## CONCEPTUAL DESIGN AND LIFE CYCLE ASSESSMENT (LCA) OF NATURAL FIBRE REINFORCED BIOPOLYMER COMPOSITES TAKEOUT FOOD CONTAINER USING CONCURRENT ENGINEERING

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Almost all municipal solid waste (MSW) collected go to landfills instead of being recycled where packaging has a big portion and mostly are contributed by food packaging. In this thesis, a product design and development process of a fully biodegradable and bio based takeout food container utilizing natural fibre reinforced biopolymer composite was carried out with the essence of design for sustainability (DFS). The overall process incorporates the principle of concurrent engineering (CE) which include materials selection of natural fibre and biopolymer matrix, concept design generation and selection of final design, and Life Cycle Assessment (LCA) of the new takeout food container design. Seven (7) key elements of product design specification (PDS) were considered based on market investigation. The evaluation and selection of natural fibre as reinforcement in the biopolymer composite was carried out by developing a decision-support model based on Analytic Hierarchy Process (AHP). The results indicated that ijuk or sugar palm fibre obtained the highest priority (14%) from the nine (9) natural fibre alternatives. The results were further verified by a sensitivity analysis where sugar palm fibre remained at the top rank for four (4) of six (6) conditions tested. Concurrently, selection of the biopolymer matrix was performed, and the biopolymer alternatives studied were limited only to starch biopolymers because of its significant global production growth for bioplastics. The method applied was Shannon's entropy integrated with AHP and Experts Choice software. From the six (6) starch alternatives, Sago starch was at the top rank with the score of 26.8% and verified by a sensitivity analysis. In parallel to the materials selection process, the design concept development and selection of the final takeout food container concept design were completed using combination of the Kano model, Quality Function Deployment for Environment (QFDE), and AHP where the Kano model was utilized to understand customers satisfaction as the key features of the new takeout food container design and incorporated in the House of Quality (HOQ) in QFDE. ii The HOQ results were the design parameters, and to develop the concept designs systematically, morphological chart (MC) was applied. Nineteen (19) concept design ideas were generated, and the final design was selected using AHP. Concept design 18 (CD18) obtained the highest score of 8.3%, a rectangular clamshell type with I-rib on wall and bottom of container base and locking structure of latching (male-female) at four corners. Lastly, the new design takeout food container was assessed by attributional Life Cycle Assessment (LCA) using SimaPro software. The results showed that the new concept of takeout food container produced a total impact of 2.63 × 10-5 DALY for the Human Heath Damage,  $9.46 \times 10-8$  species.yr for the Ecosystem damage and \$0.491 for the Resources Scarcity.