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Redesigning retail spaces based on customer habits and halal standards using market basket analysis

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ABSTRACT

The halal retailing standard was first introduced by the Department of Malaysian Standards in 2010, known as MS 2400-3:2010. This standard was developed to protect Muslim consumers with the assurance of halal products. However, this management system needs to be more prescriptive on how the retail layout should be organized. In addition, this management also overrides the consideration of customer purchase behaviors or preferences. This research aims to design the layout of retail outlets by considering customer buying behavior and halal retailing standards. This study used the association rule-market basket analysis (AR-MBA) to determine the pattern of customer shopping behavior. One Islamic retail in Indonesia was used as a case study, where one-month sales transaction data was analyzed using AR-MBA. In addition, the activity relationship chart (ARC) was used to qualitatively analyze the placement of a product department by considering halal retailing standards. The results of AR-MBA obtained 21 associations among product departments, which were then used as a basis for proposed layouts while still considering the product characteristics and halal retailing standards. This research output provided a proposed product layout for retail outlets by considering quantitative factors (AR-MBA output) and qualitative factors (MS standard).

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1. INTRODUCTION

The retail industry is an essential sector of the global economy, characterized by strict competition, competitive profit margins, and numerous consumer demands [1]. Intense competition leads retailers to take 7-15% profit margins [2]; even small-scale modern retailers take less than 5% [3]. This competitive profit margin urges retailers to reduce logistics costs by combining products in their shipments. Product mixing, both in the delivery and layout, which does not pay attention to the halal status of products, may decrease the level of confidence of Muslim consumers in halal products due to the possibility of contamination with non-halal products [4]. This issue highlights the critical need for retailers, especially those targeting Muslim consumers, to implement structured strategies that ensure halal integrity while maintaining operational efficiency.

To protect Muslim consumers with halal assurance, the Department of Malaysian Standards introduced the world's first halal retail standard, later known as MS 2400-3:2010: management system requirements for retail [5], which was further detailed in MS 2400-3:2019. The MS 2400-3 standard aims to guarantee the halal status of products in the retail industry, which covers most retailer business processes,

starting from product loading, delivery, and receipt [6]. However, according to Tieman and Bejarano [4], according to Islamic thought, the MS 2400-3 needs to be more prescribed by considering purchasing transactions, supplier selection, retail layout, and logistics.

The study explored the MS 2400-3 standard for retail operations; it did not explicitly address how retail layout and customer shopping behavior influence the effectiveness of halal compliance. Furthermore, studies on retail layout optimization primarily focus on conventional retail settings without integrating halal retail standards as a key consideration. This study aims to fill this gap by examining the relationship between customer buying behavior and retail layout adjustments while ensuring compliance with halal retail standards.

This gap is evident in the case of Retail X, an Islamic retailer in Yogyakarta, which faces challenges in aligning stores with consumer expectations and halal compliance. With rapid growth, Retail X currently has 15 outlets operating across Yogyakarta. Despite having rapid growth, Retail X has not considered consumer transactions in their outlets' layout and marketing strategies. The preliminary survey, aimed at consumers of Retail X, obtained a very high dissatisfaction level, where 70% of consumers stated that they were dissatisfied with the current outlet's layout. According to Arca *et al*. [7], an outlet's layout can define the image of stores, which can help companies stay competitive by forming loyal customers. The poor image will cause disappointment and dissatisfaction among customers [8] and reduce the number of loyal customers and sales [9]. A better store image will maintain loyal customers and motivate them to increase their shopping purchases [10]. Given the significant impact of store layout on customer perception and sales performance, optimizing layout strategies becomes crucial for halal retailers like Retail X. Therefore, layout optimization and shelf space allocation are imperative to maximize product visibility and encourage customer purchases [1]. Ozcan and Esnaf [11] also stated that product and shelf placement affect sales increases. In addition, according to Behera and Mishra [12], exposing complementary products or similar brands nearby tends to influence customers to buy other products related to the product purchased. Thus, understanding customer shopping behavior and preferences can help determine the best retail product layout strategy to increase product sales.

