Recycled 3D Printing Filaments in Fashion: Consumer Perceptions and Acceptance

Changhyun (Lyon) Nam

Jim Moran College of Entrepreneurship

INTRODUCTION

The application of 3D printing technology leverages various industries (e.g., construction, healthcare, industrial design, automotive) and higher education (Yu et al., 2023). The global 3D printing market is projected to reach over $98.31 billion by 2032 (Precedence Research, 2023). It is important to further investigate plastic-based 3D printing filament as a potential new recycling 3D filament and assess its performance, durability, and other characteristics relevant to 3D printed accessories (Meng & Bari, 2019). Using plastic-based materials can help reduce a variety of resource waste in industries and solve environmental problems associated with plastic production and consumption (Meng & Bari, 2019; Moore, 2024).

It is important to explore consumer evaluation and acceptance of 3D-printed products made of recycled materials (e.g., face masks, water bottles, etc.). However, purchasing recycling or upcycling products has not been growing according to expectations due to the lack of popularization, perceptions, and acceptance of 3D-printed accessories. **Thus, based on the circular economy (Figure 1), this study aimed to explore consumer perceptions and acceptance of potential 3D-printed accessories made of used face masks. In addition, to determine the role of experiential value between product design perception and perceived purchase intention.**

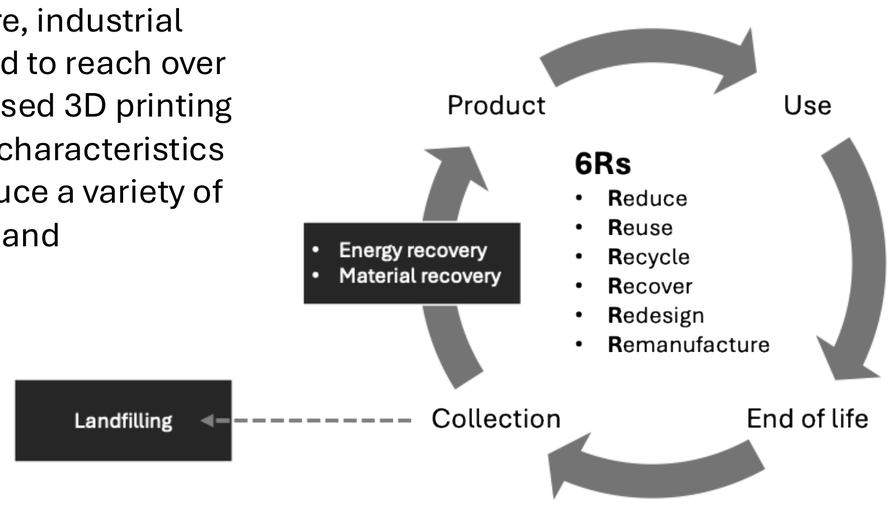

Figure 1. The concept of circular economy.

RESEARCH QUESTIONS

RQ1: What are consumer preferences and willingness to purchase 3D-printed accessories made from recycled materials, specifically used face masks in general?

RQ2: How do experiential values (including usability, social value, and pleasure in use) mediate the relationship between product design perception and perceived purchase intention for 3D-printed accessories made from used face masks?

METHODS

A total of 899 of 950 participants (recruited from crowdsourcing marketplaces) were used for data analysis, with a response rate of 94.6% in this study.

❑ *Instrument*

The survey questionnaire consists of three sections: (1) open-ended questions, (2) the constructs with multiple-item measurements, and (3) demographics. Additionally, the overall process image of 3D printing filaments made of used face masks (Figure 2) was included in the questionnaire.

To test the hypothesized paths in the proposed conceptual framework, four main variables: (1) design perceptions - visual (three items; Meng et al., 2019) and functional (four items; Suki, 2016) (2) experiential values- usability (four items, Brooke, 1996), social value (four items, Sweeney & Soutar, 2001), and (3) environmental value (three items, Suki, 2016) as well as (4) perceived purchase intention (four items; Yadav & Pathak, 2017), were rated on a 7-point Likert scale.

