



# Uncovering Challenges in Meeting SDG 12.3 Targets: A Comprehensive Examination of Factors Contributing to Food Waste

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**Abstract. Purpose of study:** This study aims to identify the drivers of food waste and major countries contributing towards this global problem to contribute towards achieving the United Nations Sustainable Development Goals 2030 agenda. Responsible consumption and production (SDG 12) to ensure sustainable consumption and production patterns cover 11 subareas.

**Methodology used:** A review of existing reports (FAO, WRAP, FUSION, UNEP, UNICEF) and literature of the last 42 years has been done to explore the major food waste contributors and efforts taken by the various countries at various levels to counter this challenge.

**Major findings:** European countries have been identified as key contributors to barriers hindering the achievement of SDG 12.3. These barriers primarily arise from consumer attitudes and behaviours, stringent food safety norms, ineffective food-sharing models lacking government support, portion sizes, and a lack of motivation within the catering sector, whether through incentives or rewards. Initiatives such as policy frameworks, media campaigns, and improved food-sharing models have been identified as crucial to mitigating food waste.

**Summary:** Although efforts are coming from around the world, especially after the launch of the UNSDG 2030 agenda, European countries are contributing more towards this global concern.

**Implications:** Achieving SDG 12.3 is crucial for addressing global sustainability concerns and fulfilling the needs of over 10% of the global population. Simultaneously, successfully implementing this goal can contribute to reducing Greenhouse Gas (GHG) emissions generated by food waste disposal, aligning with broader sustainability objectives.

**Keywords:** SDG, Sustainability, Food waste, Catering, Consumer behaviour

## 1 Introduction

[1] The Sustainable Development Goals (SDGs) were introduced by the United Nations in 2015 to safeguard the environment, the economy, and society. The targets of SDG 2030 included decent work and economic growth, good health and well-being, eliminating hunger and poverty, gender equality, clean water and sanitation, affordable and clean energy, industry innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, action against climate change, life below the water, life on land, peace, justice, and strong

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institutions, as well as partnerships for the goals. United Nations 2015 launched the Sustainable Development Goals (SDG) with a vision to protect society, the economy, and the environment. Good health & well-being, achieving zero hunger, no poverty, quality education, gender equality, clean water & sanitation, affordable & clean energy, decent work & economic growth, industry innovation & infrastructure, reduced inequalities, sustainable cities & communities, responsible consumption & production, climate action, life below water, life on land, peace, justice & strong institutions, & partnerships for the goals were the targets of SDG 2030. SDG 12.3 targeted reducing food waste (FW) by half until 2030, mainly generated during the production and consumption stage. Various stakeholders generate food waste, so a multifaceted approach is required to counter this growing problem [2-3].

[4] United Nations Environment Programme (UNEP) Food Waste Index Report 2021 found that 121 kilograms of FW are generated during the consumption stage, out of which 74 kg of food waste is generated at the household level (data from 54 countries). FW generation is done by every country, in which contribution at the household level (11%) was found to be the maximum. In contrast, catering outlets (5%) and retail outlets (2%) also contribute to this. Consumers were found engaged in generating FW either in households or at catering outlets, as recommended by [3], [5-11]. Uneaten food dumped in a landfill generates 8-10% of greenhouse gases (GHG) and is also responsible for climate change [4].

## 2 Methodology

This study adopts a secondary research methodology, encompassing a comprehensive review of various reports, literature, articles, and online data from 1980 to the present day. The primary objective is to discern the barriers impeding the achievement of SDG 12.3. The research aims to gain insights into the multifaceted domains contributing to food waste generation and its repercussions on society, the economy, and the environment, focusing on identifying impediments to SDG 12.3. A total of 83 research papers and articles were meticulously extracted from reputable databases, namely Science Direct (<http://www.sciencedirect.com>), Research Gate (<https://www.researchgate.net>), and Google Scholar (<https://scholar.google.com>). The keywords employed to curate pertinent literature include food waste, sustainability, SDG, food-sharing model, and hunger index. Given the escalating concern surrounding food waste due to its adverse social, economic, and environmental impacts, this study encompasses a comprehensive analysis of literature, reports, and initiatives spanning the last 42 years.