The retail industry has entered the era of big data with enormous transaction data, known as the 5V: variety, volume, veracity, velocity, and value. This massive transaction data is beyond the ability of traditional mining approaches [13]. However, many retail companies have not considered transaction databases as a decision-making input to improve the company's competitiveness. Verma and Singh *et al*. [13] stated that transactions in a retail store play a vital role as they can be analyzed to understand customer purchase behavior patterns. These customer purchase patterns help design product placement and promotion strategies to satisfy customers better and thus increase retailers' revenue [14]. Febrianti *et al*. [15] researched this matter using multilevel association rules (ARs), which produce marketing strategies that include store layout improvement, planogram design, and bundled product offerings. By incorporating consumer shopping patterns into layout planning using qualitative and quantitative methods, this study aims to provide a framework for optimizing store layouts in halal retail settings. Unlike previous research, which primarily focuses on general retail strategies, this study integrates association rule-mining techniques with halal retail standards to develop an optimized layout that enhances consumer experience and Sharia compliance.

2. LITERATURE REVIEW

The AR can be used to develop marketing strategies based on customer purchasing preferences, where these preferences can be measured based on support and confidence in AR principles [15]. Market basket analysis (MBA) is an example of an AR study that analyzes customer buying behavior in a particular transaction [16]. AR-MBA is a data mining technique used to discover unique and interesting relationship patterns from a collection of items in a database. It is widely used to obtain attractive business strategies [17]. Shopping patterns indicate customer preferences in their shopping, and this information can be used in product layout and promotion strategy. Several algorithms in AR-MBA have been used in previous research, such as the Apriori algorithm [18], FP-Growth [19], [20], Eclat [21], [22], and K-Apriori [23]. This study implements the FP-Growth algorithm to analyze consumer purchase behavior. FP growth is a development of the Apriori algorithm [24]–[26], which is more efficient [27] and cost-effective [20], [28]. In designing a retail layout, in addition to considering the quantitative aspects depicted by the products' proximity, it is also necessary to consider qualitative factors such as contamination risk, chemical properties of products, durability, and product hygiene [29]. Several studies, such as Tarigan *et al*. [30] and Kurnia and Lestari [31], used an activity correlation map called an activity relationship chart (ARC). Kolo *et al*. [32] explained that ARCs could be used to analyze the degree of the interrelationship of activities, products, or departments in pairs to help determine a product's or department's placement. This study combined ARCs that consider the qualitative aspects of halal retail standards with quantitative elements, such as consumer shopping behavior, resulting from the AR-MBA algorithm.

A study by Rhavi and Bhagat [33], which examined the influence of merchandising and prices as a retail strategy, suggested that future research should implement another variable of the market strategy, one of which was the retail layout. This research has filled the theoretical gap by developing the retail layout for sales strategies. This research also filled the conceptual gap in the Tieman and Bejarano [4] study on the halal retailing standard, which must be more prescriptive on the retail layout design and consideration of customer buying preferences. From the conceptual research gap perspective, this study combines the concept of halal retail with customer preferences in designing retail layouts. In addition, an empirical research gap was filled based on the Štulec *et al*. [10] study that looked for layout preferences based on consumer characteristics in a particular retail store. In addition, Štulec *et al*. [10] also recommended exploring the scope of customer shopping characteristics. To address the empirical research gap, the study identified the characteristics of customer shopping in a retail store through shopping patterns in their shopping basket. To summarize the above-mentioned statement, the novelty of this research is to provide a case study on the layout planning of the retail outlet by studying customer shopping preferences and the application of halal retail standards. This research used a retailer outlet adopting the Sharia concept as a case study. The customer purchasing preferences obtained from AR-MBA were integrated into qualitative aspects such as product risk of contamination and product toxicity using ARC.

3. RESEARCH METHOD

This research was conducted on Retail X, an Islamic retail concept providing various daily products for halal and thoyib. The selection of Retail X as the case study was based on its consistent application of halal standards, making it an ideal environment for exploring the impact of layout optimization in halal retail settings. This research focused on layout planning based on customer preferences and the halal retail standard MS 2400-3:2019. One-month transaction data, consisting of 9686 transactions, was obtained from sales transactions of Retail X. Each transaction was identified by "transaction code" and "product name". Using the transaction criteria of at least two different items in each transaction, 3725 data points were taken for further analysis. In the early stages of the study, the initial layout of Retail X was identified using direct observation. This initial layout was also used as a reference in product grouping used on the AR-MBA. Data processing, aimed at identifying customer purchasing preference patterns, was then performed based on the knowledge discovery in databases (KDD) process, which includes data selection, pre-processing, transformation, mining, and interpretation.

