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Food-Sharing Apps' Role in Mitigating Food Waste: Examples From Poland and Czechia

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Abstract

The growing challenge of food waste is a frequent topic in international debate, as significant amounts of food remain unrecovered despite being a basic need. Digital platforms and mobile applications now play a key role in redistributing surplus food by connecting local entrepreneurs and catering services with consumers. While existing research has focused primarily on food-sharing applications' (FSAs') business models and user behaviour, the spatial dimension of these platforms remains understudied. Our research examines FSAs as business-to-customer (B2C) solutions that directly connect catering facilities with consumers, analysing their role in supporting food waste mitigation across diverse urban contexts in Poland (Warsaw, Krakow) and Czechia (Prague, Brno). Through spatial analysis of FSA-participating establishments' locations and the types of food saved, we investigate how the B2C model operates within different urban functional zones, from tourist-heavy city centres to residential districts. Our findings reveal distinct patterns in how FSA adoption aligns with cities' functional characteristics, with higher concentrations in multifunctional urban cores and emerging presence in revitalized residential areas. This spatial distribution reflects both the business opportunities within the B2C model and the cities' varied functional roles, from tourist destinations to administrative centres. Our findings highlight how FSAs align with urban functions, offering insights for expanding coverage to underserved areas while adapting to local characteristics.

Keywords

catering facilities; Czechia; food-sharing applications; food waste; Poland

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1. Introduction

The growing issue of food waste is a frequent topic in international debates (FAO et al., 2022), as much of it remains unrecoverable (FAO, 2015). Despite being a basic need, large amounts of food are wasted across the supply chain. Food-sharing initiatives help mitigate this by redistributing surplus food (Davies, 2020). Local efforts—like food banks and charities—are increasingly effective through digital tools (Ciaghi & Villafiorita, 2016) such as online platforms and food-sharing applications (FSAs).

With modern information and communication technologies (ICTs), online platforms and mobile applications facilitate food redistribution by connecting local entrepreneurs and the catering sector directly with their customers (Ciaghi & Villafiorita, 2016; Farr-Wharton et al., 2014). Examples include Too Good To Go (UK, Denmark, Germany, Poland), Foodsi (Poland), Karma (UK), Nesnězeno (Czechia), as well as platforms connecting donors with charities (Italy: BringTheFood; UK: OLIO). These applications operationalize redistribution by forming partnerships with local businesses and using real-time matching algorithms to connect surplus food with consumer demand efficiently. This food redistribution, whether profit- or non-profit oriented (Harvey et al., 2014), transforms food distribution from linear-based (production to supermarket, restaurant to consumer) to network-based models (e.g., customer to producer; Harvey et al., 2019). For instance, in the linear model, surplus food from restaurants often goes to waste, whereas network-based platforms enable real-time connections between businesses with surplus food and customers seeking discounted meals (Harvey et al., 2019). Currently, various digital platforms exist for reducing food waste (Rýparová, 2021), with FSAs providing tools for businesses to list surplus and for consumers to browse and claim food, creating a more dynamic food redistribution system.

Although FSAs show potential for improving food systems (Harvey et al., 2019; Michelini et al., 2018), empirical research remains limited. Researchers have explored business participation motivations (Mazzucchelli et al., 2021; Rýparová, 2021), noting that food waste reduction requires consumer–retailer coordination (Bravi et al., 2019). Mobile applications offer valuable contributions (Hanson & Ahmadi, 2022), yet spatial aspects remain neglected in comparative studies. Our research addresses this gap by examining spatial distribution patterns of FSA-using catering facilities across urban contexts in Poland (Warsaw, Krakow) and Czechia (Prague, Brno), analyzing geographic accessibility, food-sharing patterns, and relationships to cities' functional characteristics.

In our analysis of the FSAs used by gastronomic facilities (e.g., restaurants, cafes) and food stores located in selected cities of Poland (Warsaw, Krakow) and Czechia (Prague, Brno), the following research questions were formulated prior to data collection to guide our investigation:

> RQ1: How accessible is food through FSAs in the selected cities of Poland (Warsaw, Krakow) and Czechia (Pragie, Brno)?
>
> RQ2: What types of food are being saved in these cities?
>
> RQ3: What are the spatial distribution patterns of gastronomic facilities, and how do they relate to the cities' functional roles?
>
> RQ4: How do the spatial distribution patterns of FSA-using facilities shape food-saving opportunities, and are there specific districts where food waste cannot be mitigated through these apps?

To address these questions, we analyze data from three FSAs (Foodsi, Too Good To Go, and Nesnězeno) operating in selected cities (2022–2023), covering 811 participating facilities and food types shared. Using GIS, we examine spatial patterns in relation to urban functions, comparing FSAs participating facilities with 5,726 catering establishments from OpenStreetMap (OSM).

We chose Warsaw, Krakow, Prague, and Brno for several reasons. First, they are significant metropolitan urban centres in Poland and Czechia (Frantál et al., 2015; Kuć-Czajkowska, 2009; Romańczyk, 2018; Sýkora & Ouředníček, 2007; Tonev et al., 2017) that are essential for understanding FSAs within the broader context of European and global efforts to create sustainable food systems. These cities are prominent national capitals, cultural hubs, and key players in the European urban landscape (Kuć-Czajkowska, 2009; Romańczyk, 2018; Tonev et al., 2017). They exhibit a high degree of cosmopolitanism and attract a diverse population, including students, professionals, and expatriates, contributing to dynamic labour markets and diverse food cultures (Kunc et al., 2023; Pawlusiński & Kubal, 2017; Vaníček, 2019). Second, their status as major tourist destinations (Derek, 2018; Kunc et al., 2023; Vaníček, 2019) amplifies the significance of food consumption and waste. Third, from a European perspective, these cities increasingly represent growing awareness of food systems issues, particularly through evolving cultural approaches to food waste. Warsaw and Krakow actively engage in food system transformation through initiatives like Warsaw's Food Policy and Krakow's 2024 signing of the Milan Urban Food Policy Pact. Prague and Brno participate indirectly (Gregor et al., 2018; Nováková et al., 2021), making all four cities relevant to urban food sustainability efforts. Poland demonstrates this shift through active civil society involvement, with faith-based organizations like the Caritas Foundation connecting religious institutions with food donation initiatives—a connection where traditional values and community-driven initiatives guide food-sharing practices (Filimonau et al., 2022, 2024). Notably, a generational transformation is occurring, with younger generations showing increased support for modern food-sharing technologies (Balińska et al., 2021, 2024; Jaska et al., 2022) and food waste reduction efforts (Jaska et al., 2024; Kubal-Czerwińska, 2025) compared to their parents and grandparents (Auer & Rogers, 2022). This evolving approach to food systems has positioned these cities at the forefront of food geographies—an emerging field examining urban food production, preparation, and consumption—and discussions on transitioning toward more sustainable and just urban food systems (Abbt, 2024; Pixová & Plank, 2024; Ratinger et al., 2014). Fourth, by studying FSAs in these cities, the research aligns with global and European objectives of fostering sustainable food chains that extend beyond urban centres into surrounding regions (Preiss et al., 2017; Stahlbrand, 2018). Additionally, civil society initiatives like food policy councils and movements for food justice in these cities demand greater democratic participation in food system decision-making and the rectification of social inequalities, particularly those tied to post-Soviet power dynamics in Central and Eastern Europe (Gregor et al., 2018; Nováková et al., 2021; Urząd miasta stołecznego Warszawy, 2020). The regional focus on Central and Eastern Europe fills a gap in the literature predominantly centred on Western Europe or North America (Ciaghi & Villafiorita, 2016; Farr-Wharton et al., 2014). The GIS methodology offers a quantitative approach to understanding sustainable urban systems and digital innovation in food systems (Baumann, 2020).