## 3 Review of Literature

All 83 papers underwent a systematic and thorough examination, leading to their categorisation under five distinct headings. These headings are as follows:

1. FW generation in retail sectors across different countries: Papers within this category explore and analyse FW generation in retail sectors across various countries (TABLE I).
2. FW generation in the catering industry across different countries: This category encompasses papers that specifically delve into the dynamics of food waste generation within the catering industry (CI) across diverse countries (TABLE II).
3. FW generation in various countries due to lifestyle practices: Papers under this heading investigate the correlation between lifestyle practices and FW generation in different countries (TABLE III).
4. Impact of demographic variables on FW generation in various countries: This category focuses on papers examining how demographic variables influence FW generation in diverse countries (TABLE IV).
5. FW reduction approaches adopted by various countries: Papers in this category discuss and evaluate the strategies and approaches different countries implement to reduce food waste (TABLE V)

Through this systematic classification, the review provides a comprehensive exploration of food waste generation and reduction, organised under these five distinct and relevant headings.

TABLE I: FOOD WASTE GENERATION IN VARIOUS COUNTRIES IN RETAIL SECTORS

S. No.	Author/s	Food Waste areas	Findings	Studied country/ies
1	[12]	Retail	Retailers are a link between the producer and the consumer and play an essential role in influencing overall food waste in the food supply network.	Sweden
2	[13]	Retail	FW quantities at grocery stores are difficult to quantify since data availability and accessibility are limited by government legislation, corporate policy, and managerial practices.	United Kingdom (UK.)
3	[14]	Retail	There is no universal definition of waste; waste differs from one business to the next, and there are numerous causes of FW in retail sectors.	UK.
4	[13]	Retail	Wrong forecasting, receiving, and insufficient storage facilities about consumer purchasing habits are common causes of retail food waste.	UK.

5	[14]	Retail	Consumer purchasing decisions are influenced by weather fluctuations, seasonal availability, trends, and consumer moods.	UK.
6	[13]	Retail	Consumers put a lot of pressure on retailers to deliver high-quality, fresh, and out-of-season products, which is quite difficult to adapt to sudden changes in demand.	UK.
7	[15]	Retail	Management challenges such as inefficient shop regulations, high product quality requirements, and insufficient consumer demand forecasts contribute significantly to FW generation.	UK, Austria & Germany
8	[16]	Retail	Retailers are frequently confronted with selling items that soon become unsellable.	Sweden, Norway, Finland & Denmark
9	[17]	Retail	Unsalable goods do not match customers' expectations because of deformed shape, apparent damage, or have passed their 'best before' date.	UK, Austria & Germany
10	[18]	Retail	Unsalable items are still edible and usable if they adhere to health and safety regulations.	Globally
11	[17]	Retail	Dumping edible food showcases inadequate resource efficiency for the sector and a massive loss for retailers.	UK, Austria & Germany
12	[19]	Retail	Mass disposal of unsalable foods is unethical because it wastes possibilities to offer nutrition and undermines efforts to ensure global food security.	UK.

The literature mentioned above indicates that FW is a severe concern that is very common at the retailing stage due to various factors such as unpredictable consumer demand, health safety norms, government policy and food law, weather fluctuations, insufficient storage space, freshness, seasonality, latest eating trends, the mood of an individual, minor physical damage and ambiguity regarding the FW definitions. European countries were mainly involved in food waste at the retail stage, showing retailers' helplessness as food waste generation directly impacts their profitability. Careless attitude towards food, high spending power, lack of knowledge regarding hungry people and their adverse impact on the environment, concern about health and safety, food safety norms, and consumer expectations concerns were found above atmosphere concern at retail sectors lead to the generation of FW at the retail stage.

