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Abstract

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Designing Facility Layout of an Amusement Arcade using Market Basket Analysis

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Abstract

In this study, we applied the market basket analysis to design facility layout of an amusement arcade in Surabaya. The problem faces by the amusement arcade is customers only play in certain games that causes many game machines to be idle. This problem will be difficult to resolve because of revenue pattern has not been acknowledged. Therefore, market basket analysis is applied to know the customer behavior in playing the games. As the result we proposed two layouts. First proposal layout will be designed based on game type. This layout will classify game machines based on market basket analysis results in each category where each category is independent of other category. The independent assumption in the first layout is released in the second layout proposal. In the second layout proposal each game category is dependent of other category. As the result, the second proposal is more likely to be applied, since this arrangement does not cost any money and does not require specific material handling.

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Keywords: Facility layout; market basket analysis; games machines; arcade.

1. Introduction

Market basket analysis (MBA) is a technique in data mining that usually used to predict the customers purchasing behaviors. In the market basket discovers co-occurrence relationships among activities performed by customers. Many researchers used the market basket analysis in the retail sectors such as in [1] and [2]. Although, MBA pictures the

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shopping carts and supermarket shoppers, it is also applied in many other sectors, such as to in fraud detection [3], mobile showroom [4], library circulation data [5], and many other sectors.

Various methods and approaches have been proposed to solve layout problems whether in manufacturing layout problems or retail layout problems. Ertugrul [6] developed the integrated data mining and Multi-Dimensional Scaling analysis (MDS) is discussed for products shelf layout. Lewison [7] mentioned selling floor layouts are very important since they strongly influence shopping atmosphere, shopping behavior, operational behavior. Punjaisri and Wilson stated layout has a big influence on customers and the customers want stores to spend whatever it takes to design a layout that minimizing wasted steps and motion in the shopping process [8]. Another interesting facility layout problems also appears in theme parks layout. A survey has been conducted by Yingsha *et al* to determine how attraction and spatial layout attributes affect theme park visitor movement for a theme park in China [9]. The layout design for attraction based enterprises such as theme parks, museums, and exhibitions is also proposed using block layout. Layout designs are designed by combining a space filling curve with tabu search algorithm [10].

In this study we applied the MBA for designing facility layout of an amusement arcade in Surabaya. The amusement arcade is a playing area for arcade game. In Surabaya, the business is still in the public interest. However, based on the data recorded in that amusement area from 1 December 2017 until 28 February 2018, 42.11% of the game machines was idle. There are 32 out of 63 game machines only played less than 100 times. This research is proposed to find out how to rearrange the layout with the expectation of increasing revenue. This problem is difficult to resolve because of play pattern and game categories are not known. Play pattern can be identified with data analytics using MBA method.

2. Methods

2.1. Market basket analysis

Market Basket Analysis (MBA) is an accidental transaction pattern that purchasing some products will affect the purchasing of other products. MBA is used to predict what products that customer interested in. MBA has three parameters which are support, confidence, and lift. Support is a proportion of event B because of event A. Confidence is a probability event B happened because of event A dependently. Lift is a probability of event B happened because of event A independently [11].

Market Basket Analysis can be used in a lot of sectors such as theme park, grocery, etc. MBA is also used for analysing pattern and make route for theme park such as Universal Studios Hollywood (USH) based on the visitor flow pattern [12]. MBA can also be used in amusement arcade such as Amusement Arcade (gaming centre) in Surabaya.

2.2. Facility layout

Facility is a building where people use material, machine, etc [13]. Facility layout used to minimize material and personnel flow, but in this research the reverse applied. This facility layout is focused on how and where the facility placed, designed, and categorized. This research uses amusement arcade principals which are:

1. Make entrance sensational for customer
2. Use free flow floor plan [14]
3. Avoid “butt-brush effect” which is customer turn their back to product because of the aisle is not large enough
4. Put some thought into the ambience where thinking about customer atmosphere
5. Mix things up every so often at least once every 3 months

3. Results and Discussions

In this study we used the three-months recorded data from the amusement arcade player’s cards. To analyse

data, first we recapitulated the data, cleaned the data and aggregated.