Food waste research in urban settings lacks spatial focus, particularly regarding ICTs' role. This study addresses this gap by examining FSAs in Poland and Czechia, connecting digital innovation, spatiality, and sustainability. While existing literature covers technological, social, and economic aspects, it neglects urban spatial dynamics in food waste patterns. Our GIS-based analysis examines food-sharing opportunities as a spatial challenge—especially relevant in Central and Eastern Europe where planning disparities affect sustainability. By analyzing

gastronomic clusters and underserved districts, we reveal how digital and spatial factors influence food waste reduction, contributing to equitable urban food-sharing practices.

This study contributes theoretically by advancing food waste management through network-based models and GIS-driven urban sustainability insights. It integrates geographical, sociological, and technological perspectives for more effective interventions. Practically, FSAs offer scalable tools to connect surplus food with consumers, especially in underserved areas. Managerially, FSAs act as a corporate social responsibility (CSR) instrument that help businesses reduce waste, boost revenue, and provide policymakers with data-driven strategies for equitable food-sharing practices. The article covers FSA literature, methods, spatial distribution, saved food types, and areas for expansion, concluding with key findings, future research, and policy recommendations.

2. Research on FSAs

Food waste has prompted online food-sharing initiatives (Ganglbauer et al., 2014) that evolved into apps like Too Good To Go and NoFoodWasted. These platforms connect surplus food with consumers through real-time matching algorithms (Apostolidis et al., 2021). By partnering with restaurants, bakeries, and supermarkets, they allow users to browse available food, purchase at discounted rates, and collect items directly from vendors.

2.1. Emergence and Development of FSAs

Research on FSAs is relatively new; however, it is becoming increasingly relevant. Initial emerging research in the field of FSAs mainly focused on presenting the tool of FSAs as a mechanism to reduce food waste, while exploring its potential for further development and improvement (Ciaghi & Villafiorita, 2016; Farr-Wharton et al., 2014; Fraccascia & Nastasi, 2023). FSAs align with the global goal of urban sustainability by addressing food waste challenges in densely populated areas where waste generation and food insecurity coexist. In response to the food waste problem, FSAs have become an increasingly popular initiative among users and as a business model (Hong, Kafa, & Jaegler, 2024). Michelini et al. (2018) addressed FSAs in classifying food-sharing models in the context of motivation and sustainability. The study presents three main models: (a) the "sharing for money" model, which is primarily a business-to-customer (B2C) for-profit model to reduce waste and, at the same time, generate revenue (e.g., Too Good To Go); (b) the "sharing for charity" model in which food is collected and given to non-profit organizations (e.g., Food Rescue US); and (c) the "sharing for the community" model which is a peer-to-peer model where food is shared amongst consumers (e.g., OLIO, The Food Rescue Hero; p. 205, Michelini et al., 2018); with FSAs being included in the "sharing for money" model—this does not mean that FSAs cannot be effective in other sectors.

2.2. FSAs as Business and Social Innovation

FSAs have been studied from business and social perspectives, highlighting their effectiveness. From a business standpoint, FSAs have been identified as catalysts for growth in social businesses (Vo-Thanh et al., 2021), particularly in the context of sustainable entrepreneurship. For instance, mathematical analyses of the business model of the Too Good To Go application have highlighted its profitability while significantly reducing food waste (Yang & Yu, in press). Similarly, Vo-Thanh et al. (2021) emphasized how FSAs contribute to social business growth by fostering innovative solutions to urban sustainability challenges. From a social

innovation perspective, FSAs play a critical role in addressing societal problems through innovative, community-driven solutions. Too Good To Go, for example, operates based on social, functional, and emotional values, which are critical to its success in achieving its social mission. The platform's ability to engage users by offering an affordable, impactful way to reduce food waste aligns with key social innovation principles, such as addressing social problems through innovative, community-driven solutions (Vo-Thanh et al., 2021). The Food Rescue Hero app, for example, connects volunteers with nonprofits to deliver surplus food to individuals facing food insecurity, reducing waste and aiding vulnerable populations (Bozhinova, 2018). Likewise, the Abundance app facilitates access to free or low-cost food, promoting inclusivity and reducing stigma (Etingoff, 2019). Barboza and Filho (2019) highlight that mobile eco-applications provide society with innovative opportunities and alternatives for promoting green consumption, including fostering lifestyle changes. Emerging research highlights both the benefits and risks of FSAs. While they promote sustainable consumption, they may also contribute to food waste. Yang et al. (2024) found that convenience and enjoyment can unintentionally encourage wasteful behaviours. FSAs raise awareness of food waste across production and consumption levels, including among children (Carulli et al., 2022; Mathisen & Johansen, 2022). Unlike food banks, which may evoke stigma, FSAs offer a dignified alternative (Ayala et al., 2022; Ntsondé & Aggeri, 2017; Zaman et al., 2025), positioning them as tools for both economic and social empowerment. Rooted in social innovation theory, FSAs balance functional and emotional values to drive user engagement (Lewandowski, 2023). This current study suggests that FSAs like Too Good To Go and Nesnězeno can mitigate urban food waste by fostering collaboration among businesses, consumers, and local authorities. Integrating social innovation frameworks, FSAs emerge as key drivers of urban sustainability, advancing food-sharing practices while promoting social and economic benefits.

