is a short-term or long-term plan to achieve sustainable profitability. A business can often succeed in its position in the market with the right strategy and the business will suffer in the long run with the wrong strategy. Strategic behavior occurs on a regular basis especially among executives, managers and investors in the business world.

In game theory, each game is required to have interdependence in the interaction between players. Therefore, the minimum number of players is two people or two parties, for example A and B. Action A affects B and vice versa, action B affects A. The choice of action taken by a player is called strategy, while the set of strategies available to a player is called the strategy room of the player. A player chooses a strategy from his strategy space in order to achieve his mathematically formulated goal called the reward function which has a domain or region of origin in the form of a set of strategy combinations. This means that the pairs of strategies that can be chosen by the players. The reward function also has a co-domain or destination area in the form of a reward value which is a real number. The way to express a game is called a normal form representation, which is a formula that reveals the number of players, the strategy space of each player, and the reward function of each player. Thus, the elements of a game can be formulated as follows:

There are players with a minimum number of 2 people or 2 parties Strategy space, which is the set of strategies available to each player Exogenously defined reward functions from outside the game. One of the problems with decision-making among many people is the prisoners dilemma, which is the dilemma of two prisoners who are caught by the police along with evidence and taken to the police station. Police interrogated both detainees for court proceedings. If there is no confession (they are silent and there are no witnesses), they are only subject to the article on arrest and are sentenced to one month in prison. On the other hand, if there are witnesses, they are proven to have stolen and the sentence is six months. In an effort to get a confession, the police interrogate them separately so that they cannot communicate with each other. The police offered an agreement that if the first suspect confessed to his actions and testified to committing the crime together while the second suspect was unwilling to confess, the first suspect was immediately released for assisting law enforcement, and the second suspect was sentenced to nine months in prison. The strategy pairs and their rewards are shown in the following table:

		Pemain II	
		Bungkam	Mengakui
Pemain I	Bungkam	-1, -1	-9, 0
	Mengakui	0, -9	-6, -6

In the figure, there are four pairs of reward values, namely the top left (-1, -1), the top right (-9, 0), the bottom left (0, -9), and the bottom right (-6, -6). The value before the comma is the reward for player 1, while the value after the comma is the reward for player 2. The top left cell represents a situation where both players choose the silence strategy (B), while the bottom right cell represents a situation where both players choose the admit strategy (M). The upper right cell represents a situation where player 1 chooses strategy B while player 2 chooses strategy M. The bottom left cell represents a situation where player 1 chooses strategy M while player 2 chooses strategy B. The similarity of the characteristics of the two players in terms of reward value and the situation faced causes this game to be included in a symmetrical game. In this game it is assumed that both players simultaneously make one choice. This means that the choice that has been determined by player 1 is not known by player 2 while player 2 will make his own choice, but the reward table is equally known by all players. The representation of the normal form is as follows:G = {S1, S2; u1, u2}, number of players is 2, n = 2 S1 = S2 = {B, M}, both players have twin strategy spaces u1 {B, B} = u2 {B, B} = -1, if both players choose B, then their reward is equally -1 u1 {M, M} = u2 {M, M} = -6, if both players choose M, then their reward is equally -6 u1 {B, M} = u2 {M, B} = -9, the heaviest penalty (-9) is given to the player who is silent while the other player acknowledges. u1 {M, B} = u2 {B, M} = 0, the lightest penalty (0) is given to the player who chooses to

Both players are assumed to be rational who want to maximize their own rewards, in this game they minimize their own punishment and do not care about the rewards their opponents receive. The rewards received in this game if sorted are 0 > -1 > -6 > -9, this order is labeled by Gibbons in Priyarsono, Wijaya, Pradiptyo (2022) with T > R > P > S, namely temptation, reward, punishment, and sucker. The temptation for the inmates is when he admits that when his opponent is silent, the reward is the reward of the situation where the two inmates are willing to cooperate to be both silent, the punishment is the reward of the situation where the two inmates are not willing to cooperate and finally confess together, while the loser is the reward for the prisoner who is willing to cooperate (silence) but is betrayed by the opponent (confess).

If the mutual benefit (group) is considered, it can be seen that the cooperative strategy pair (both silent) gives the largest total reward which is -1 + -1 = -2, therefore if both players choose the cooperative strategy, then they get a reward (R) each punishment of only 1 month. However, if the player is equally uncooperative and only thinks about the benefits for himself and does not care about the fate of other players, then player 1 will be tempted to change his strategy because there is a temptation of a greater reward which is T = 0, so he chooses to admit it, on the other hand player 2 also thinks the same way (wants to get a bigger reward where T = 0), then the total reward of the two is -6 + (-6) = -12 so that the total benefits they receive are much sharper than if they were cooperative. As for S, it is a reward for losers, namely rewards for unlucky inmates because their strategy to be cooperative is betrayed by their opponents who choose to be competitive. If each player is rational, who cares only about his own reward, then a competitive strategy provides greater rewards than cooperative, whatever strategy the opponent chooses is called the dominant strategy.