3.1 Data preparation

The game machines in this amusement arcade is categorized based on age (toddler, teen and toddler/teen-both) and type. There are 35 teenage game machines, 11 toddler game machines, and 21 toddler/teenage game machines. There are seven types of game machine categories which are prize, gambling, simulation, physic, kiddy ride, arcade, and card game. This proposed layouts also use store layout theory. These data are also aggregated to days, times, early month and end of month.

3.2 Customer Description

The amusement arcade customers mostly are toddlers and teenagers. Teenagers also play more often on weekday and weekend, mostly in the evening. The toddlers very like to play Kiddy ride game, whereas teenagers like simulation game.

3.3 Initial layout

The initial layout is mapped based on real condition, where each name of the game machine has a different number (See Fig. 1). Some of the same game machine has amount more than one so there are some same number. This layout uses a 30 cm x 30 cm scale for each tile. This design also needs to concern about some factors. There are four factors, namely as follows:

- Safety
  Sport game like Street Basket (28) will not be combined with other games to prevent being hit by the ball
- Ease of game search
  Balance check machine must be placed in front so that customers can easily find it which according to boost your kiosk's potential theory
- Aesthetic
  Pillars should be covered by game machines and aisle must be at least 90 cm to prevent butt-brush effect
- Attract customer
  Kiddy ride category must be placed in front of to prevent parents to lie to their child/children that the kiddy ride games are broken

These proposed layouts will use market basket analysis.

3.4 First proposed method

First proposed layout will be designed based on game type. This layout will classify game machines based on MBA results in each category where each category is independent of other category. Free form layout method is used for this layout. The first proposal initial layout can be seen in Fig 2. Different colours mean different categories. First layout is designed by adopting entrance sensational theory. This layout also considers frequency from each category where prize category is placed on the edge because it got the highest frequency. The purpose of this consideration is that the customer will surround the other game when looking for prize game. This layout also considers put some thought into the ambience theory where to think about the customer atmosphere. This approach begins with grouping game machines in their respective categories to increase the likelihood of continuous transactions. The combination of this design in each category is sorted from the biggest support. Game machines' cluster, position number, and game category can be seen in Table 1. Example of rule from card game category can be seen in Table 2.