2.3. Motivations for Using FSAs: Perspective of Consumers and Businesses

Motivations for using FSAs from the perspective of consumers and businesses are multifaceted as demonstrated in Table 1. While financial benefits are a primary driver, research indicates that a sense of environmental responsibility (Aschemann-Witzel et al., 2018) and the perceived usefulness of these apps (Bolton & Alba, 2012) also play a role. One of the central arguments for FSAs is their ability to economically incentivize consumers to adopt sustainable practices. Economic motivations, including cost optimization, stand out as compelling drivers for engagement, both for consumers and businesses. Balińska et al. (2024) emphasize that affordability and payment security are pivotal factors in user adoption. These apps offer practical solutions to reduce operational costs related to surplus food management (Hong, Jaegler, & Gergaud, 2024). However, focusing predominantly on economic incentives risks undermining the broader goal of fostering intrinsic motivations for sustainable behaviour. Without addressing the "value–action gap" (Essiz et al., 2023)—where individuals fail to act on pro-environmental intentions due to barriers such as convenience or lack of knowledge—the long-term impact of these apps may remain limited. Studies by Clark and Manning (2018) and Viccaro et al. (2023) have overlooked the interplay between financial incentives and other motivations, leaving a gap in understanding the broader drivers of food-saving behaviours.

Determination and motivation to use FSAs may vary depending on the side of the transaction. Apostolidis et al. (2021) identified key features and functions relative to the FSA functionality of two transactional sides—business representatives and consumers (Table 1). This allowed the identification of the divergent motivations of each party in using FSAs. Relationships between donors and recipients were also indicated by Harvey et al. (2019) for application functionality based on analysis of user data. The analysis carried out using analytical and

Table 1. FSAs stakeholder perspectives.

Aspect	Business Representatives	Consumers
Motivations	Reduce food waste while gaining revenue; Enhance brand image; Comply with sustainability goals	Save money; Access affordable food; Support sustainability and community efforts
Key features of FSA functionality	Tools to manage surplus efficiently; Integration with existing supply chains	User-friendly interface; Perceived usefulness and ease of use
Challenges	Fragmented supply chains; Need for operational adjustments	Perceived risks (e.g., food safety concerns); Trust in app functionality
Findings	Most transactions lack reciprocity; Third-party involvement fragments supply chains	Willingness to use FSAs boosted by perceived benefits, but reduced by perceived risks
Opportunities for improvement	Streamline supply chains; Tailor app features to business needs	Increase transparency; Enhance perceived safety and ease of use

graphical tools led to the conclusions that (a) the majority of transactions are not based on reciprocity, (b) the participation of third parties increasingly fragments supply chains, and (c) the structure of the FSA network is a determinant of sharing. Motivation and feelings about FSA functionality among users and product recipients were also addressed as part of learning about potential changes proposed by users (Fraccascia & Nastasi, 2023; Sienicka & Kozłowska, 2022; van der Haar & Zeinstra, 2019). For example, perceived usefulness and ease of use significantly boost consumers' willingness to use mobile apps aimed at reducing food waste, whereas perceived risks lower this willingness (Fraccascia & Nastasi, 2023). These insights underscore the importance of tailoring FSA functionality to address business representatives' and consumers' unique motivations and perceived challenges.

2.4. FSA Adoption: Opportunities and Challenges

FSAs present numerous opportunities for promoting sustainable consumption and reducing food waste. Research suggests that these apps act as "green default options" (Thaler & Sunstein, 2023), simplifying decision-making for users by embedding sustainability into everyday habits. They contribute to measurable economic and environmental benefits, offering users convenience, cost savings, and access to diverse food options (Dirsehan & Cankat, 2021). Market incentives such as public recognition or rewards for waste reduction milestones have the potential to enhance user engagement and align individual behaviour with broader sustainability goals (Mathisen & Johansen, 2022). For businesses, FSAs align with CSR objectives and deliver financial benefits by reducing surplus food volumes (Ntsondé & Aggeri, 2017), while legal incentives, such as tax breaks in Italy and France, encourage participation (Cane & Parra, 2020). Advanced technologies, including AI and smart contracts, enhance redistribution efficiency and align environmental and social objectives (Maleki Vishkaei & De Giovanni, 2024), improving business reputation and fostering customer loyalty.

From a systemic perspective, FSAs have the potential to foster collaboration across the food supply chain. With strong policy support and public education, they can tackle food waste at its source (Schanes et al., 2018) and scale from niche solutions to transformative tools for sustainable food systems (Baragwanath, 2021). The effectiveness of FSA adoption also depends on the digital readiness of the countries where these

applications operate. According to the Digital Economy and Society Index (European Commission, 2022), Czechia demonstrates moderate digital performance with 54% of its population possessing basic digital skills, aligning with the EU average. In contrast, Poland shows lower digital skill levels at 43%, positioning it among the EU's lower-performing countries in this aspect (European Commission, 2022). Unfortunately, FSA research is limited to investigating motivation and willingness to use FSAs from the user perspective (Fraccascia & Nastasi, 2023; Sienicka & Kozłowska, 2022; van der Haar & Zeinstra, 2019) without providing (inter)national comparisons.

Despite their promise, FSAs face several challenges that limit their effectiveness and scalability. A lack of trust in AI-driven technologies and concerns over data privacy can deter user engagement, as noted by Zarifis and Fu (2023) and Wang et al. (2023). Ethical challenges related to data collection must also be addressed to maintain consumer trust (Sapienza, 2018). Furthermore, younger users often prioritize convenience and brand reputation over sustainability, creating a misalignment between app design and user expectations (Calafell et al., 2019). To address this, app developers need to reevaluate their platforms to balance ease of use with meaningful educational content that fosters long-term behavioural change. The usability and perceived quality of food offered through FSAs also play a crucial role in user satisfaction and loyalty (Ng et al., 2023). While young users often appreciate convenience and time-saving benefits (Balińska et al., 2024), inconsistent product offerings and limited options can undermine their experience (Dirsehan & Cankat, 2021; Hong, Jaegler, & Gergaud, 2024). Additionally, structural inequalities within the food supply chain and inconsistent engagement from suppliers pose significant barriers to the broader adoption of FSAs (Ciulli et al., 2020).

Businesses also face notable challenges in FSA implementation and sustainability. Balancing surplus food allocation between donations and sales highlights the profit-driven nature of B2C FSAs (Rýparová, 2021). Supply–demand mismatches and fluctuating supplier participation further complicate the scalability of these platforms. Moreover, much of the existing literature focuses on consumer behaviour, leaving gaps in understanding the factors that drive or inhibit business participation in food waste management initiatives (Schanes & Stagl, 2019). Without addressing these challenges and fostering systemic collaboration, FSAs risk being relegated to incremental rather than transformative solutions for food waste reduction.