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RESEARCH METHODOLOGY

The research was conducted to observe how the object of the research, namely cooperative and non-cooperative behavior, applies to the research subject, namely food vendors, and has an effect on the rewards received by the two players, thus forming a pattern, namely the highest, highest, high, medium, and low rewards that meet the analytical aspects according to the prisoners dilemma model.

The data used in the study is primary data whose source comes directly from the source of information, namely food street vendors in Bengkulu City. The questions in the questionnaire include information about the demographic characteristics of the respondents, business characteristics, selling strategies, and rewards received by street vendors as measured by nominal, ordinal, and ratio scales. Meanwhile, data collection is carried out by

field officers by distributing a questionnaire containing a set of questions and statements in a closed and open manner that must be answered by respondents. With the development of technology that makes it easier to fill in and collect data, the distribution of questionnaires is carried out using google forms.

Data analysis was carried out as rules in the theory of the prisoners dilemma game. There are five stages that must be passed to apply the prisoners dilemma model, namely the entry, coding, reduction, quantitative descriptive analysis, and continue by applying the prisoners dilemma model from the results of quantitative descriptive analysis.
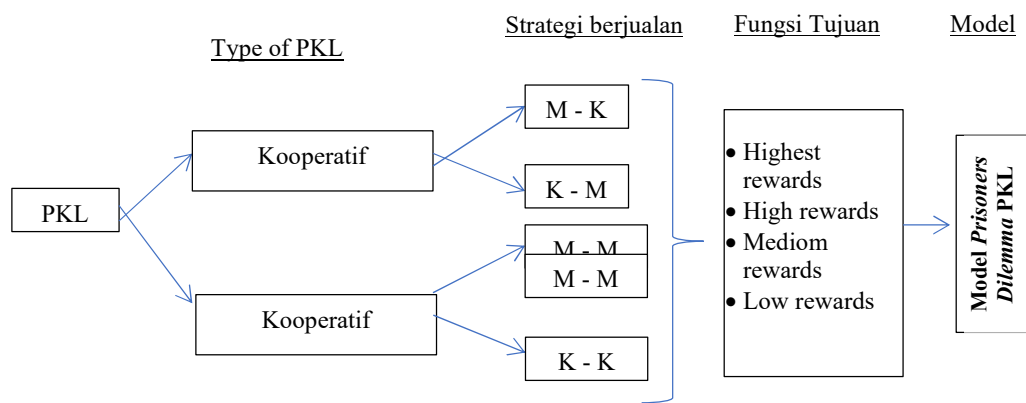

Figure 3.1. Street vendor strategy thinking flow in the prisoners dilemma modelThe following is a schematic of the research stage to make it easier to understand the direction of research activities and the outputs achieved at each stage of the activity.

Table 3.1. Research stage and outputs achieved

Research stage	Component	Component	Achievement
Entry	All respondents	• All respondents' answers	Documented in excel format
Reduction	All respondents	• Irrelevant questions/answers are excluded from the data removed from data	Selected and ready to code data
Coding	All respondents	• Respondents' answers in the form of qualitative data	Data dalam bentuk numerik dan siap diolah

Research stage	Component	Component	Achievement
Descriptive analysis	Respondent grouping	• Central centering and cross tab sizes	• Display data in the form of a tabulation consisting of demographic characteristics, business, selling strategy, and rewards. At this stage, respondents are grouped according to their respective types so that cooperative and non-cooperative respondent groups are obtained, and respondent groups based on selling strategies
Model application		Responden strategy : 1. M – K → kooperatif 2. K – M → kooperatif 3. M – M → non kooperatif 4. K – K → non kooperatif • Respondents determine the rewards for each selling strategy Imbalan paling tinggi • High rewards Imbalan sedang • Low rewards	A reward matrix is obtained that is arranged in accordance with the selling strategy, so that it becomes a model of the prisoners dilem

The representation of the normal form of the game is as follows: G = {S1, S2; u1, u2}, number of players is 2, n = 2 S1 = S2 = {circumference (K), settle (M)}, both players have twin strategy spaces u1 {K, K} = u2 {K, K} = if both players are both using the strategy of going around (K), then their reward is low u1 {M, M} = u2 {M, M} = if both players are using the sedentary strategy (M), then their reward is medium u1 {K, M} = u2 {M, K} = if street vendor 1 uses a roaming strategy (K) when other street vendors settle down (M), then the reward obtained is a high reward u1 {M, K} = u2 {K, M} = if street vendor 1 uses a sedentary strategy

(M) when other street vendors are traveling (K), then the reward obtained is the highest reward.