Data pre-processing is a step to prepare data before entering the data mining process. This research used data cleaning, reduction, and integration to pre-process data. Data transformation was done before data mining processing by changing the data into binary (1 and 0). The data mining process in this study was performed using RapidMiner software by incorporating the FP-Growth algorithm. The FP-Growth algorithm and RapidMiner software were chosen for their efficiency in discovering ARs in large datasets, a method commonly used in retail data analysis, e.g., Chang *et al*. [27]. This step resulted in ARs representing a pattern of customer shopping preferences. Interpretation consists of interpreting the results of associations formed from data processing. The evaluation was then performed by looking at the values of the algorithm parameters, support, confidence, and lift of each association formed. The next step was identifying relationships between departments using the ARC based on ARs and product characteristics. This step's output was a diagram representing the proximity of department relationships. This methodology was chosen to address the gap in current literature, as no previous studies have integrated customer purchase behavior with halal retail layout standards using association rule mining techniques.

3.1. Initial layout identification

The layout of Retail X, in its existing condition, was qualitatively determined by considering the product type. However, there were still product placements that could be more suitable. Retail X implemented a random shelf to display different products on special occasions. The random shelf was located next to the entrance of Retail X. Therefore, products placed on random shelves are subject to change as needed. On the other hand, unsuitable placement also existed for garment-related products. Underwear, a sub-product of the garment, was placed next to rice, which may reduce the products' hygiene. In the existing condition, products with the same characteristics were placed far apart. In addition, the product layout has never been changed or adjusted based on the customer's buying preferences.

3.2. Product grouping

Retail X products were classified based on their type or similarity and consideration of the current layout. Ninety-four Retail X products were grouped into 27 departments based on their similarity. Details of the departments and products are shown in Table 1.

Table 1. Product grouping

Department	Product
Ice cream	ice cream
Drink	soft drink; tea; juice; health drinks; coffee; yogurt
Mineral water	mineral water
Breakfast	ground coffee; liquid milk; tea; cereal; milk powder; beverage powder; condensed milk
Rice	rice
Local snack	chips; crackers
Condiment	seasoning; soy sauce; cheese; salt; coconut milk; jelly powder; sauce
Instant food	instant noodles; sardines
Jam and bread	bread; jam; meses
Modern snack	chips; pilus; nuts; wafers; biscuits; brownies; seaweed
Ingredients 1	eggs; sugar
Ingredients 2	flour; oil
Confectionary	chocolate; candy; sausage
Frozen food	nugget, raw sausage
Healthcare	medicine; vitamin; pain relief patch; honey; medicated oil; wound plaster; mask
Beauty kit	perfume; deodorant; hair oil; facial wash; lotion;
Stationary	stationery; books; glue; accessories; batteries
Toiletries	toothpaste; toothbrush; soap; shampoo;
Cleaner	softener; bleaches; dish soap; floor cleaning detergent; liquid laundry detergent
Insecticide and air freshener	insect repellent; fragrance
Sanitary	tissue; cotton swabs
Baby	baby wet wipes; baby powder; baby soap
Sanitary pads	pantyliners; diapers; sanitary pads
Detergent	washing powder
Entertainment	slippers; toys
Houseware	cutlery; brooms; mops; greaseproof paper; washing brushes; sponges; candles

Source: Yanti [34]

4. DATA PROCESSING

4.1. Data pre-processing

Data pre-processing consists of data cleaning, reduction, and integration [35]. Data cleaning was performed by deleting incomplete transaction data, transactions containing only one product, or transactions containing more than one product from the same department. Data variables not used in the next step were eliminated in the data reduction. These unused variables were transaction date, barcodes, product codes, purchase quantity, units, selling price, promotional services, and total price. This study considered the item name on each transaction as the research aimed to find relationships, patterns, and associations of products purchased by customers on each transaction. In the final step, i.e., data integration, products with the same similarity were categorized into one group. The results of the pre-processing phase are shown in Table 2.

Table 2. Data pre-processing

Transaction	Product
1	wound plaster; deodorant
2	cooking oil; brownies; chips; local chips
3	slipper; spices; salt; eggs
4	liquid milk; wash soap; spices; instant noodles; chips; wafer; cooking oil
…..	……
3728	drink, jam, and bread

Source: Yanti [34]

4.2. Data transformation

Data transformation was performed before the data mining process to adapt the data to the algorithm or the processing software's characteristics [35]. This research used the FP-Growth algorithm. Transaction data from the data pre-processing step, shown in Table 2, was transformed into binary numbers 0 and 1. The number 1 means the product department is contained in the purchase transaction, and 0 otherwise.