2.5. Spatial and Urban Considerations of FSA Adoption

Despite growing research, FSAs remain underexplored from a spatial perspective, particularly in urban systems. Cities, as complex socio-technical systems, face ecological and social sustainability challenges, especially in their food systems (Davies & Evans, 2019). Geographical location shapes food service operations and strategies (Lee et al., 2019). In Hangzhou, China, Zhai et al. (2015) found that food establishments are most visited in historic centres, with appeal decreasing in newer areas. Studies highlight how economic, technological, and social shifts influence the spatial distribution of gastronomy, creating concentration models in city centres and suburbs with residential areas of various density and small businesses, and tourist hubs (Kowalczyk, 2020; Kowalczyk & Derek, 2020). Thus, location likely impacts where and how FSAs might emerge in urban environments.

There are various forms of resisting food waste in urban spaces, ranging from worldview changes, community initiatives, and the use of ICTs, including FSAs. Global research has produced a classification, typology, map,

and database of food waste initiatives (Davies et al., 2017a; Davies & Legg, 2018) with a focus on ICTs in urban areas (Davies et al., 2017b). For example, Morrow (2019) compared digital food-sharing initiatives in Berlin and New York, assessing their effectiveness in promoting urban sustainability. Rýparová (2021) identified food-sharing platforms in Czechia, while Pączek et al. (2023) explored the services used in Czechia and Poland.

3. Socio-Economic Characteristics of Selected Cities for Urban Food Waste Research

Warsaw, Krakow, Prague, and Brno serve as compelling case studies for this research due to their shared histories as post-socialist cities that have undergone significant political and economic transformations since the end of communist rule. Each city has navigated the complex transition from centrally planned economies to market-oriented systems, leading to unique urban development patterns and socio-economic dynamics (Neduči & Krklješ, 2017). Detailed socio-economic characteristics are in Appendix 3 in the Supplementary File.

Warsaw, Poland's capital and largest city, has around 1.8 million residents (National Statistical Office in Warszawa, 2023). Population distribution varies across districts, with central areas like Śródmieście and Praga-Północ declining since 2021, while peripheral districts such as Białołęka and Wilanów grow due to suburbanization (National Statistical Office in Warszawa, 2023). In 2022, Białołęka gained 1,263 residents, Ursus 622, Wawer 441, Wilanów 331, and Włochy 330, while Śródmieście (−725), Bielany (−534), Mokotów (−452), and Ochota (−406) saw declines (National Statistical Office in Warszawa, 2023). These demographic disparities between central and peripheral districts of Warsaw highlight the diverse challenges and opportunities for initiatives such as FSAs, indicating the need to tailor strategies to the specific characteristics of each urban area (Urząd miasta stołecznego Warszawy, 2023; National Statistical Office in Warszawa, 2023). Warsaw's diverse population is reflected in its socio-economic structure, with younger, economically active residents concentrated in developing districts like Ursynów and Wilanów, while central areas have a higher proportion of elderly residents (National Statistical Office in Warszawa, 2023). As Poland's political, financial, and cultural hub (Raport o stanie miasta Warszawa, 2023), Warsaw has a strong service-based economy, with a GDP per capita of $47,430 (2022), low unemployment (1.5%), and over 900,000 people employed, mainly in business services, finance, IT, and retail (NSP, 2024; Śleszyński, 2015). Key business districts, including Śródmieście (98,000 residents) and Mokotów (226,000 residents), serve as major employment hubs, attracting high-skilled professionals and international investments (National Statistical Office in Warszawa, 2023). Despite this, disparities exist, with districts like Praga-Północ (60,000 residents) and Targówek (123,000 residents) having higher unemployment and lower income levels (National Statistical Office in Warszawa, 2023). Housing development reflects Warsaw's socio-economic divide (Mendel, 2013): The majority of new housing investments occur in Białołęka (159,000 residents), Wola (150,000 residents), and Włochy (50,000 residents), where large-scale residential projects cater to the growing demand for housing (Żylski, 2019). In contrast, older districts like Praga-Północ and Wola still face deteriorating housing, despite ongoing revitalization (Żylski, 2019). Such spatial and economic patterns impact food accessibility and waste management, especially in high-density, commercial areas where food services—and FSA adoption—are concentrated. Ochota, known for its young population, and Białołęka, a rapidly expanding district attracting young families, reflect Warsaw's shifting demographics (National Statistical Office in Warszawa, 2023). While Śródmieście and Mokotów remain business and gastronomy hubs, peripheral districts like Białołęka and Ursynów rely more on supermarkets than small-scale food services. Wola and Praga-Południe act as key food service centres outside the core. Warsaw's strong entrepreneurial and start-up scene, particularly in Wola and Ochota, contrasts with lower business density in Białołęka and

Ursus (National Statistical Office in Warszawa, 2023; Urząd miasta stołecznego Warszawy, 2023). These spatial-economic dynamics shape where FSAs thrive and guide food waste management strategies.

Kraków, Poland's second-largest city with around 800,000 residents (National Statistical Office in Warszawa, 2023), is a cultural, academic, and tourism hub shaped by its history, tourism, and universities (Pawlusiński & Kubal, 2017). The city shows clear socio-economic divisions between the dense, tourist-driven Old Town, a UNESCO World Heritage Site and major commercial hub with 29,000 residents and a population density of 7,357 people/km², which serves as a key area for FSAs due to surplus food from restaurants (Kruczek & Mazanek, 2019; Yang & Yu, in press), and peripheral districts like Prądnik Biały (72,000 residents, 2,876 people/km²), Podgórze Duchackie (54,000 residents, 5,879 people/km²), and Bieżanów-Prokocim (63,000 residents, 3,874 people/km²), where housing is more affordable (14,000 to 12,000 PLN/m²; (PrimeTimePr, 2024). These outer districts have stable populations and rely more on supermarkets and local markets for food access (PrimeTimePr, 2024). Nowa Huta, a district originally built in the 1950s as a socialist city for steelworks workers (Hołuj, 2017), remains less densely populated (49,260 residents, 816 people/km²; BUP Kraków, 2023) and has a lower-income profile compared to central Kraków. While heavy industry has declined, Nowa Huta is still home to large residential blocks and affordable housing, attracting young, well-educated individuals (Pawlusiński & Kubal, 2017). The district's food services are more localized, with grocery stores, traditional markets, and small eateries (Hołuj, 2017), unlike the restaurant-dominated Old Town. This creates different challenges and opportunities for FSAs. On one hand, food waste may be lower due to a more localized food economy; on the other, there may be fewer surplus food sources compared to the restaurant-heavy city centre. Additionally, lower digital engagement among older residents in Nowa Huta may pose adoption barriers for app-based food-sharing initiatives (Calafell et al., 2019).

