Designing a Green Food Delivery Packaging with QFD for Environment (QFDE) and TRIZ

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Abstract. The Indonesian food delivery service market is projected to grow until 2020. Looking at these trends, food packaging plays an important role in the running of the system. However, until now the packaging on the delivery order is still similar to the package on take-out orders. Seeing this, several problems might occur such as changes in food temperature during transportation, poor presentation of food, changing food tastes, and other causes that impact on decreasing customer satisfaction with the quality of food delivery services and restaurants. The existence of food packaging is very close to the waste it produces. Responding to the problem, this study attempts to examine the proper food delivery packaging (tertiary packaging) design so that food quality can still be maintained by applying the Quality Function Deployment for Environment (QFDE) and Teorija Rezhenija Izobretatelskih Zadach (TRIZ) methods. This study succeeded in answering the research objectives, namely to find out the attributes of customer needs and weighing their importance to the quality of food packaging, as well as succeed in providing food packaging design recommendations with a function focus to maintain food hygiene during the delivery process and considering environmental aspect along the design process.

1. Introduction
The total market value of foodservice home delivery in the Asia Pacific region is projected to grow until 2020. Including Indonesia in it, market value is projected to increase to more than 5% when compared to conditions in 2015 [1]. Three main factors influence food consumption [2], namely individual characteristics, food characteristics, and environmental characteristics. In 2020, the millennial generation is predicted to dominate by 34% of the total population in Indonesia [3] with this generation’s tendency to order food by delivery. Indonesia, which is classified as a lower-middle-income economy, tends to follow the trend of food consumption in high-income countries such as Germany or America [4]. In 2012 and 2014, an online food ordering platform was successfully launched in Germany (Foodpanda) and the United States (Grubhub). Likewise in Indonesia, GO-JEK and Grab companies offer similar services by the name of GO-FOOD and GrabFood. The two food delivery service businesses offer the convenience of consuming more diverse types of food at lower prices for customers.

Along with the ongoing trend, the role of packaging certainly cannot be separated. Until now, orders intended for delivery is still using packaging similar to take-out packaging. If traced through the customer journey on the customer getting food from online food delivery services, there is an additional process that needs to be passed by the product, namely the process of transportation carried out by food delivery messengers from the location of the restaurant to the customers’ desired destination. Some possible problems can arise such as changing food temperatures during...
transportation, poor food presentation, changing tastes, and other causes that impact on declining final customer satisfaction with the quality of food delivery services and restaurants.

The entry of third-party delivery services as new stakeholders into the food delivery system, which has only been played by restaurants, requires them to adapt to existing systems. The packaging system aims to accommodate all the needs of the relevant stakeholders in delivering value to end customers, which can be realized at three packaging levels, namely primary, secondary and tertiary packaging. Seeing the role of third-party delivery services in the food delivery system, they are responsible for maintaining food quality in shipping so that it requires packaging that can facilitate handling, transport and storage activities. On the other hand, GO-JEK and Grab allow driver-partners to use two-wheeled motorbike transportation modes to carry out operational activities such as transporting passengers (GO-RIDE features on GO-JEK and GrabRide features on Grab), delivering food, delivering goods, and other facilities with the same driver account. The business process from the on-demand booking platform which intersects between functions has become an obstacle for third-party delivery services in implementing tertiary packaging in their daily operations.

Besides, in some industrialized countries, changes in consumption patterns have a strong impact on household waste production [5]. It was stated the same thing on [6], the factor that is often problematic in purchasing food on take-out is the type of packaging used is one of them. Whilst the rapidly changing trend, there are still few studies that publish research related to the innovation of Ready-to-Eat food packaging [7]. So, it is necessary to review the existing packaging, in its use in the food delivery order and further design of food packaging as a recommendation for problem-solving.

2. Theoretical review

2.1. Take-out food packaging

In food delivery industries, packaging logistics plays an important role in logistics systems because the packaging is required to fulfill the transportation function of the product efficiently, ensure product quality is maintained during shipping, and product safety [8]. This is a broad and crucial discussion for third-party delivery services because they will be fully responsible for the delivery activities and the process is an opportunity for them to add value to it. Take-out food packaging is one example of packaging development with its function to run the logistics process optimally. In the business model of food delivery services, food is sold remotely. The packaging is a component that makes it possible for customers to consume outside the restaurant. Terms such as take-out, carry-out, to-go, take-away food or other terms are often used to refer to the type of food ordered at a restaurant but can be consumed elsewhere outside the restaurant. The designation of take-out food is often intended for convenience food, which is produced by various restaurants with a type of quick-service restaurant that sells food at prices that tend to be more affordable when compared to casual restaurants and restaurants, which are ordered through cashiers, and require payment before food can be produced and served to customers [9].