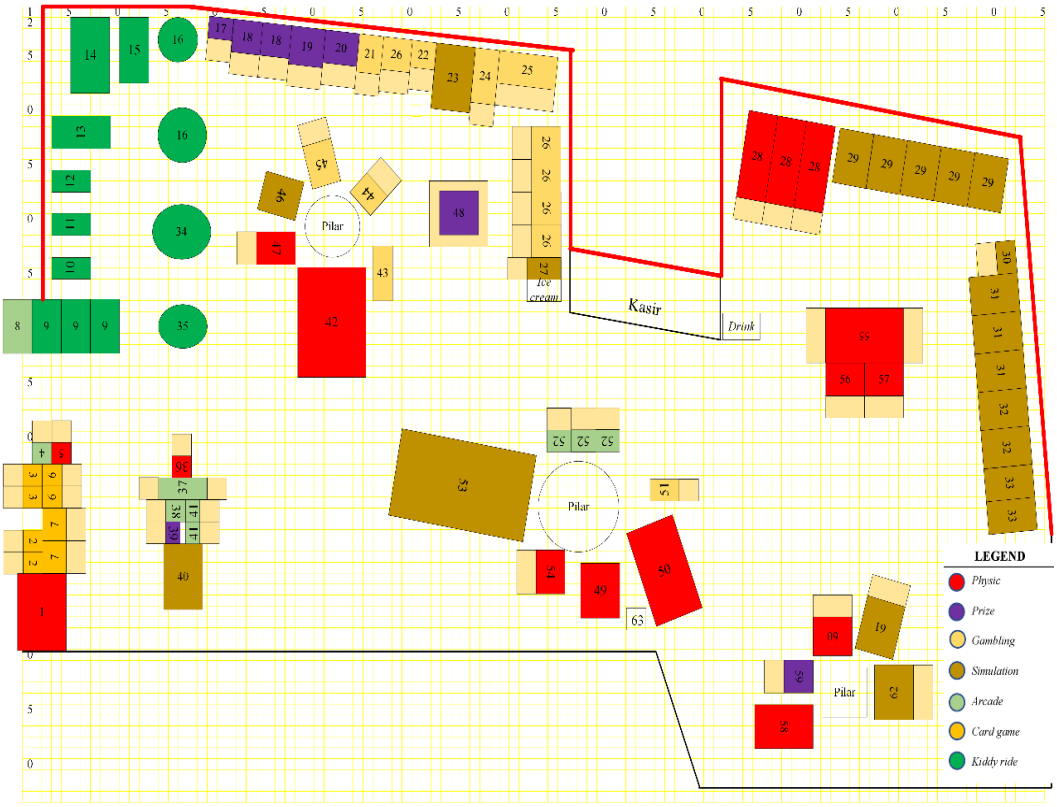

Fig. 1. Initial layout of the amusement arcade.

Table 1. Game machines' name.

Cluster	Position number	Game Category
Teenager	1,28,42,47,49,50,54,58,60	Physic
	17,18,18,20,39,59	Prize
	21,24,25,43,45	Gambling
	2,3,6,7	Card game
	38,41	Arcade
	23,29,30,31,32,33,46,53,61,62	Simulation
Toddler/Teenager	5,36,55,56,57	Physic
	48	Prize
	22,26,44,51	Gambling
	4,8,37,52	Arcade
	27,40	Simulation
Toddler	9,10,11,12,13,14,15,16,34,35	Kiddy ride

This rule proves that customers mostly played in Oreca Battle (7) then go to Hero Robots (3) where the support is 0.1053. The parameter is focused on support, while confidence of at least 0.5 and lift at least 1, that will be no problem. This design does not consider frequency and revenue because it only considers support. This layout has some advantages and disadvantages such as:

Advantages:

- Game machines which have low revenue may have more chance to be played because based on MBA where MBA results maybe juxtapose game machines with low revenue
- Customers who like some category may know the other game from the same category
- Juxtaposition based on category means considering age category, so customers will not be disturbed of age difference