Prague's socio-spatial structure contrasts between its historic centre, listed as a UNESCO World Heritage Site, and its suburban fringes (Zděradička, 2023). Its districts vary in urbanization, population density, and socio-economic composition (Ouředníček et al., 2015). Some districts, such as Praha 1 (22,967 residents, 4,200 people/km²), embody the essence of an urban centre, while others, like Praha 12 (56,591 residents, 2,400 people/km²), are distinctly suburban (Czech Statistical Office, 2023). Central districts like Praha 1 and Praha 2 have high population density, driving economic activity and digital engagement, making them prime locations for FSAs. In contrast, suburban areas housing fewer than 500 residents (e.g., Praha-Nedvězí and Praha-Královice; Czech Statistical Office, 2023) have lower population densities (1,500–3,000 people/km²) and less digital infrastructure, which can limit FSA scalability (Czech Statistical Office, 2023). Central Prague contributes about 70% of the city's economic activity (Czech Statistical Office, 2023), with significant cultural, administrative, and tourism-related establishments, fostering a dynamic and digitally connected population ideal for adopting FSAs. Prague's economy is mainly driven by the service sector, including finance (44,800 employees in 2022), IT (71,300 employees), education (45,900 employees), and public administration (39,700 employees; Czech Statistical Office, 2023). For example, central Prague, with its concentration of multinational companies, government agencies, and cultural institutions, fosters a dynamic, digitally savvy consumer base (Ouředníček et al., 2015; Sýkora & Šimoníčková, 1994). This economic and demographic vibrancy, supported by 95,000 high-skilled professionals (Czech Statistical Office, 2023), makes it an ideal hub for food services and digital innovations like FSAs. High foot traffic and strong gastronomy further drive demand for efficient food waste management, positioning FSAs as effective tools for both environmental and consumer needs (Lochman, 2021).

Brno, the second-largest city in Czechia, presents a somewhat more homogeneous urban landscape yet still exhibits a clear central-to-peripheral gradient (Kunc & Tonev, 2022). The central district, known as Brno-střed (4,617 people/km²) serves as the city's primary commercial and cultural nucleus (Czech Statistical Office, 2023; Mulíček et al., 2016). Surrounding districts Brno-sever (4,089 people/km²), Brno-Židenice (4,562 people/km²), Brno-Žabovřesky (4,944 people/km²), and Brno-Vinohrady (6,297 people/km²), although of smaller area, feature a high population density of approximately 4,000 to 6,000 inhabitants per km² (Czech Statistical Office, 2023). In these districts, a high concentration of economic activity and a tech-savvy consumer base (Kunc et al., 2023) support higher adoption rates of digital tools, including FSAs. Conversely, peripheral districts in Brno generally report lower population densities—typically between 1,000 and 2,000 inhabitants per km² (e.g., Brno-Chrlice, Brno-Černovice, Brno-Bystrc)—and face challenges related to commuting to the central area, reduced digital readiness, and low economic activity (Frantál et al., 2015), which can hinder the broader implementation of FSAs. Unlike Prague, Brno's economy is driven by high-tech industries, research institutions, and manufacturing (Kunc et al., 2023). Major employers like AVG Technologies, Kiwi.com, and leading universities foster innovation and digital engagement. These socio-demographic factors highlight the importance of considering urban-scale dynamics when assessing FSA effectiveness.

Poland shows more advanced FSA adoption than Czechia (698 vs. 113 facilities, see Table 2). While further research is needed to identify precise reasons, potential explanations include market maturity, policy incentives (Schanes et al., 2018), food prices (Balińska et al., 2024), and promotional strategies. The success of early Polish adopters likely created competitive pressure, motivating others to join (Balińska et al., 2024). This pattern appears in city heatmaps comparing all catering facilities versus those using FSAs (Appendix 1 in the Supplementary File). Warsaw leads with 431 facilities (22.7% adoption), followed by Krakow with 267 facilities (32% adoption), while Czech cities show lower rates: Prague has 57 facilities (2.4% adoption) and Brno has 56 facilities (9.6% adoption). Poland's advanced adoption is evidenced by FSAs spreading beyond central districts to peripheral areas, suggesting successful early adoption created new market opportunities. Further research is needed to verify these patterns.

4. Methodology

It is important to acknowledge that FSAs represent just one of many approaches to addressing food waste in urban environments. Both Poland and Czechia have diverse ecosystems of food waste reduction initiatives, including grassroots movements, non-governmental organizations, institutional programs, and informal community networks that operate independently of digital platforms (Brunclíková & Kliková, 2018; Filimonau et al., 2022; Rýparová, 2021; Veselá et al., 2023). Our study specifically focuses on the spatial distribution and impact of FSAs as an emerging technological solution.

Three FSAs—Foodsi, Too Good To Go, and Nesnězeno—were examined. During this study, Foodsi and Too Good To Go operated in Poland, where Foodsi is a Polish-based company focusing on food sharing (Foodsi, 2024) and Too Good To Go is an international company based in Denmark (Too Good To Go, 2024). Nesnězeno is a Czech-based company that was the only FSA during our research present in Czechia (Nesnězeno, 2024; Too Good To Go entered the Czech market in 2024). Following Michelini et al. (2018), all selected apps belong to the "sharing for money" type, where catering facilities generate income by selling discounted food, reducing waste, and recouping potential losses. This underscores the diverse motivations and functionalities of FSAs in addressing food waste, optimizing supply chains, and contributing to sustainability.

Our data collection directly addressed our research questions. To examine food access through apps (RQ1), we documented the locations of all participating facilities. Information about food offerings addressed our second question about the types of food saved (RQ2). To investigate spatial distribution patterns and their relationship to cities' functional roles (RQ3), we combined FSA facility data with OSM data on all catering establishments and relevant urban research. Finally, kernel density maps highlighted areas of high and low FSA participation to identify gaps in coverage (RQ4).

We implemented a two-step data collection process. First, we collected data through direct observation of FSAs from the user perspective, without app provider collaboration. After developing a standardized manual, investigators created user accounts and systematically collected information about available offerings between September 2022 and January 2023. We gathered 811 records from catering and food trade establishments across Warsaw, Krakow, Prague, and Brno, merging them into one database with duplicates removed.