❑ *Data Analysis*

The statistic package for social sciences (SPSS 29) and analysis of moment structure (AMOS) software were used to achieve this study's purpose and test hypotheses. With SPSS 29, descriptive analysis was adopted to analyze the preliminary test results and determine the sample demographics. Confirmatory factor analysis was also conducted using AMOS to validate the psychometric properties of the measured variables, while structural equation modeling (SEM) was used to test hypotheses (see Figure 3).

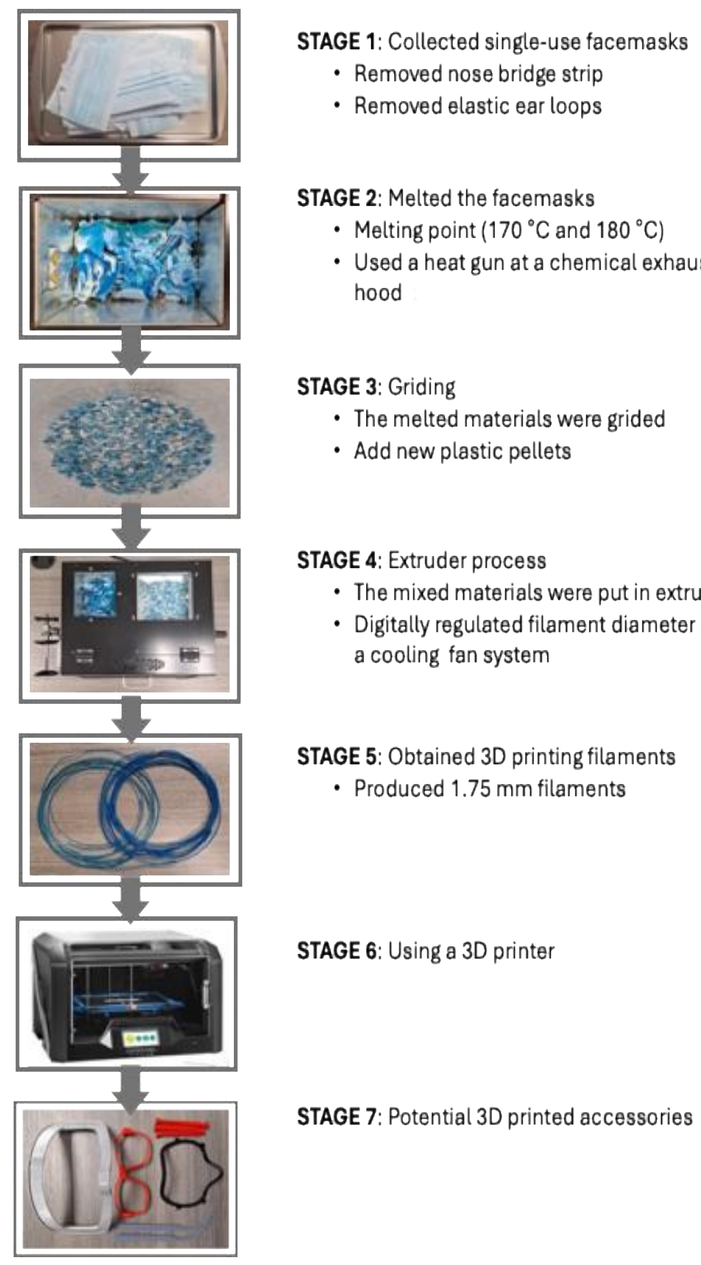

Figure 2. Recycling filament process for 3D printing filament.

RESULTS

Of the 899 respondents, female and male participants were 52.3% (*n* = 470) and 47.7% (*n* = 429), respectively, while 74.1% of respondents were Caucasian, followed by Asian (9.7%), Hispanic American/Latino (5.9%), and African American (3.8%). Most participants were full-time (71.9%) and part-time (13.8%) employees. Most participants had a college degree above (78.1%). 53.5 % of participants had annual incomes between $25,000 and $74,999.

