3. METHODOLOGY

This research focuses on the use of SUP in the fast food chains located in Semarang. Fast food chains selected to conduct this research consists of two types; i.e. burger based fast food chain (FC1) and fried chicken based fast food chain (FC2). The research boundaries and methodology are explained below.

3.1. Research Boundaries

This research focused only on SUP. The estimation of SUP waste is only limited to those generated from dine in activity, not including take away or drive-thru services. This research only covered the SUP waste generated by meals purchased at the main counter. FC1 and FC2 were each represented by three restaurants. The selected restaurants of FC1 are located in Java Mall, Ciputra Mall, and Pandanaran street. The selected restaurants of FC2 are located in Duta Indah Pertiwi mall (DP mall), Mt. Haryono street, and Pemuda street.

Literature review also used to find some alternatives for product design that assessed their feasibility to be applied and their effectiveness in reducing the amount of SUP waste. New design concept were applied to product which contribute the largest amount of SUP waste by considering food quality and safety.

Observation at each restaurant took around 60 minutes. To minimize the error, the observation was done in three different times, i.e. two observations during rush hours (lunch and dinner) and one observation during quiet hours (breakfast). The observation was conducted in February until April 2019, in the beginning, middle and end of each month. Each week the observation took place three weekdays and weekend (Saturday and Sunday). Since some fast food chains were open for 24 hours, an additional observation was conducted at dawn (quietest hours). Summary of the design of the observation is shown in Table 1.

Table 1. The stages and the outcomes of the research

Stages	Process	Outcomes
1	Determination of the samples. 3 restaurants of each FC1 and FC2. Method: Random sampling	▪ FC1 located on Pandanaran, Java mall and Ciputra mall ▪ FC2 located on Dp mall, Pemuda and Mt. Haryono
2	Categorization of food generating SUP. Method: Field observation and literature study. Reference for food category: (Rhodes, Adler, Clemens, & Moshfegh, 2017)	10 Categories of Food: ▪ Condiments and sauces ▪ Grains ▪ Milk and dairy ▪ Mixed dishes ▪ Non-alcoholic beverages ▪ Protein foods ▪ Snacks and sweets ▪ Vegetables ▪ Water ▪ Other
3	Identification and characterization of SUP used as food packaging Method: Direct observation of the sample and literature study to determine the polymer types	Grouping of SUP waste based on polymer types : ▪ PET ▪ HDPE ▪ PVC ▪ LDPE ▪ PP ▪ PS ▪ LLDPE

Table 1. (Continued)

Stages	Process	Outcomes
4	Determination of the numbers of food products sold Methods: Observation in three and four times per day (based on the rush and quiet hours). Each observation carried out for 60 minutes. The observation repeated for three weeks.	Prediction of total products sold for dine in consumers. Replication is based on the relevant determinants i.e., different types of fast food restaurants and the tendency of SUP waste generation between weekdays and weekends.
5	Specify the amount of SUP waste generated by FC1 and FC2, based on the total products sold. Method: estimation based on the amount of the total SUP waste	Prediction of the total single use plastic waste generated by FC1 and FC2 based on polymer types and the volume of SUP waste.
6	Approximation of carbon footprint values based on SUP waste data. Method: Approximate of weight of SUP waste multiplied by conversion coefficient based on the standard by "Franklin Associates, 2011"	Carbon footprint value based on polymer types and food categories.

Table 1. (Continued)

Stages	Process	Outcomes
7	Appraisal of the relationship between the current product design and the potential of SUP waste Methods: Based on step five and the literature review	Some key factors to improve product design and to reduce the amount of SUP waste Interaction between packaging and product design, especially on suitability, and their correlation with food quality and safety
8.	Proposal of new product designs to reduce the amount of SUP waste Method: Literature review to determine better product designs to reduce the SUP waste	New design concept for the products which contribute the largest amount of SUP waste by considering food quality and safety.

3.2. Computation and Data Analysis

Quantitative data was obtained from the observation. The data will be analyzed according to each type of fast food restaurant using Microsoft Excel program. SUP wastes were measured as the total amount and weight per hour, which were then extrapolated into daily amount and weight. Based on the daily values, the weekly SUP wastes generation was calculated according to the formula below.

$$WSW = \{5 * (ASWD)\} + \{2 * (ASWE)\} \quad (1)$$

where

WSW = Weekly generated SUP waste (kg/week)

ASWD = Average of SUP waste generated during weekdays (kg/day)

ASWE = Average of SUP waste generated during weekends (kg/day)

The weight of each polymer type of SUP waste was obtained by multiplying the quantity and the average weight of plastics. To estimate the carbon footprint values of each polymer type of SUP, a specific conversion factor (Franklin Associates, 2011). The conversion factors for PET, HDPE, PVC, LDPE, PP, PS, and LLDPE are 2.733, 1.897, 2.419, 2.201, 1.860, 3.242, and 1.901, respectively. The carbon footprint values of each type of polymer was then divided by the numbers of dine in consumers to arrive at the SUP based carbon footprint values per person. The formula for calculating carbon footprint is depicted in the formula below.

$$CF = \frac{\sum_{i=1}^{P} Pi \times CCi}{n} \quad (2)$$

Where

CF = Carbon footprint value (kg CO_2 equivalents)

Pi = Total weight of polymer i (kg)

Cci = Conversion factors for polymer i (kg CO_2 equivalents)

i = Index of polymer

n = Number of dine in visitors