Additionally, we collected data on all catering facilities to understand FSA adoption rates. We extracted data from OSM using Overpass Turbo, a web-based data filtering tool for OSM. OSM was selected for its comprehensive coverage, standardized categorization, and open accessibility (Arsanjani et al., 2015; Barron et al., 2013; Long & Liu, 2016). Overpass Turbo was chosen for its ability to effectively extract specific geographic features (Arsanjani et al., 2015; Dewedar & Pepe, 2024). In total, 5,726 catering facilities were obtained as shown in Table 2.

Table 2. Catering facilities: FSAs and OSM.

City	Catering facilities: FSAs*		Catering facilities: All
	n	%	*n*
Poland	698	25.5%	2,736
Czechia	113	3.8%	2,990
Prague	57	2.4%	2,407
Brno	56	9.6%	583
Warsaw	431	22.7%	1,902
Krakow	267	32%	834

Note: * no duplicates.

Using QGIS, we determined spatial distribution patterns based on location data and food types. Kernel density estimation generated heatmaps visualizing concentration patterns of FSA-participating facilities, allowing comparison with all catering facilities and between cities.

Despite our methodological approach, limitations exist. Data accuracy depends on information from FSAs or OSM, which may not always be current. By focusing on specific FSAs, we may overlook other innovative food waste reduction strategies employed by non-participating restaurants, potentially providing an incomplete picture of industry-wide food waste reduction efforts.

5. Results

5.1. How Accessible Is Food Through FSAs in the Selected Cities of Poland and Czechia?

In the cities of Warsaw, Krakow, Brno, and Prague, access to food through FSAs is primarily determined by the spatial presence of participating gastronomic facilities in the cities' central multifunctional districts, which are primarily concentrated in the central areas of the above cities (Appendix 2 in the Supplementary File; Kuć-Czajkowska, 2009; Romańczyk, 2018; Tonev et al., 2017). These areas typically host diverse functions, such as tourism, administrative offices, and entertainment hubs (Górka, 2004; Kunc & Tonev, 2022; Płaziak, 2019), leading to high accessibility for FSAs among residents, office workers, and tourists alike, making food saved through these apps highly accessible to individuals in central urban zones. For instance, in Krakow, Warsaw, Prague, and Brno, the highest concentration of FSA-using establishments is found in vibrant, well-trafficked parts of the cities, where a blend of residents, office workers, and tourists regularly visit well-trafficked parts of the cities (Kunc et al., 2023; Płaziak, 2019; Vaníček, 2019). In Krakow, the primary access points for FSA-using establishments are the Old Town and the Krowodrza (particularly in parts bridging with the Old Town on the northeast side). In Warsaw, the Śródmieście (city centre), Wola, Ochota, and both Praga-Północ and Praga-Południe exhibit the highest concentration of FSA-participating establishments, enhancing access for a wide urban demographic (Chrzanowski & Strzebońska, 2016). In Prague, central access is primarily in Praha 1 (Nove Mesto, Stare Mesto, Visechrad, Josefov), Praha 2, Praha 3, and Praha 7, these areas are representing significant food access establishments through FSAs. Catering facilities that use FSA centres in Brno are concentrated around the Brno-Stred district, making food-sharing opportunities accessible within the city's multifunctional centre.

Catering facilities using FSAs are increasingly found in revitalized residential neighbourhoods in cities like Warsaw, Krakow, and Brno (Appendix 2 in the Supplementary File). These areas, transformed from neglected urban zones into housing and office spaces, now serve as hubs for FSAs, providing residents easier access to surplus food without travelling to the city centre. Examples include Grzegórzki, Czyżyny, Prądnik Biały, and Borek Fałęcki in Krakow, and Białołęka in Warsaw. This trend shows FSAs' adaptability across urban spaces and growing acceptance beyond traditional city centres.

However, the limited presence of FSAs in suburban and industrial areas highlights gaps in food-sharing accessibility. This is evident when comparing maps of catering facilities and FSAs in Warsaw, Krakow, and Prague (Appendix 1 in the Supplementary File). Peripheral districts like Brno's western regions, Warsaw's Rembertów, Ursynów, and Wesoła, and Krakow's Wzgórza Krzesławickie and Nowa Huta show low or no participation in FSAa. Areas characterized by extensive green spaces, low population density, and a high level of functional diversity—combining residential, commercial, and recreational functions (Raman & Roy, 2019)—pose challenges for the implementation of FSAs due to dispersed demand and logistical complexities for food service businesses (Chrzanowski & Strzebońska, 2016; Kunc & Tonev, 2022; Murawska, 2013; Temelová & Ouředníček, 2009). For example, the complexity of managing diverse functions in mixed-use developments can lead to logistical difficulties in coordinating food waste collection and redistribution, while also causing inconsistent participation among residents and businesses, complicating uniform waste management practices. Furthermore, the increased foot traffic and density associated with mixed-use areas can strain existing waste management infrastructure, potentially hindering the efficient processing of food waste (Hong, Kafa, & Jaegler, 2024).

5.2. What Types of Food Are Being Saved in These Cities?

The gathered data provide a picture of commonly shared food via FSAs (Figure 1; see also Appendix 2 in the Supplementary File). The most shared food items across all locations are pastries (29%), with desserts (28%), already-made meals (18%), and food products with a short life (16%) as the second most common group of shared food, and food items like pizza, vegan meals, sushi, or drinks as the less commonly shared food (3% or less). The dominance of pastries and desserts can be attributed to bakeries' daily production patterns and demand estimation practices, where surplus items remain safe for consumption and are logistically simpler to handle through FSAs. In contrast, items like pizza and sushi appear less frequently as they are typically prepared to order rather than in advance.

Country-level comparisons show different levels of FSA adoption where not only in Poland are there more catering facilities involved in food sharing via apps (Table 2), but the type of food is more diversified in Poland as well. These differences reflect combinations of different market maturity, local food business participation levels, and stages of FSA adoption, as mentioned above in 5.1. Similarities across countries can be observed in the high share of pastries and bakeries involved in FSAs, both at the national level and within individual cities. Observing the city level, Prague shows a higher diversity in food types than Brno, while Warsaw and Krakow have similar patterns. Knowing what food is saved reveals what may still be wasted. While desserts and pastries are well-covered, FSAs could expand to include more prepared meals from restaurants and short-shelf-life products.