Butt-brush effect will not happen because aisle width is enough

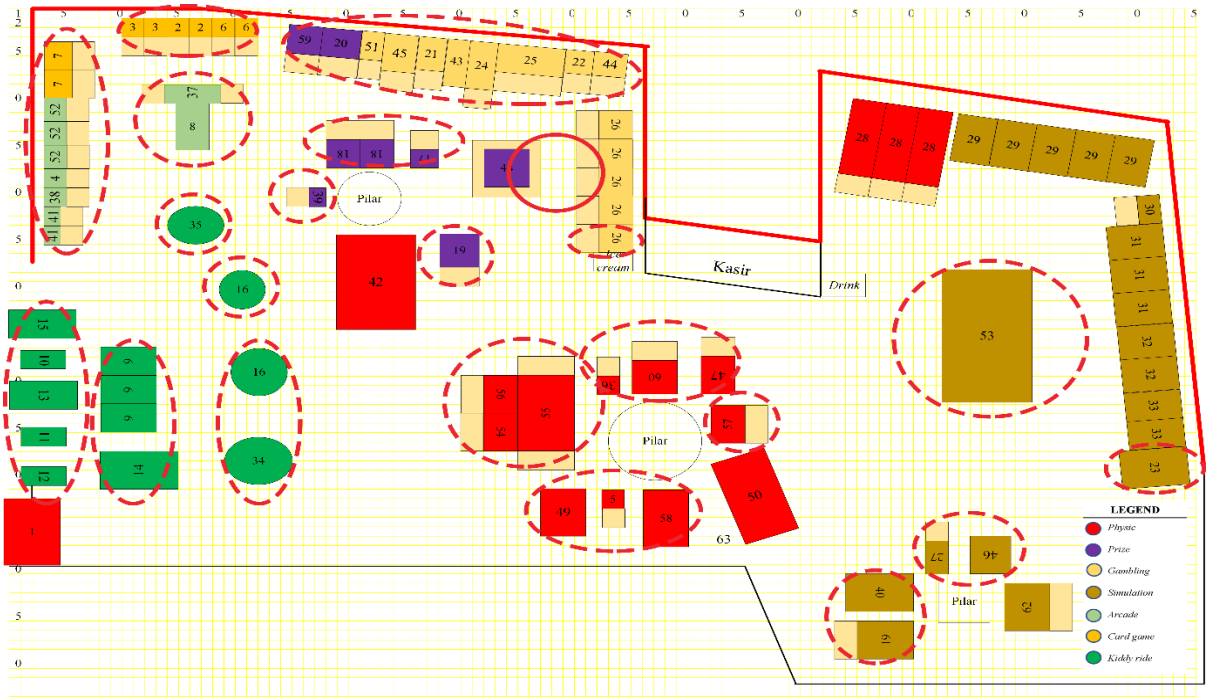

Fig. 2. First proposed layout.

Table 2. The market basket analyis results.

	lhs		rhs	support	confidence	lift	count
[1]	{ORECA BATTLE}	⇨	{HERO ROBOTS}	0.10526316	0.5	1.187500	2
[2]	{ORECA BATTLE}	⇨	{ANIMAL KAISAR}	0.10526316	0.5	1.357143	2
[3]	{HERO ROBOTS, ORECA BATTLE}	⇨	{ANIMAL KAISAR}	0.05263158	0.5	1.357143	1
[4]	{ANIMAL KAISAR, ORECA BATTLE}	⇨	{HERO ROBOTS}	0.05263158	0.5	1.187500	1

Disadvantages:

- Some of game machines like Speed Rider (53) look at the back of the machines which reduces aesthetics because they have an untidy cable
- Game machines with high revenue may not always be on the edge which make them less eye catching

Game machines location like Pump It Up Prime (1) does not changed because due to attracting attention of the customers. The first proposal layout is shown in Fig. 3.

3.5 Second proposed layout

Second proposed layout will be designed based on game type. This layout will juxtapose game machines based on MBA results between categories where each category is dependent of other category. Different colours mean different categories. Second layout is designed by adopting entrance sensational theory also. The second proposal design is almost the same as first proposal design. The difference between them is the MBA between categories. The design is done by juxtapose the lowest revenue game machine from some category with the highest revenue game machine from other category. This design is expected to increase the low revenue game machine and create sustainable transactions. This proposal will sort game machine from the highest revenue to lowest revenue game machine in each category. Rule of MBA can be seen in Table 3. Rules that will be used are rules with yellow highlights based on rule priorities. Example how to read the rule is shown in rule 2 where {prize} → {physic} means customer who play in prize game will play at physic game. Second proposal layout can be seen in Fig. 3.

Table 3. The MBA rule used for the second layout proposal.

	lhs		rhs	support	confidence	lift	count
[1]	{}	⇨	{Physic}	0.6296296	0.6296296	1.000000	102
[2]	{Prize}	⇨	{Physic}	0.3703704	0.7058824	1.121107	60
[3]	{Physic}	⇨	{Prize}	0.3703704	0.5882353	1.121107	60
[4]	{Gambling}	⇨	{Physic}	0.3333333	0.7297297	1.158983	54
[5]	{Gambling}	⇨	{Prize}	0.3209877	0.7027027	1.339269	52
[6]	{Prize}	⇨	{Gambling}	0.3209877	0.6117647	1.339269	52
[7]	{Simulation}	⇨	{Physic}	0.3024691	0.7424242	1.179144	49
[8]	{Gambling, Prize}	⇨	{Physic}	0.2469136	0.7692308	1.221719	40
[9]	{Gambling, Physic}	⇨	{Prize}	0.2469136	0.7407407	1.411765	40
[10]	{Physic, Prize}	⇨	{Gambling}	0.2469136	0.6666667	1.459459	40
[11]	{Simulation}	⇨	{Gambling}	0.2283951	0.5606061	1.227273	37
[12]	{Simulation}	⇨	{Prize}	0.2283951	0.5606061	1.068449	37
[13]	{Arcade}	⇨	{Physics}	0.2160494	0.8536585	1.355811	35
[14]	{Arcade}	⇨	{Simulation}	0.1913580	0.7560976	1.855876	31
[15]	{Prize, Simulation}	⇨	{Physic}	0.1851852	0.8108108	1.287758	30
[16]	{Physic, Simulation}	⇨	{Prize}	0.1851852	0.6122449	1.166867	30
[17]	{Kiddy ride}	⇨	{Physic}	0.1790123	0.6904762	1.096639	29