TABLE II: FOOD WASTE GENERATION IN VARIOUS COUNTRIES IN THE CATERING INDUSTRY

S. No.	Author/s	Food Waste areas	Findings	Studied country/ies
1	[20]	Catering industry (CI)	Food waste is a challenging issue for the catering business, directly or indirectly generating significant amounts of waste.	Egypt
2	[21]	CI	As the sector grows exponentially, customers are putting more pressure on the catering industry to reduce food waste's negative socioeconomic and environmental consequences.	UAE
3	[22]	CI	In Europe, the catering sector generates massive food waste (second largest) just after households at the consumption stage.	Europe
4	[23]	CI	Each consumer of hospitality services produces around 1 Kg of waste per day.	Europe
5	[11]	CI	Due to government legislation and corporate standards, food waste reduction is a big concern for hospitality firms.	United States of America (USA)
6	[24-25]	CI	This top-down management strategy is unduly concerned with consumer safety and happiness, reducing businesses' motivation to engage in sustainable waste management measures.	Canada
7	[26]	CI	Food items can only be preserved or restructured for serving for a certain amount of time due to tight food safety regulations and hygienic rules.	Finland
8	[11]	CI	Instead of dumping food into landfills, better to redistribute or send to a food bank or charity is a more ethical approach to counter this growing problem. Still, as per law, food donors liability for any illness.	USA
9	[22], [26], [27]	CI	A significant cause of FW in hospitality is customer recognition with differing portion requirements.	Canada
10	[28]	CI	Plate waste is more likely to be caused by excess quantity than poor quality,	Sweden

			accounting for 50% of total trash produced by catering establishments.	
11	[26]	CI	Plate waste in the catering industry emerged from the SERVQUAL model gap (served food could not meet expectations).	Finland
12	[27]	CI	Due to increasing consumer demands, hospitality organisations frequently focus on preserving the perceived quality of food.	Canada
13	[29]	CI	Uneaten food uses natural resources during manufacturing, preparation, and disposal; plate waste harms the environment and the economy.	Canada
14	[25]	CI	By providing takeaway boxes or 'doggy bags,' food service organisations are alternatives or temporary solutions to switch the responsibility of FW from the caterer to the customer.	UK
15	[30]	CI	Bringing leftovers home is popular in the UK and the USA.	Italy
16	[31]	CI	Consumers in several European countries avoid ordering or carrying takeaway boxes due to social norms and their societal reputation.	France & Czech Republic

The CI emerged as the second-largest FW generator after households. The catering industry is growing like a mushroom in the current competitive environment. Still, it feels helpless regarding unpredictable consumer demands, the requirement of food portion size, government laws and corporate policies, strict food safety norms, and consumer safety and satisfaction. These factors create barriers to a catering business's engagement in sustainable practices. It was found that plate waste (a major waste contributor in the catering sector) was mainly caused by disliking (taste) of food as it was unable to stand the consumer expectation due to more considerable portions than poor quality; therefore, it can be assumed that taste and portion size both contribute equally in the generation of FW.

The CI has started the initiatives to offer takeaway food in 'doggy bags' to nudge the wasteful consumer behaviour. It is a common practice in the UK and USA. In contrast, some European countries refrain from this act due to their societal status prejudice. Directing unconsumed or extra food to food banks may be a probable solution to this growing concern. Still, government legislation creates obstacles (food donors are liable to be responsible for any foodborne illness) in this approach. Although mainly European people are found engaged in FW in the CI, developing and emerging countries are either understudied or unexplored. Eating out culture has increased everywhere; therefore, more studies on FW in the catering sectors are required in

developing countries to understand the factors responsible for wasteful consumer behaviour, which can help remove barriers while attaining SDG12.3.

TABLE III: FOOD WASTE GENERATION IN VARIOUS COUNTRIES DUE TO LIFESTYLE PRACTICES

S. No.	Author/s	Food Waste areas	Findings	Studied country/ies
1	[9]	Lifestyle practices	Individual attitudes are a precursor to food waste behaviours when it comes to lifestyle habits.	Western Countries
2	[32]	Lifestyle practices	Many customers use their purchasing selections to express their beliefs and personal values, which is especially visible in the case of "green" consumers and their lifestyles.	Canada
3	[33-34]	Lifestyle practices	"Green consumers" refers to individuals engaged in traditionally environment-friendly actions like reusing and purchasing locally grown food and lowering the consumption of non-veg items.	UK & Ireland
4	[35]	Lifestyle practices	The green consumer concept can significantly reduce FW, as environmental concerns significantly determine people's attitudes about FW.	Norway
5	[36]	Lifestyle practices	Evidence suggests that FW mitigation can improve when people shop locally and cultivate food.	Italy & Germany
6	[37]	Lifestyle practices	Despite growing concern about green purchasing, discrepancies between attitudes and actual behaviour can be easily observed.	Germany
7	[38]	Lifestyle practices	The 'attitude-behaviour gap,' also known as the value action gap or KAP gap (knowledge-attitudes-practice), emerges because personal preference overtakes societal or environmental concerns.	Belgium
8	[39]	Lifestyle practices	Disparities between attitudes and behaviours are evident in food waste, indicating that green consumers also generate huge amounts of edible FW due to the nature of raw materials (perishability, lack of storage area, and eating-out behaviour).	Australia