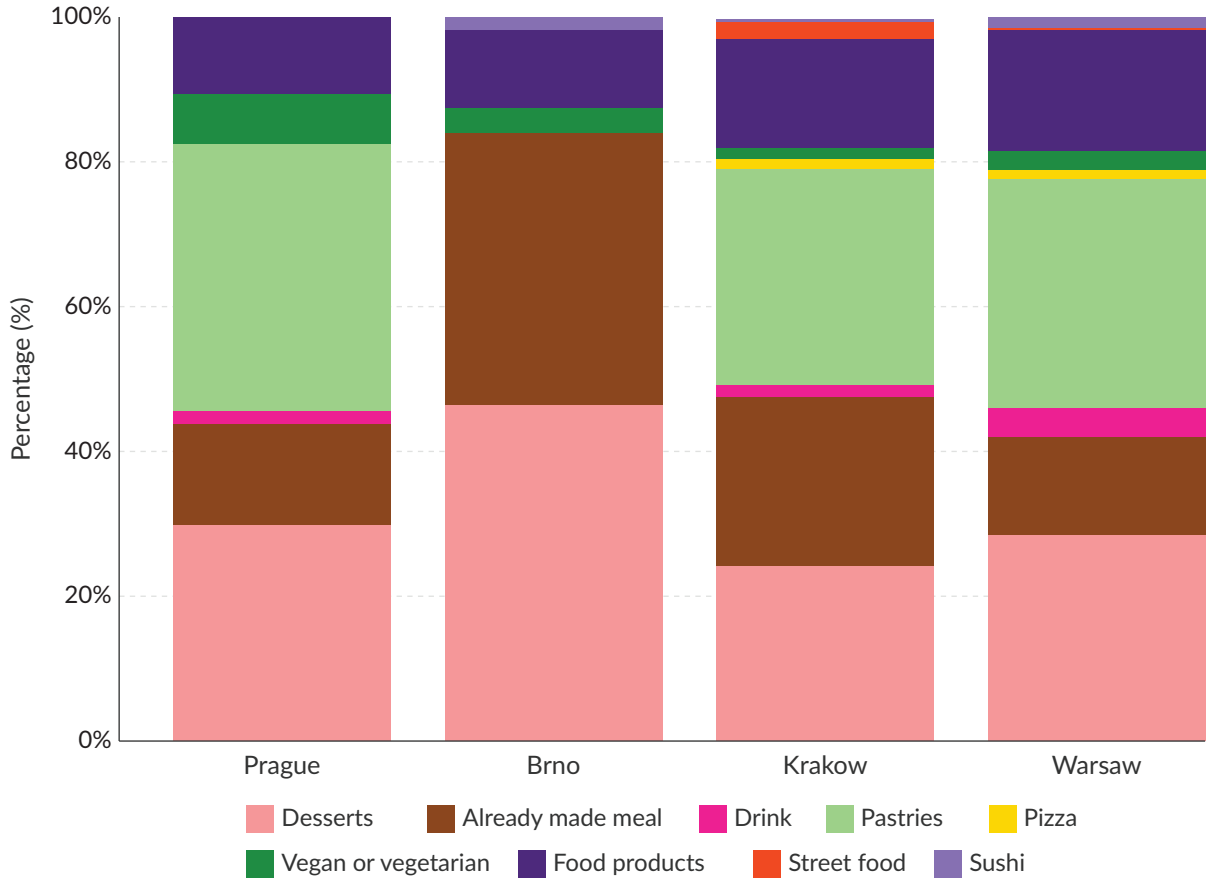

Figure 1. Type of food shared via FSAs.

5.3. How Does the Spatial Distribution of Gastronomic Facilities Reflect Urban Functions?

The spatial distribution of FSA-affiliated gastronomic facilities in Warsaw, Krakow, Brno, and Prague demonstrates regular patterns related to urban functions. Central districts serve as hotspots for FSA facilities, aligning with high social and economic activity areas, such as tourist attractions, administrative centres, and entertainment venues. Krakow, Warsaw, Prague, and Brno are distinguished as vibrant tourist destinations, administrative hubs, and centres of entertainment, each with unique landmarks and attractions that highlight these roles (Kunc et al., 2023; Pawlusiński & Kubal, 2017; Vaníček, 2019).

Krakow, Warsaw, Prague, and Brno reflect a typical urban structure where FSA adoption correlates with areas of high foot traffic and mixed-use functionality. Each city's core districts (e.g., Old Town and Krowodrza in Krakow, Śródmieście in Warsaw, Praha 1 in Prague, and Brno-Stred in Brno) concentrate FSA-affiliated facilities due to districts multifunctional roles. What is more, FSAs are spreading into revitalized residential areas with new housing, commercial spaces, and offices, creating hotspots outside central districts, particularly in Warsaw, Krakow, and Brno. In Krakow, there are nine of those hotspots, in Warsaw 11, and in Brno 10. For example, Warsaw's Białołęka (National Statistical Office in Warszawa, 2023) and Krakow's Zabłocie (Płaziak, 2019) demonstrate this trend. In these districts, new housing estates appear (in Białołęka: Osiedle Głębocka and Nowodwory; in Zabłocie: Riverside and Craft Zabłocie), which are key destinations for well-educated young people and students beginning their careers and starting families (Murawska, 2013; Płaziak, 2019). The expansion of catering facilities adopting FSAs in these districts highlights the facilities' responsiveness to growing residential demand and urban regeneration efforts, bringing food-saving opportunities closer to suburban populations. Unlike in other cities, in Prague, FSA facilities are primarily concentrated in central tourist districts (Praha 1–3 and 7), with availability decreasing in suburban areas. This pattern suggests a link between FSA distribution and tourism, as well as potential socio-economic disparities in food-sharing access outside central zones. Across the cities, FSA distribution aligns with urban functions and demographics, providing greater access in densely populated and economically active areas, while expanding into some residential areas.

5.4. How Does FSA Distribution Affect Food-Saving, and Which Areas Are Underserved?

It is mentioned above that the highest density of catering facilities that use FSAs is in centre and inner cities. With growing distances from the centre and inner city, access to FSAs decreases. The city districts with food-saving opportunities are absent in the majority of Prague. This is the case of industrial and commercial zones on the outskirts of the city (shopping centres, offices), for example Praha 10 (Malešice, Štěrboholy), Praha 15, Praha 20, Praha 18 (Letňany), Praha 6 (Ruzyně), and Praha 14 (Hloubětín), mixed with typical housing estates (blocks of flats) built in the afterwar period (WWII), for example Praha 4 (Chodov, Háje), Praha 12 (Modřany), Praha 13 (Stodůlky), Praha 8 (Kobylisy, Střížkov), Praha 18 (Letňany), and Praha 14 (Černý most), where new housing and commercial development is taking place nowadays (Ouředníček & Kopecká, 2023). These findings confirm our claims that the adoption of FSAs in Prague is in the early stages with potential growth, especially in the localities Praha 4, Praha 10, Praha 11, Praha 3, Praha 7, and Praha 17, with a population density similar to the centre and inner city (Czech Statistical Office, 2022).