2.2. Quality function deployment for environment (QFDE)

Quality Function Deployment (QFD) is a method that often applied as a tool in the early stages of product development, which is developed to analyze the functions needed so that a product or product structure can support the desired function. The method was successfully developed further along with the need for environmental preservation functions under the name Quality Function Deployment for Environment (QFDE). The method consists of four stages, the first and second stages have outcomes to identify components that need to be focused on product design when considering environmental elements. Followed by the third and fourth stages to test the possibility of design improvements and the impact of changes in each component that is applied [10][11][12].

2.3. Teoriiya resheniya izobretatelskikh zadatch (TRIZ)

TRIZ (Teoriiya Resheniya Izobretatelskikh Zadatch) was successfully developed by Genrich Altshuller by studying 400,000 pieces of technology patents and describing similarities in patterns that describe the problem-solving process and the emergence of new ideas or innovations. In technical
issues, contradictions are often found if you want to improve a characteristic, then other characteristics will get worse. The TRIZ method is a method that helps solve these technical problems with a variety of tools, such as 40 inventive principles, contradictory matrices, and others [11][12][13].

3. Research method
This research begins by identifying customer needs, engineering metrics, and packaging components. The data was collected by conducting interviews with several prospective respondents (primary data) and conducting reviews on the literature related to packaging design (secondary data). Then make a questionnaire that asks the weighting of customer preferences for the interests of a packaging design attribute. Followed by distributing it to 100 respondents, 50 of them as end-consumer and the rest as food delivery courier (GO-JEK and Grab) in detail. Table 1 shows the weighted value of customer needs that can be used as input to the QFDE Phase I.

Table 1. Weighted customer needs.

| Customer needs | Primary needs | Secondary needs | Final weight |
|----------------|---------------|-----------------|--------------|
| Protection     | Maintain physical shape | 4.39 ≈ 4        |
|                | Maintain hygiene | 4.57 ≈ 5        |
|                | Maintain temperature | 4.10 ≈ 4        |
|                | Maintain food volume | 4.15 ≈ 4       |
|                | Able to hold fluid | 4.39 ≈ 4        |
|                | Maintain the appearance of food | 4.28 ≈ 4     |
| Logistic       | Easy to lift and move | 4.21 ≈ 4        |
|                | Stable when carried | 4.50 ≈ 5        |
|                | Easy to store | 4.16 ≈ 4        |
|                | Can be Stacked | 4.03 ≈ 4        |
|                | Dimensions that match the load | 4.09 ≈ 4   |
| Environment    | Easy to dispose | 4.03 ≈ 4        |
|                | Produces minimum waste | 4.09 ≈ 4       |
|                | Prevent food waste | 3.82 ≈ 4        |
| Ergonomic      | Can be opened easily | 4.08 ≈ 4        |
|                | Can be closed again | 4.04 ≈ 4        |
|                | Ergonomic shape | 3.88 ≈ 4        |
|                | Easy to understand when used | 4.04 ≈ 4     |
| Communication  | Has a load description | 3.86 ≈ 4       |
|                | Has a usage instructions | 3.87 ≈ 4      |
|                | Has post-consumption processing instructions | 3.83 ≈ 4    |
|                | Easy to identify | 4.00 ≈ 4        |

In the QFDE method, it is necessary to identify the relationship between customer needs and engineering metrics and the relationship between engineering metrics and packaging components. This was done by reviewing the literature and consulting with related experts in phases I and II. Before proceeding to phase III and IV, the researcher determined the direction of the packaging design which was deemed appropriate as the solution to the problem. The designated solution is to focus on customer needs to maintain hygiene by optimizing engineering metrics such as the form of packaging, packaging resistance on maintaining food quality, impermeable/tight packaging and resistant to external interference that could be done by setting the technology and sealing aspect of the final product. Mentioned attributes will also be used as a benchmark for the calculation of the solution design improvement rate, which is carried out in phases III and IV.