9	[40]	Lifestyle practices	Despite their good intentions and positive sentiments toward sustainable behaviours, many customers prioritise behavioural control considerations more than environmental values.	Denmark
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Attitude, behaviour, habits, environmental concerns, and green-purchasing practices develop in consumers mainly from lifestyle practices. The gap between attitude and behaviour is the epicentre of the FW generation at the consumer level and needs to be studied holistically. The gap needs to be filled by keeping all the probable fillers. Mainly, European countries highlighted these gaps. Consumers engaged in green purchasing were found to be more involved in FW generation due to the short shelf life of edible food products and eating away from home compared to the average consumer. Green purchasing concerns are growing every day and everywhere. Still, the discrepancies between attitude and actual behaviour were found in the case of food waste, which is a significant concern in the present scenario. At the same time, when prioritising the choices, a higher preference is given to behavioural control considerations than sustainability. Therefore, a comparative study between behaviour and attitude should be conducted to understand the behaviour of food waste towards green purchasing, which can be a helpful step towards attaining SDG12.3 (reducing food waste to halve at the consumption stage).

TABLE IV: DEMOGRAPHIC VARIABLES IMPACT ON FOOD WASTE GENERATION  
IN VARIOUS COUNTRIES

S. No.	Author/s	Food Waste areas	Findings	Studied country/ies
1	[41]	Demographic factors	FW is a complicated and multifaceted problem; socio-demographic characteristics are frequently used as household FW production indicators.	Denmark & Spain
2	[11]	Demographic factors	Understanding demography's role helps us consider how consumer waste habits vary over time.	United States
3	[6], [22], [42-43]	Demographic factors	FW reduction was influenced by age, with older consumers producing less waste than younger ones.	UK, European Union, Denmark
4	[3], [44]	Demographic factors	Older adults throw away less food for various reasons, one of which could be negative views regarding waste shaped by earlier experiences of hardship and food restriction during World War II.	Sweden & UK

5	[45]	Demographic factors	Older adults plan their day shopping, prefer to eat freshly cooked foods, and are less likely to stockpile products or buy things they do not need.	Croatia
6	[46-47]	Demographic factors	Gender impacts individual attitudes and behaviour, which is responsible for FW generation. Some research identified that females waste less food than males.	UK & Switzerland
7	[48-49]	Demographic factors	Other research contradicted findings, implying that females waste more food than males.	Finland & Lebanon
8	[50]	Demographic factors	Female behaviour varies as women become older and their children grow, changing female roles in the home.	Romania
9	[39], [49], [51]	Demographic factors	Women are more involved in household domestic work such as meal planning, shopping, and cooking.	Finland, Germany, UK, Czech Republic & Spain
10	[52]	Demographic factors	Due to the high perishability of fruits and vegetables, women pay more attention to longevity and hence get involved in the food waste reduction approach.	UK
11	[6], [53]	Demographic factors	Women often feel guilty since it is interpreted as a negative sign for household management and providing a balanced meal to family members.	UK & USA
12	[54]	Demographic factors	Health, nutrition, and sustainability concerns taught females to purchase local and organic vegetables.	USA
13	[36]	Demographic factors	Purchasing local and organic vegetables may also help reduce FW, as consumers who shop locally waste less food.	Italy & Germany
14	[50]	Demographic factors	Females are more aware of the negative consequences of FW and are more likely to change their habits to reduce waste. However, females'	Romania