This proposal has some advantages and disadvantages such as:
Advantages:

- Game machines which have lowest revenue each category may have more chance to be played because it is next to highest revenue game machine from other category
- Customers who like some category may know the other game from the same category
- Juxtaposition based on category means considering age category, so customers will not be disturbed of age difference
- Storefront will be more attractive because physic game is placed in front where it has the most support too
- Butt-brush effect will not happen because aisle width is enough

Disadvantages:

- Some of game machines like Speed Rider (53) look at the back of the machines which reduces aesthetics because they have an untidy cable
- There are some rules which cannot be fulfilled because there are higher supports from other rules

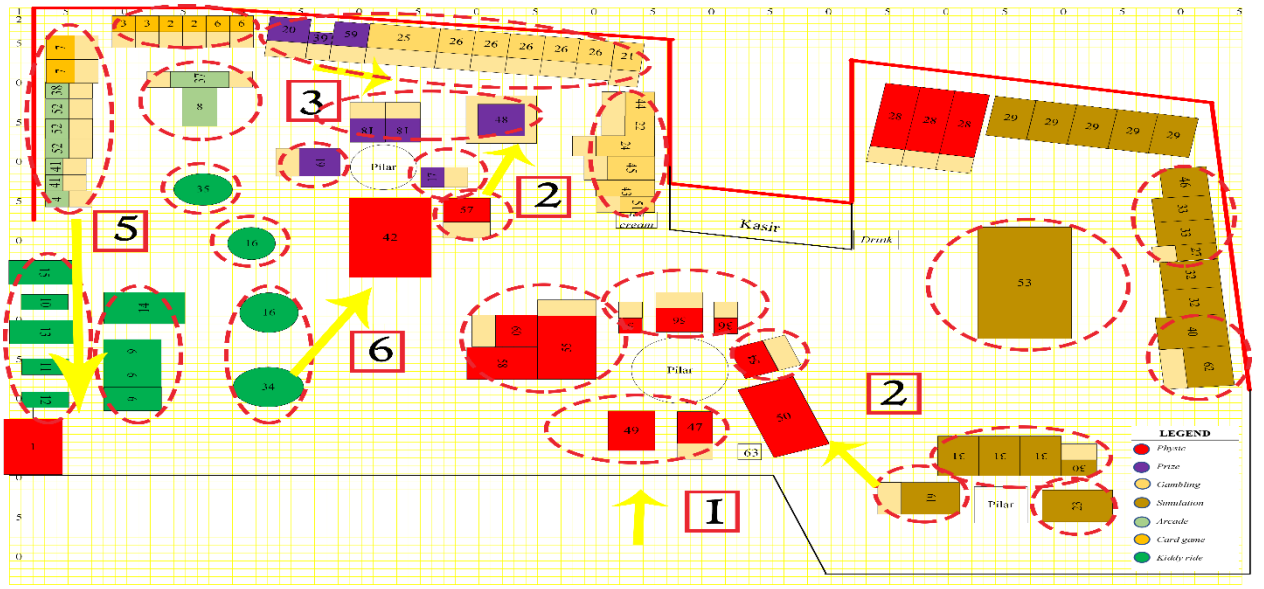

Fig. 3. Second proposal layout.

4. Conclusions

Game machines proposed layout is needed because people only tend to play in certain games. These rarely played game machines cause many of them to be idle. This problem can be solved by designing the layout based on the play pattern using the Market Basket Analysis (MBA) method, store layout theory. Results of this research are two proposed layouts. First and second proposal layouts is designed by adopting entrance sensational theory [15], but they are focused on MBA. Second proposal is more likely to be applied due to its MBA each category which increasing the probability of the game in the same category being played rather than first proposal. The first proposal only sorts the games that had highest to lowest revenue each category. Customers will be more attracted when they look some game which had the low revenue next to the game with high revenue. This arrangement does not cost any money and does not require specific material handling. In the future work we will combine the market basket analysis and cross merchandising approach to maximize the facility layout in order to attract more customers to play and to spend more time and money in each game stations.

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