4.3. Association rule parameters

According to Larose and Larose [36], the minimum support and confidence values can be determined using a trial-and-error approach. In this study, the support and confidence parameters were determined using trial and error by looking at the results of the associations formed. The minimum values of support and confidence based on the experiments are shown in Table 3. The minimum support and confidence values used were 2.5 and 25%, respectively, by the fifth experiment.

Table 3. Experiments in determining the minimum support and confidence

Experiment	Support	Confidence	Results
1	0.1	0.5	No association rule found
2	0.1	0.25	No association rule found
3	0.05	0.3	Seven association rules
4	0.05	0.25	Eleven association rules
5	0.025	0.25	Twenty-one association rules

Source: Yanti [34]

5. RESULT AND DISCUSSION

5.1. Customer's preferences based on association rule

Customer shopping preferences in this study were quantified using mining rule associations. Association means that when a customer buys a product in the premises department, it is likely that the customer will purchase the product in the conclusion department. The AR mining technique identifies patterns in customer purchasing behavior by determining which products are likely to be bought together. For example, if a customer buys a product in one department, the rule predicts a higher likelihood that they will also purchase a related product from another department. Table 4 shows customer purchase preferences from the AR. As shown in Table 4, the highest-ranking associations were the relationships between 'modern snacks' and 'drinks' with the highest lift values. AR mining formed 21 associations with a minimum support value of 2.5% and a minimum confidence of 25%. The study revealed that customer preferences tend to cluster in departments related to daily convenience, with 'modern snacks,' 'breakfast,' and 'ingredient 1' leading the list. Of the entire association, the departments with the most purchases are "modern snacks", "ingredient 1", and "breakfast." In association rankings, researchers consider different parameters by adjusting research needs. The research by Valle and Morras [37] used lift values, while Said *et al*. [38] used confidence and support values to rank the associations formed. Similar to previous studies, confidence and support values were used to rank associations, revealing patterns that align with prior retail behavior models. The highest association, based on the highest lift values, was the association between "modern snacks", "drinks", and "mineral water". On the other hand, the highest association based on confidence and support values was the association between "jam and bread" with "modern snacks," followed by the associations between "instant food" and "condiments".

Table 4. Association rules among product departments

No.	Premises	Conclusion	Support	Confidence	Lift
1	breakfast	modern snack	0.080	0.308	1.061
2	modern snack	jam and bread	0.090	0.310	2.586
3	confectionary	drink	0.060	0.316	2.429
4	condiment	instant food	0.070	0.333	3.030
…	….	…..	…..	…..	…..
20	modern snack, mineral water	drink	0.030	0.750	5.769
21	modern snack, drink	mineral water	0.030	0.600	6.000

Source: Yanti [34]

5.2. Consideration of halal retailing standards in layout planning

As a retailer committed to applying the Sharia concept in their business process, Retail X needs to pay attention to the halal retail standard issued by the Department of Malaysian Standards, MS 2400:3. The MS 2400-3 standard is a guideline for retailers to guarantee halal products sold, covering six cycles of processes: i) supplier selection and product ordering, ii) inventory management; iii) product receipt, sorting, and storage; iv) product processing and shelf display, and v) product inspection. Based on these cycles, this research position is on the fifth cycle, the shelf display. There are four procedures in the shelf display by halal retail standards: i) identifying, separating, handling, and labeling non-halal products; ii) storing and adding shelves; iii) customer tracking and product selection; and iv) designing corridor routes to prevent contamination.

Other things related to the retail product layout are display and merchandising activities. Some of the display and merchandising procedures explained in MS 2400:3 are i) ensuring that the product is effectively protected from contamination, ii) implementing personal hygiene programs for employees such as proper handwashing procedures, the use of gloves or tools to pick up certain products if necessary, avoiding empty-handed contact with ready-made products, and limiting sick employees, iii) preventing cross-contamination of dirty equipment and supplies, and iv) minimizing contamination from customers. In addition, the product layout must enable good hygienic practices, including product protection from cross-contamination, which may result in non-halal products.