			ability to implement sustainable FW practices is hampered due to a wider variety of choices by the family members (children, older adults, and others) that can contribute to FW.	
15	[55-56]	Demographic factors	Households with diverse levels of wealth have different attitudes and behaviours regarding food waste.	Italy
16	[2], [43], [57]	Demographic factors	Food waste is less common in households with lower incomes.	UK & Denmark
17	[45]	Demographic factors	In low-income families, household food purchasing contributes to much of their spending; therefore, food waste is rarely seen in such families.	Croatia
18	[55]	Demographic factors	Low-income households' diets primarily comprise staple items that are less likely to deteriorate. Moreover, consumers with tighter budgets are more likely to buy large amounts of cheaper commodities in bulk, which may result in food waste because of excess purchases.	Italy
19	[55]	Demographic factors	Less expensive food items are often connected with low-quality products with less nutritional value and shorter shelf life, which may cause consumers to reject products, resulting in increased waste.	Italy
20	[6], [58]	Demographic factors	Food waste rises in tandem with household income.	UK & Australia
21	[59]	Demographic factors	Increased food waste could result from higher household income, which allows people to diversify their meals to include more perishable foods like fruits, vegetables, and animal products.	USA
22	[60]	Demographic factors	Households with higher food budgets produce more food waste than those with lower food budgets.	Canada

23	[60]	Demographic factors	Eating out behaviour is mainly found in high-income people. Due to the spontaneous decision to eat out, things already available are forced to be thrown away, and they get involved in FW. It suggests that high income is highly associated with more food waste generation.	Canada
24	[60], [61-62]	Demographic factors	There is a tiny or no link between income and food waste.	Finland, UK & Britain
25	[36], [43], [45], [49], [60]	Demographic factors	The link between the size of the family and the amount of trash produced implies that more nuclear families waste more food.	Croatia, Italy & Germany, Finland, Canada, and Denmark
26	[60]	Demographic factors	Larger households waste more food because of more excellent shopping bills and a preference for big-box stores for bulk purchases.	Canada
27	[58], [63]	Demographic factors	Larger homes, on the other hand, produce less food waste than smaller ones.	UK & Sweden
28	[36], [49]	Demographic factors	Individuals who live alone generate the most garbage per capita.	Italy & Germany, and Finland
29	[64]	Demographic factors	Portion sizes on food products and the fact that many items are inexpensive or more significant.	UK
30	[60]	Demographic factors	Food waste reduction efforts in large households are sometimes hampered by time and practical restrictions.	Canada
31	[6-7], [60], {62}, [65-66]	Demographic factors	The presence of small children highly influences food waste generation at home.	Australia, England, Canada, European Union, USA.
32	[45]	Demographic factors	Larger volumes of trash are expected since young children's feeding habits are difficult to predict.	Croatia

33	[36]	Demographic factors	'Fussy' kids frequently refuse to complete their meals.	Italy & Germany
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Demographic variables like gender, income, family size, and family structure were found to be FW drivers in the studies. Demographic variables acted as moderators in these studies as they were found to increase and decrease food waste at the consumption stage. Females were less engaged in food waste than males, and older people were less involved in food waste, whereas income was seen as engaged in influencing food waste behaviour. Education as a demographic variable was not tested in the studies mentioned above; therefore, it can be used as an effective moderator in understanding wasteful consumer behaviour. The above-mentioned demographic variables need to be tested in the context of developing or emerging countries and compared with studies conducted in developed countries. Food waste behaviour drivers can be identified, and findings can be generalised.

TABLE V: FW MITIGATION APPROACHES ADOPTED BY VARIOUS COUNTRIES

S. No.	Author/s	Food Waste areas	Findings	Studied country/ies
1	[67]	FW mitigation approaches	FW mitigation has become a prominent agenda in policy development, media coverage, and various noble cause movements in recent years. Food waste is now recognised as a global concern due to its interdisciplinary nature.	Globally
2	[68]	FW mitigation approaches	Businesses must constantly adjust to meet quickly changing consumer needs while tackling the issue of food waste due to increasing social pressures.	UK
3	[69]	FW mitigation approaches	The food sector frequently needs help figuring out how to prevent food waste at the source.	Greece
4	[70]	FW mitigation approaches	Surplus food is deemed waste by the industry when there are monetary losses, yet it is often fit to be consumed by humans.	UK
5	[71]	FW mitigation approaches	Alternative techniques are required to manage surplus food effectively and efficiently and avoid its disposal and loss of value.	Spain