In phase III and IV, the Engineering Metrics Improvement Rate for packaging solution performance is obtained and the Customer Requirement Improvement Rate and Customer Requirement Improvement Effect on customer need related to the environmental factors. The rate helps to evaluate the design of quantitative improvement solutions. The results of the QFDE method can be presented in the following table.
The QFDE method succeeded in producing a repair solution design with detailed technical characteristics, along with contradictions that might be present when wanting to improve it. TRIZ is a creativity technique that helps researchers to find solutions to each contradiction in technical characteristics. The Engineering Metrics obtained in the QFDE method are translated into 39 types of parameter improvements in the TRIZ method along with parameters that contradict them. Regarding this contradiction, the Contradiction Matrix tool containing 40 TRIZ invention principles is used to bring up innovative solutions.

4. Result and analysis

After identifying the contradiction parameters and finding inventive solutions with the Contradiction Matrix tool, 9 inventive principles can be applied to the concept of solution design namely (#14) Spheroidality - Curvature, (#15) Dynamics, (#1) Segmenta, (#39) Inert Atmosphere, (#22) Blessing in Disguise, (#24) Intermediary, (#31) Porous Materials, (#40) Composite Materials, and (#28) Mechanics Substitution.

Based on the concepts that emerged from the integrated methods, a solution design in the form of bags intended for food delivery couriers in the process of sending food with cube-like shape with curved edges, can be folded and moved, has a separate layer of bags to be cleaned, form the atmosphere different for the packaging it carries, it has a barrier that interacts with the packaging carried and arranged by hollow material, and can be easily moved. The above specifications are intended to support packaging functions that can maintain hygiene [14], support the environmental aspect of a product, and try to adapt to how third-party delivery services work in Indonesia.

The solution design concept is consisting of three components, backpack, thermal insulation, and construction. The backpack component serves as the outermost protection of the packaging, while the backpack design aims to make it easier for the sending courier to bring food. The thermal insulation component is made from aluminum foil foam material which can maintain temperature and applied as a component that makes direct contact with the primary or secondary packaging it carries. Construction components are formed from strong and rigid materials such as aluminum pipes, intended to give the shape and sturdy properties of the packaging. On the inside of the package, a webbing anchor can also be added which is useful to ensure the food does not move from its place during transportation. The product has dimensions of 48 cm x 48 cm x 48 cm while assembled and could transform into 48 cm x 28 cm x 10 cm while collapsed, so that food delivery couriers could fit the food delivery packaging inside the motorbike while taking orders besides food delivery order.

5. Conclusion

This study aims to provide food packaging design recommendations by examining the appropriate packaging design attributes to improve customer satisfaction and considering environmental aspect along the design process. After going through the research phase, it can be concluded that the packaging system has a very important role as an extension of the restaurant's hand in sending food to the customer. Also, the packaging is responsible for maintaining the quality of food delivered.

### Table 2. EM improvement rate

| No. | Engineering metrics                        | EM improvement rate |
|-----|--------------------------------------------|--------------------|
| 1   | Form of packaging                          | 0.32               |
| 2   | Packaging resistance on maintaining food quality | 0.49              |
| 3   | Impermeable/tight packaging                | 0.56               |
| 4   | Resistant to external interference         | 0.49               |

### Table 3. CR improvement rate and CR improvement effect

| CR improvement rate | CR improvement effect |
|---------------------|-----------------------|
| Environmental needs |                       |
| Easy to dispose     | 0.02                  | 0.09                |
| Produces minimum waste | 0.03                | 0.11                |
| Prevent food waste  | 0.13                  | 0.51                |
attributes of customer needs for hygienic food packaging occupy the greatest weight when compared to other attributes. The implementation of packaging with a focus maintaining hygiene has a good impact on customer needs related to the environment, such as a packaging that is easy to be disposed of after use, produces minimum wastes and prevents food wastes.

The research also succeeded in producing a solution design concept in the form of transport packaging, which acts as a tertiary packaging in an existing packaging system. All design specifications were successfully obtained from inventive principles on the TRIZ method as well as successfully fulfilling the requirements of Environmental VOC including packaging that can be easily cleaned, has a longer product life cycle and is easy to dispose of. The concept of the design solution is an opportunity for third-party delivery services, especially in Indonesia, to improve service quality and make it an added value when compared to other platforms.

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