

INTRODUCTION & OBJECTIVE

3D food printing (3DFP) offers customizable sensory attributes and nutrition, digital gastronomy, functional products for specific groups, food processing diversity, waste utilization, and faster product development (1–6).

Research on 3DFP adoption in practical settings is understudied. Assessing new technology adoption helps in reducing risk of investment and increasing market success by understanding its opportunities and challenges (7). Diffusion of innovation (DOI) model aids in understanding technology and organizational factors in new technology adoption, including adoption process, social system and key aspects of successful innovation (i.g., relative advantage, complexity, compatibility, trialability and observability) (7). Therefore, studying 3DFP adoption by food businesses and using the DOI model is beneficial for informing decision-making for stakeholders.

Objective: To investigate drivers, obstacles, and proposed solutions to 3DFP adoption by businesses using 3DFP. DOI model was implemented to investigate these factors.

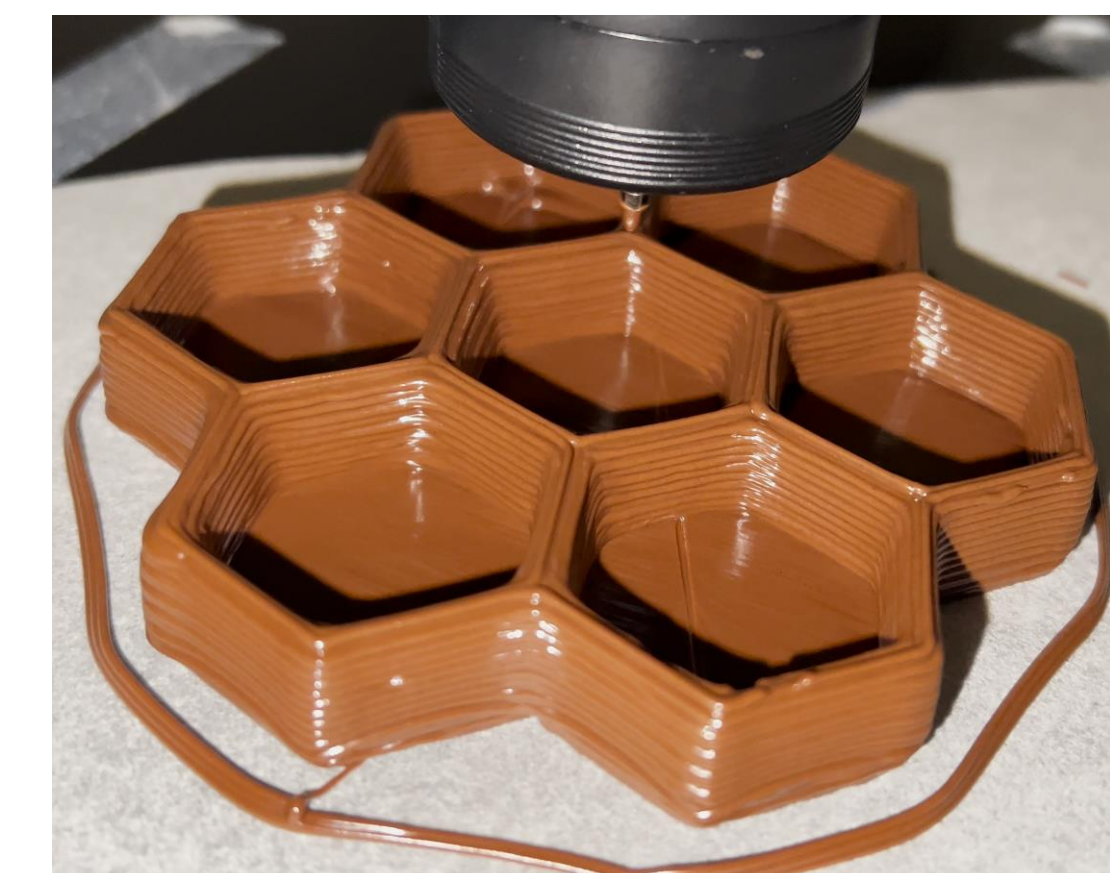
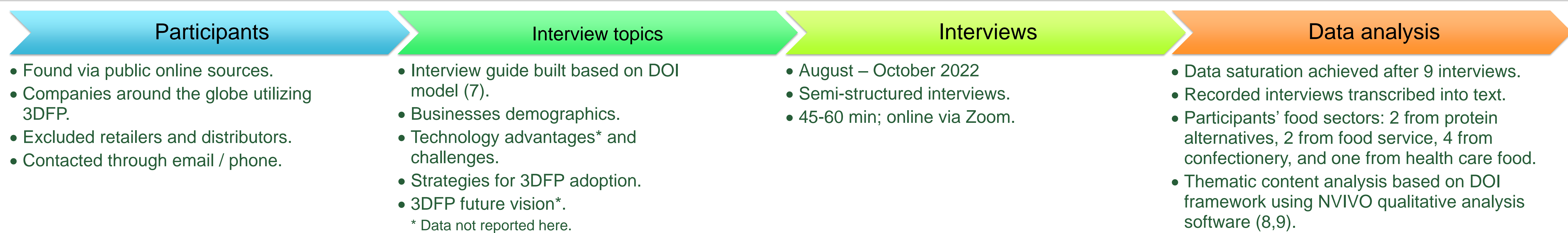