RESULT AND DISCUSSION

Through the distribution of income of street vendors who sell sedentarily and travel around the Bengkulu City area, a prisoner dilemma model is built as shown in figure 4.2. In the figure, the average income of street vendors who sell cooperatively and non-cooperatively is visualized in the reward scheme. This scheme describes the income received by street vendors if they sell cooperatively or non-cooperatively.
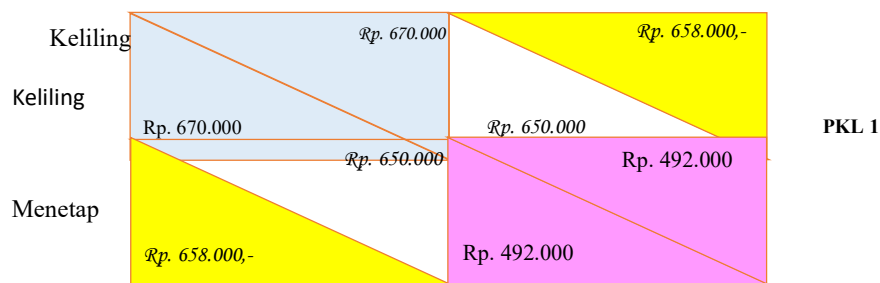

Figure 4.19. Rewards in prisoners dilemma games with a strategy of traveling and settling

On the upper left side, street vendors 1 and 2 are uncooperative and sell in a mobile way. For both street vendors, selling with this strategy is able to provide the highest income when compared to selling cooperatively. This is because both street vendors provide easier access for buyers to get the food offered. However, behind this convenience, street vendors have to spend more resources and energy because selling around demands higher labor and costs than selling permanently.

In the upper right and lower left positions, the income scheme of street vendors is the same, they sell cooperatively. However, in the upper right position, street vendor 1 sells by going around and street vendor 2 settles. Meanwhile, in the lower left position, street vendor 1 sells sedentarily and street vendor 2 goes around. The income obtained with this cooperative strategy is smaller than the non-cooperative strategy, which is Rp. 650,000,- for street vendors who sell on a mobile basis and Rp. 658,000,- for street vendors who sell on a permanent basis. `    `

Furthermore, in the lower right position, the two street vendors selling are uncooperative, namely both living in the same location. As a result, they earned the same

income and the lowest among the other three strategies, which was Rp. 492,000,-. This low income is due to the competition that occurs in both street vendors, resulting in buyers having to choose one of the two options. The end result of the non-cooperative strategy by settling down is that the total sales of street vendors at the location must be allocated to all street vendors there. As a result, each street vendor earns a lower income than if street vendors sell in different locations in a cooperative way.

According to this theory, when all street vendors do the best strategy for them, then the result will end up in a worse situation for them. For example, in a non-cooperative strategy where street vendor 1 sells permanently, this action has an effect on street vendor 2 so that it results in a decrease in street vendor 2's income to Rp. 492,000,-. Furthermore, street vendor 2 will take the best strategy for him, for example moving to another location. This action has an effect on other street vendors, namely a decrease in income, while in street vendor 2 the income obtained will be divided between the two street vendors. If one of the street vendors takes the best strategy for him, which is to go around, then the effect will arise on street vendor 2, namely an increase in income to Rp. 658,000, - because street vendor 2 has no competitors. However, for street vendor 1, there may be an increase in income if street vendor 1 sells around and earns an income of Rp. 670,000,-. According to the prisoners dilemma theory, the consequence of the market outcome is that the game will end in a worse situation for both of them, i.e. they will not be able to get the maximum income unless the two street vendors trade on the road. The dilemma faced by street vendors is that every two street vendors interact, the actions that are most beneficial to each street vendor but not beneficial to the group. When all the players do the best strategy for them, then the result will end up in a worse situation for both of them.

CONCLUSION

The strategy of selling street vendors in a cooperative and non-cooperative way in Bengkulu City provides different rewards for their income. When all street vendors are cooperative (one admits the other does not), they get a low reward for their income (Rp. 658,000,- and Rp. 650,000,-). When all street vendors are non-cooperative by selling in the same place (both admitted), the results are worse where the income obtained is the lowest

(Rp. 492,000,-). And when street vendors are non-cooperative (both do not admit), the income obtained is the highest (Rp. 670,000,-). Thus, the postulates of the prisoners dilemma in street vendors in Bengkulu City are proven. When street vendors 1 and 2 think that selling in different locations (settling – going around) will give the highest rewards for both of them, but the fact is that the rewards obtained are low. And when they think that settling is the best option, it is precisely the lowest reward received. Finally, the best strategy is to go around together because that way both get the highest rewards.

Given that the premise of the prisoners dilemma theory is proven in this study, which is that "when all players do the best strategy for them, then the result will end up in a worse situation for both of them", it is better for each street vendor to have their own characteristics that other traders do not have. By having their own peculiarities, whatever strategy is chosen does not prevent street vendors from getting maximum income because consumer tastes are able to be met by street vendors with the peculiarities of the food produced by them.

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