This research was conducted in one of Retail X's outlets, with the principle of Sharia, which only sells halal and tayyib daily need products. Cigarettes, alcoholic beverages, contraceptives, pork-related products, or other non-halal ingredients are prohibited at this retail store. Therefore, in designing the product layout, there was no need to separate halal and non-halal products or label non-halal products since all products were guaranteed to be halal products. However, the proposed design should pay attention to the hallways and the placement of products on the shelves to prevent physical, chemical, and biological contamination and ensure hygienic practices. Therefore, this research used the ARC to propose a layout based on these qualitative requirements. Taking the Sharia principle into account, the proposed layout in this study was not intended to trigger impulsive purchases. Impulsive purchases are consumer tendencies to buy spontaneously, in a hurry, without reflection, and driven by psychological aspects and market incentives [39]. Impulsive decisions are made spontaneously in stores because factors influence them, including consumer characteristics and marketing strategies, such as layout and promotions [40]. Islam said in *QS. Al-Isra'*: 26-27 gives a firm attitude to consumers by prohibiting excessive and unprofitable actions. Impulsive purchases, based solely on preferences without considering the products' usefulness, are contrary to Islamic Sharia.

5.3. Layout planning using an activity relationship chart

This study used ARC to support quantitative interdepartmental associations resulting from AR-MBA. As stated in the previous chapter, associations represent a pattern of purchase behavior. Generally, some researchers, such as Karthiyayini and Balasubramanian [41], used this method to facilitate customers by closely placing products with the highest association. On the other hand, if the goal is to extend consumer reach to the products sold, the customer needs to be motivated to walk through the store hallways. Therefore, products with the highest association should be placed far apart [16]. This study's proposed layout was more dedicated to facilitating customers by closely placing products with the highest association. Therefore, this decision will minimize the required time and facilitate product search.

In addition to the purchase pattern, ARC needs to consider qualitative factors such as product characteristics, contamination risk, chemical properties of products, and product hygiene [29]. Both contamination risk and product hygiene are stated in the halal retail standard MS 2400-3:2019. The combination of quantitative (customer preferences) and qualitative (halal retail standard) information is depicted in Figure 1. Figure 1 shows the relationship chart among departments, where the degree of proximity is represented in six different colors. Two numbers under the colors indicate the closeness code based on customer preferences (AR-MBA results) and the product's properties (retail standard). These two closeness reasons determine the degree of proximity among product departments.

The ARC visually represents the relationships between product departments based on customer preferences and product characteristics [32]. By analyzing the ARC result above, the findings from the AR-MBA can be used to identify the most efficient product placements, ensuring a layout that aligns with customer shopping behaviors while adhering to halal retail standards. The annotation, color code, and the relationship chart among product departments are shown in Figure 1. If, according to consumer preferences, the products should be placed close together, but according to the product characteristics and halal retail standards, the products should not be placed close together. The decision taken in the proposed layout is that the product placement should not be placed close together. Quantitative analysis of customer preferences using the AR-MBA method obtained an association between "healthcare" and "ingredient 1", meaning these two departments should be placed close together. However, based on product properties and halal retail standards, both products must be kept away because "healthcare" products have chemical properties that can contaminate food products, such as "ingredient 1". Conversely, some products do not have quantitative relationships because they do not form customer preference associations but have qualitative closeness based on the similarity of product types and uniformity, for example, the relationship between "ice cream" and "drink" or "toiletries" and "sanitary" products.

In addition, there are product relationships signed with brown, which means that they should not be kept close due to the risk of contamination or concerning the hygiene and cleanliness of the product. Products in this category were "healthcare", "cleaners," "toiletries," "insecticides," and "air fresheners." In addition, "apparel" contains underwear sub-categories that should be kept away from the rice category because they can reduce the cleanliness of the "apparel". Based on the description above, the product layout design is based on customer preferences by considering the halal retailing standard MS 2400-3: 2019, as shown in Figure 2. The ARC diagram was pivotal in translating the AR-MBA method's quantitative findings into a practical product layout. By mapping out the interdepartmental relationships, the ARC helped to visualize proximity preferences while ensuring compliance with halal retailing standards. For instance, the diagram highlighted departments that should be placed closer together based on customer preferences, like "modern snacks" and "drinks", while also identifying the need to separate specific departments to avoid contamination risks, such as "healthcare" and "ingredient 1".