6	[69], [72]	FW mitigation approaches	Alternative techniques can be achieved by establishing food distribution networks such as food banks and charities.	USA & Greece
7	[69]	FW mitigation approaches	Extra food perishability is challenging in transportation and keeping things fresh during redistribution.	USA
8	[18], [71], [73]	FW mitigation approaches	Leftover edible food, if not circulated on time for food banks or charities, should be segregated for different uses such as composting, energy conversion, and animal feeding before dumping in landfills.	USA, France, and Globally
9	[74]	FW mitigation approaches	Food-sharing networks not only make social food sharing more accessible, but they also help consumers to become more conscious of their food provision, whereabouts, and literacy.	Australia
10	[75]	FW mitigation approaches	The "Love Food Hate Waste" campaign is a UK-wide initiative that works with governments, businesses, and communities to improve resource efficiency.	UK, USA, Japan, Denmark, Malaysia, South Korea
11	[76]	FW mitigation approaches	In 2012, the organisation launched a program in West London to raise consumer awareness through various advertising and community events, which resulted in a 14% reduction in unnecessary food waste over six months.	UK
12	[58]	FW mitigation approaches	Even though food waste information is widely available, many customers are already aware of food waste reduction approaches, but their careless attitude prevents them from following the advice.	Australia
13	[77]	FW mitigation approaches	Nudging can prevent food waste and overconsumption by encouraging sustainable behaviours.	Malaysia

14	[58], [75]	FW mitigation approaches	If local governments, NGOs, businesses, and other stakeholders give enough assistance and monetary benefits to consumers, it can act as an influential factor in mitigating food waste.	Australia, the UK, the USA, Japan, Denmark, Malaysia, South Korea
15	[78]	FW mitigation approaches	The most important method of waste minimisation is source reduction.	USA
16	[79]	FW mitigation approaches	To give economic incentives for consumers to reduce waste pollution, governments around the world are framing laws and regulations related to food waste, such as charging landfill fees, incinerator taxes, and individual trash pricing schemes.	South Korea
17	[80]	FW mitigation approaches	A specified fee must be charged based on their garbage generation in "Pay As You Throw" (PAYT) programs.	Developed & developing countries
18	[81]	FW mitigation approaches	South Korea has developed a PAYT system that recommends buying certified plastic bags for waste disposal to encourage recycling and minimise pollution. Still, recyclable bag disposal is considered free of cost.	South Korea

FW is a global issue that has gained popularity due to media campaigns, policy frameworks, social issues, campaigns, and increased environmental concerns. FW needs to be minimised at its origin by adopting the PAYT model, increasing dumping and incineration fees, incentivising the catering outlet engaged in generating less FW, training servers and people involved in its production, nudging the customers, segregation of unconsumed food, etc. The active role of local governments, NGOs, businesses, and other stakeholders can play a significant role in this regard by providing financial incentives to the consumers, which can be a powerful motivator to mitigate FW at the consumption stage. Continuous FW reduction is required from all the stakeholders to remove the barriers to attaining SDG 12.3 and support sustainability.

## 4 Findings

SDG 2030 has 17 goals, which include SDG 12.3, targeted to reduce FW to halve at the retail and consumer levels during the production and consumption level to feed the population of 811 million – more than 10% of the world population goes to bed hungry every night [82]. In the era of globalisation and industrialisation, the number of hungry people has increased drastically, especially after the COVID-19 pandemic. 418 million Asian people are undernourished, whereas, in terms of percentage, Africa ranked number one, i.e., 21% [83]. Various organisations like WRAP, UNEP, FUSIONS, FAO, WFP, IFAD, and UNICEF, along with multiple researchers, are nailing every opportunity to fight against this emerging problem.

Due to the unavailability of exact food waste data in the retail sector, it is very tough to frame the right policy to reduce its negative socioeconomic impact. Discrepancies in FW definition that differ from business to business, unpredictable consumer demands and habits, and mass disposal of unsaleable food in the retail sectors create hurdles to global food security and become barriers to attaining SDG12.3. Developing and emerging countries are either understudied or unexplored in this context; therefore, more study is also required.