RQ1A: Participants preferred to make the following top three 3D-printed accessories: jewelry (45%), electronic cases (35%), and home decor items (20%). Additionally, they identified water bottles (35.8%), wood/fabric (32.2%), and food cans or containers (22%) as the top three potential materials for making 3D printing filaments. Most participants (75.8%) expressed willingness to purchase 3D-printed accessories made from used face masks. However, they would pay no more than 25% more for the accessories made from recycled materials using a 3D printer. Moreover, the most important factors influencing their purchasing decisions were functionality (33.8%), followed by price (24.6%), design (23.7%), material (15.6%), and color (2.3%). After obtaining information about the recycling filament process using face masks (as shown in Figure 2), participants identified the following potential 3D-printed accessories: face-covering frames (30.8%), eyeglass frames (28.9%), phone/laptop cases (17.2%), golf tees (8.8%), footwear (6.5%), keyholders (5.1%), and others (2.7%).

RQ2A: After confirming the measurement model, the SEM was explored for hypotheses testing. The SEM demonstrated an acceptable fit, as shown in Figure 3.

(χ^2 = 939.81, *df* = 220, χ^2/df =4.27, CFI = 0.94, RMSEA = 0.06, SRMR = 0.05)

- Visual value had a positive effect on usability (**H1a:** β = 3.94, p = 0.001), social value (**H1b:** β = 0.665, p = 0.001), environmental concern (**H1c:** β = 2.10, p = 0.001).
- Functional value had a negative effect on usability (**H2a:** β = -3.58, p = 0.001), social value (**H2b:** β = -3.22, p = 0.001), environmental concern (**H2c:** β = -1.42, p = 0.01).
- Usability had a negative effect on perceived purchase intention toward 3D-printed accessories made of used face masks (**H3:** β = -0.09, p = 0.05).
- Social value positively affected perceived purchase intention toward 3D-printed accessories made of used face masks (**H4:** β = 0.27, p = 0.001).
- Environmental concern positively affected perceived purchase intention toward 3D-printed accessories made of used face masks (**H5:** β = 0.69, p = 0.001).

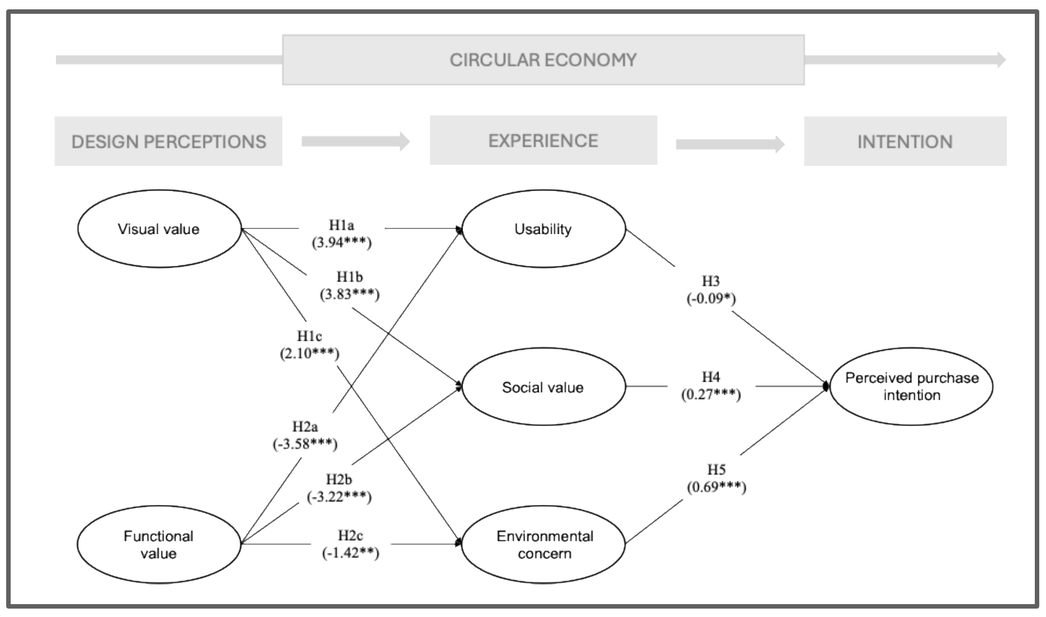

Figure 3. Hypotheses testing in the theoretical conceptual framework.

contact information: cn12@fsu.edu