Figure 1. 3D-printed chocolate

METHOD



Study procedure (ID: 00120228) was reviewed and approved by the Research Ethics Board at the University of Alberta

RESULTS

Participants: Nine companies from Europe, North America and Middle East. Businesses have between 1 to 5 years of 3DFP experience, 2017 the earliest year of adoption.

Barriers and solutions to 3DFP adoption across the food industry are represented in Figure 1 and Figure 2 based on interviews data analysis.

Barriers to 3DFP adoption across food industry

- Adopting 3DFP economies of scale is crucial for cost reduction in budget-driven sectors like healthcare and high-volume markets like protein alternatives.
- Food service businesses use multiple printers or produce in advance to meet high volume orders. However, slow printing and high printer costs hinder the adoption of 3DFP.
- Technology small scale and not feasible production line as anecdotal reasons for large companies not adopting 3DFP.

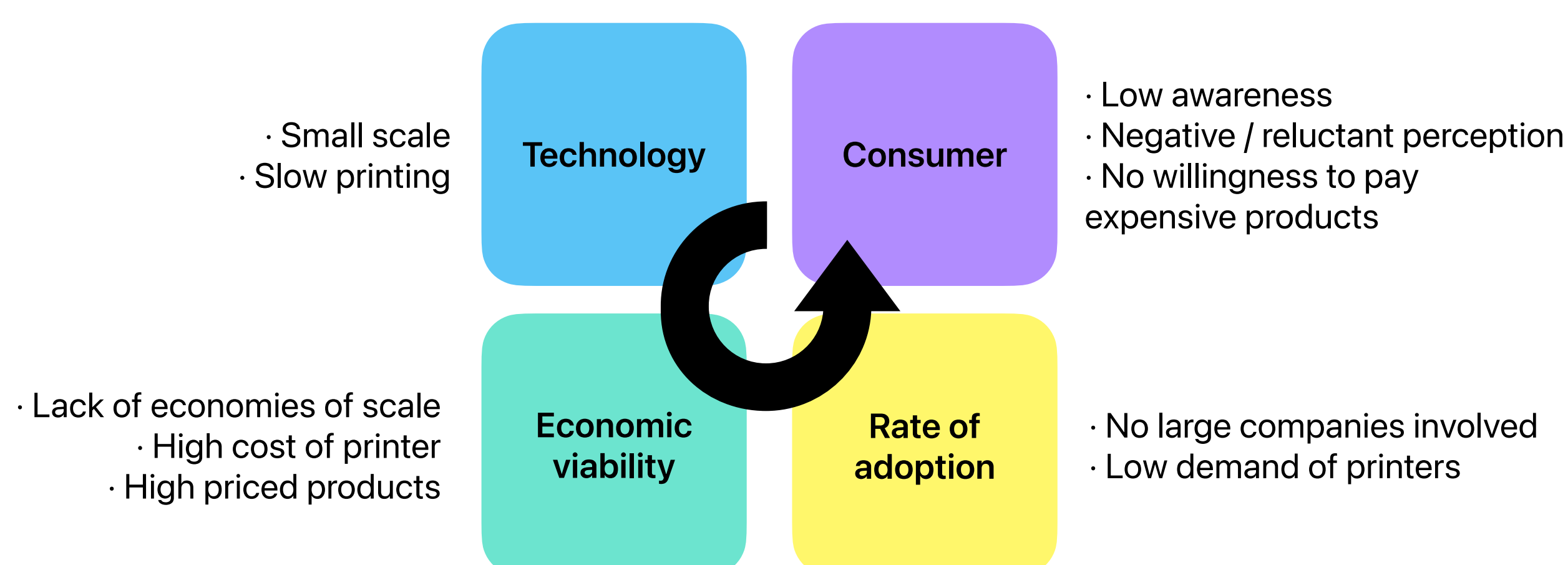
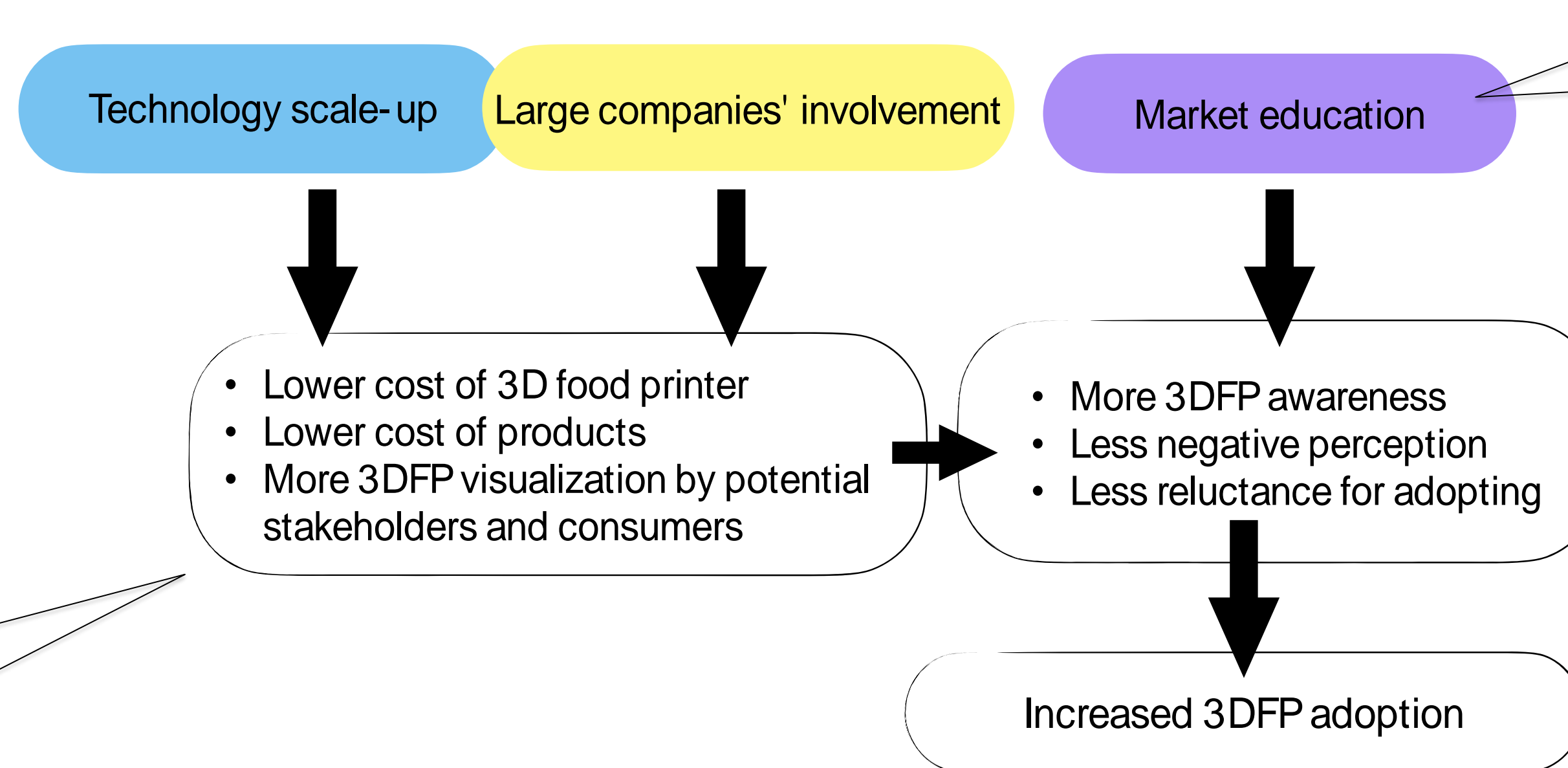