Studies from the last 17 years (2004 to 2021) suggest that FW in the catering sector was the second-largest food waste producer after households, mainly in Europe. Consumer health, safety, happiness, and government guidelines emerged as significant drivers of food waste in the catering sector. Food preservation and restructuring can only be practical for a specific time. The portion size was a vital FW contributor to plate waste and increased consumer demands. Offering takeaway boxes or the ‘doggy bags’ concept has shifted the responsibility for food waste from caterers to consumers. Due to societal prejudices, carrying leftover food is not considered a good practice, but it can be used as a nudging tool to mitigate FW from the consumer's end.

Behaviour develops from attitudes. The “Green” Consumer approach in buying and selecting food items can be used as a food waste mitigation driver. Still, due to the attitude-behaviour gap, this approach is also not working as effectively as expected. Despite consumers’ positive sentiments toward sustainable behaviour, there is an imbalance between behavioural control (FW behaviour) and environmental values (sustainability).

As FW is a multifaceted problem, socio-demographics (age, income, gender, education) can significantly influence its generation. FW habits vary from individual, as older adults were found to be less engaged in food waste as compared to young ones, females were found to be less involved as compared to males, whereas, in some research, the females were found more engaged; therefore, it’s a contradicting statement which needs to be thoroughly studied. Less-income households were found to be less involved in FW as they cannot afford to throw food out compared to high-income, whereas, in some studies, there is no link between food waste generation and income. Less expensive items were found throwing out more due to their short shelf life and lack of nutritional content. Prominent families are found to be more engaged in FW than small families, whereas individuals produce most of the garbage alone.

Portion size, number of children in the family, an ineffective effort of FW reduction in larger families, and ‘fussy kids’ were also found responsible for more food waste.

FW reduction approaches have increased in recent years due to policy design, the active role of media, and various social movements. Mitigating FW at the production/generation level is the biggest challenge for any business while keeping unpredictable consumer demand in mind. If dumped, food fit for human consumption creates a substantial economic and environmental loss; therefore, various alternative techniques are required to control this emerging problem. Establishing food banks, tie-ups with charities, surplus food recovered for animal feed, FW mitigation campaigns, nudging techniques with customers by encouraging sustainable behaviours, government incentive programs for minimum food waste producers, and PAYT programs can be helpful.

## **5 Conclusion**

While attaining the UNSDG 2030 agenda (SDG 12.3), various barriers were identified, such as catering sectors, retail sectors, consumers, lifestyle practices, demographic profiles of consumers, and FW mitigation approaches on different levels. These barriers can be controlled by developing a food-sharing model with the help of the government and NGOs. Media campaigns, policy framework, nudging the consumer behaviour by offering choices in portion sizes, offering ‘doggy-bag’ for leftover food to the consumer, developing FW mitigation behaviour, reward techniques, customisation of portion size, education and training, information about the negative impact of FW on society and environment since childhood. To attain SDG12.3, the techniques mentioned above can be very effective in providing food to everyone through a food-sharing model and proper training to staff engaged in food production. In this regard, all three stakeholders (consumers, caterers, and government) should come together.

## **6 Recommendations, implications and limitations**

The FW problem is found to be the most significant barrier for any economy or country; therefore, necessary and immediate actions are required from every corner, such as retail sectors, catering sectors, consumer attitudes and behaviour, lifestyle practices, and food waste-reducing efforts either from the government in the form of policy development or through consumer awareness. To sustain the environment by reducing the GHG emissions generated from food dumping and achieving SDG 12.3, FW needs to be minimised at the consumption stage, especially at the retail and catering stage. Consumer behaviour is a root cause of FW that needs to be controlled through effective strategies and proper monitoring through incentives and rewards.

The food waste reduction approach can be started with households (the biggest significant waste contributor), then catering and retail sectors. PAYT model, incentives

for less FW producers, food sharing to people in need, and media campaigns are practical tools in this approach. Customisation of portion size, careful menu design, and proper forecasting techniques can be helpful in this regard.

Most studies were conducted in developed countries (Europe), whereas developing and emerging countries were ignored or understudied. Higher spending power, nuclear family concept, education, age, and less engagement in food buying and its production need to be studied from the perspective of FW generation, which can be helpful in further research in the context of developing countries.

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