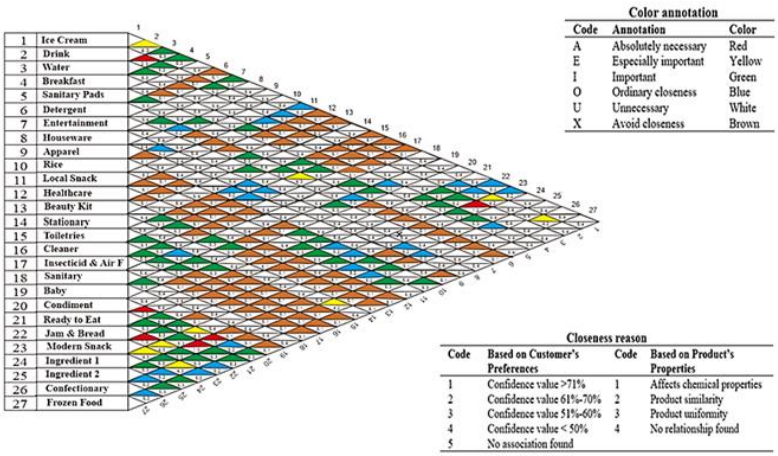

Figure 1. Result of ARC [34]

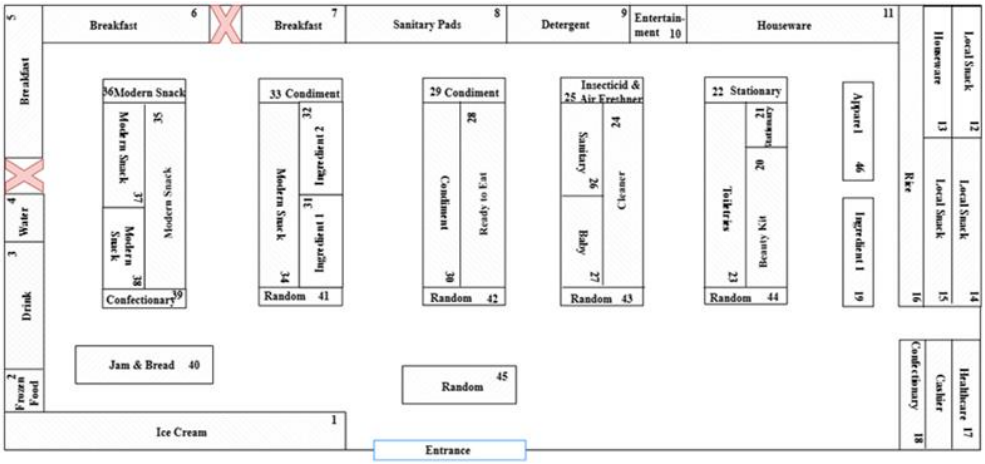

Figure 2. Proposed layout [34]

Using the ARC in layout planning ensured that the store's design would not only meet customer expectations but also adhere to Islamic principles regarding cleanliness and hygiene, contributing to an overall shopping experience that is efficient and compliant with Sharia law. While this study provides valuable insights into product layout and customer preferences, further research could explore the impact of layout adjustments on long-term sales performance and consumer behavior across diverse retail environments. The findings suggest that optimizing product layout based on customer preferences while adhering to halal standards could significantly enhance the shopping experience, contributing to greater customer satisfaction and loyalty.

6. CONCLUSION

This study proposes a retail layout design based on customer preferences and the halal retail standard MS 2400-2:2019, aiming to facilitate a shopping environment that aligns with Sharia principles while maintaining hygiene and cleanliness. The layout modifications include adding shelves in the “apparel” category to meet halal standards, positioning “jam and bread” products closer to the entrance, and adjusting other product categories like “modern snacks”, “houseware”, and “local snacks” based on their similarities. The “confectionery” section is strategically placed near related products such as “breakfast”, “drinks”, and “modern snacks”, while “ingredient categories 1 and 2” are positioned near “condiments” and “instant food” for better customer navigation. This study also incorporates ARC analysis, which was used to identify and visualize key product relationships, further optimizing the layout design based on customer preferences and hygiene considerations. While this redesign primarily addresses hygiene and contamination issues in halal retail, it does not explicitly address non-halal products, as all products at Retail X comply with halal standards. Future studies should explore halal-mixed retail environments that sell halal and non-halal products, applying the halal retail standard MS 2400-3. Additionally, exploring alternative algorithms beyond

Apriori and FP-Growth and designing marketing strategies based on customer shopping preferences and halal standards could further optimize retail layouts and enhance consumer experiences. These findings contribute to a deeper understanding of how halal standards can be integrated into retail layout design, suggesting practical applications for improving shopping experiences in halal-compliant retail environments, with potential for broader implementation in the retail industry.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

Data availability does not apply to this paper as no new data were created or analyzed in this study.

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