Figure 2. Barriers to 3DFP adoption across the food industry identified by participants

- Consumers opinion vary across the food sectors depending on previously introduced ideas or food familiarity.
- Although 3DFP novelty attracts consumer's attention, mentioning it requires explanation and potentially drives unfavorable perceptions (e.g., artificial, lab-made) and related to plastic or metals.
- Concept of 3DFP not easily understood by consumers.

Proposed solutions to 3DFP adoption barriers

- Making sure the technology will last long-time and will work smoothly will attract 3DFP adoption by large companies.
- Upscaling 3DFP will enable to get production costs down and a feasible production line for large-volumes.
- Showing 3DFP more will support the change of people's and other companies' perception and awareness about it.



"Avoiding to mention 3DFP will prevent second guess from consumers and looking for new ways for communicating 3DFP to consumers" Protein alternative business.

"You really need to upscale the technology to make a product that is available for everybody." Confectionery business

Figure 3. Participants proposed solutions to overcome 3DFP barriers to adoption in the food industry.

Businesses' strategic market entrance for 3DFP:

- 3D printed products meeting market demands where potentially are well received, e.g., protein alternatives in high plant-based adoption markets like US or UK.
- Confectionery, pastry, and restaurant sectors benefit from 3DFP due to consumer familiarity with intricate designs.
- In the food service and confectionery sectors, targeting non-price-sensitive consumers offers better business viability.

CONCLUSIONS

- Discovered barriers to 3DFP adoption were high cost of printer, high priced products, technology capacity, consumers' negative perception, and low rate of adoption by large companies.
- To increase 3DFP adoption, businesses prioritized technology scale up and large company involvement to improve 3DFP economies of scale, plus looking new ways to communicate 3DFP to increase positive perception.
- Proposed strategies for market entrance are products designed to meet high market demands, for non-price-sensitive consumers, or in sectors where consumers are familiar to intricate food designs.
- DOI model application supported the analysis of technical, organization, and social factors related to 3DFP adoption.

REFERENCES

- Dankar et al. Trends Food Sci Tech. 2018, 75, 231–42.
- Sun et al. Int J Bioprint. 2015. 1, 27–38.
- Portanguen et al. Trends Food Sci Tech. 2019. 86, 188–98.
- Kewuyemi et al. Crit Rev Food Sci Nutri. 2022. 62, 7866–7904.
- Pant et al. Virtual Phys Prototyp. 2023, 18, 1.
- Derossi et al. Food Biosci. 2023. 52, 102417.
- Rogers. Free Press. Third. 1983.
- Erlingsson et al. Afr Fed Emerg Med. 2017. 7, 93–9.
- Matthews et al JDR Clin Trans Res. 2016. 1, 77–85.

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