While Brno, Krakow, and Warsaw share with Prague the characteristic that most catering facilities are in the city centre and inner areas, the outskirts show a different picture, featuring zones with mixed functions

(including residential, commercial, and industrial estates). In Brno, we could see that northern, western, and southern districts can access FSAs. This is the case of districts with single-family detached homes (Brno-Tuřany) mixed with industrial function (Brno-Černovice) or residential districts in the outskirts with a mix of single-family detached homes and large housing estates (Brno-Slatina, Brno-Líšeň; Frantál et al., 2015; Sýkora & Ouředníček, 2007). Although it is true that northern, western, and southern districts on the outskirts of Brno have access to catering facilities with FSAs, in absolute numbers these catering facilities represent nearly 20% of all identified catering facilities with FSAs. Districts like Brno-Komín and Brno-Medlánky with residential and commercial functions, or Brno-Ivanovice, Brno-Jehnice, Brno-Ořešín, Brno-Útěchov, Brno-Bytrc, and Brno-Kníčky with a mix of single-family detached homes (Frantál et al., 2015; Sýkora & Ouředníček, 2007) are also without any access to FSAs. Thus, in Brno as well, one can conclude that FSAs' potential is not fully exploited.

In Krakow, catering facilities with FSAs extend beyond the city centre into residential districts, bringing food-saving opportunities closer to people's homes. However, they have yet to reach the outer districts, such as Wzgórza Krzesławickie and Nowa Huta. Although these areas have large residential populations, they are less well-equipped with gastronomic facilities. For example, it has been observed that the central area of the Nowa Huta district was undergoing a decline in local commercial and service functions (Brzosko-Sermak et al., 2017), limiting the reach of entities using FSAs there.

In Warsaw, catering facilities with FSAs are not yet available in Rembertów, Wesoła, Wawer, Wilanów, and Ursynów—suburban districts known as "Warsaw's bedrooms" due to their residential nature (Murawska, 2013). Rembertów, for instance, has low population density and dispersed housing, with ample green space—over 30% of its area is forested (Maciejewska et al., 2024; Murawska, 2013). These districts are less densely populated than central districts (National Statistical Office in Warszawa, 2023), suggesting that current demand and logistical considerations may influence FSA expansion in these areas. Expanding FSAs into these areas could improve food access and contribute to food waste reduction for residents of these districts.

6. Discussion

The findings reveal that the spatial distribution of FSAs in Warsaw, Krakow, Brno, and Prague predominantly follows a central-to-peripheral gradient, with food-sharing via FSA activity primarily concentrated in central urban zones. This pattern is particularly evident when examining specific districts across our study cities, where each city's central zone demonstrates distinct characteristics that support FSA adoption. These central areas, which include high-density districts with multifunctional spaces—such as Śródmieście in Warsaw, Old Town in Krakow, and Praha 1–3 and 7 in Prague (Górka, 2004; Murawska, 2013; Ouředníček & Kopecká, 2023; Płaziak, 2019)—serve as crucial FSA hubs due to their unique combination of urban functions. These districts typically host diverse functions, such as tourism, administrative offices, entertainment hubs, and residential areas (Górka, 2004; Kunc & Tonev, 2022; Płaziak, 2019), leading to a higher concentration of catering facilities involved in food sharing. Consequently, the strong presence of FSAs in these areas aligns with the broader socio-economic landscape of these cities, where central districts function as primary hubs for food consumption and redistribution. This concentration aligns with city socio-economic structures, where central areas serve as key food consumption and redistribution hubs (Derek et al., 2020; Kowalczyk, 2020; Motycka, 2021). Catering facilities willing to use FSAs are gradually

expanding beyond city centres into revitalized residential areas like Warsaw's Białołęka and Krakow's Prądnik Biały, Czyżyny, and Zabłocie (Chrzanowski & Strzebońska, 2016; Maciejewska et al., 2024; Murawska, 2013). These regenerated districts serve as emerging secondary hubs, improving local food access without necessitating travel to central zones. This trend reflects an adaptive strategy by catering businesses using FSAs, acknowledging growing demand in diverse urban spaces beyond traditional core areas (Ciaghi & Villafiorita, 2016; Farr-Wharton et al., 2014).

Differences in population density, economic concentration, and digital infrastructure across Prague, Warsaw, Krakow, and Brno shape both opportunities and challenges for FSA adoption. In Prague, a service-driven economy—centred on finance, IT, tourism, and public administration—fosters a digitally savvy consumer base (Ouředníček et al., 2015). The presence of multinational firms, government agencies, and cultural institutions in central districts enhances digital readiness, supporting FSA adoption. High foot traffic and economic activity further drive demand for efficient food waste management, making FSAs a practical solution for both environmental and consumer needs. In contrast, Brno's economy, driven by high-tech industries, research institutions, and manufacturing, fosters digital engagement but remains more decentralized than Prague, leading to regional disparities in FSA adoption (Sýkora et al., 2000). While central areas show higher FSA participation, peripheral districts with lower economic density face challenges in digital integration. This technological orientation creates a favourable environment for digital applications; however, the more decentralized nature of Brno's employment and the lower concentration of service-oriented jobs compared to Prague may lead to regional disparities in FSA adoption. In Brno, central areas tend to show higher engagement with FSAs, while peripheral districts—characterized by less dense economic activity—might face challenges in digital integration and consumer participation. In Krakow, the Old Town's dense food scene supports FSAs primarily for commercial gain, whereas districts like Nowa Huta and Prądnik Biały rely on strong local food networks but need policy support for FSA integration. Digital readiness also varies—young professionals in central areas adopt FSAs readily, while older residents in districts like Nowa Huta and Bieżanów-Prokocim may require targeted engagement. Krakow's economy, like Warsaw's, benefits from a strong service sector, but tourism plays a larger role in shaping consumer habits (Sobala-Gwosdz et al., 2024). The presence of universities influences food consumption trends, as students represent a key demographic for FSAs. However, economic disparities between districts impact the availability and adoption of food-sharing solutions.

In Warsaw, Krakow, and Brno, we observe the emergence of hotspots for FSA outside central districts. Zabłocie in Krakow, once an industrial area, has undergone significant transformation and is now a part of the city's innovation-driven urban regeneration, contributing to its development as a "naturally occurring innovation district" (Morawska et al., 2021). Zabłocie is home to new residential complexes such as Riverside, Tarasy Wiślane, and Cordia, attracting a dynamic population, including young, well-educated professionals who are beginning their careers and establishing families (Płaziak, 2019). The influx of residents into Zabłocie mirrors the urban shift toward knowledge-based industries and innovation ecosystems, driven by the growing demand for sustainable, modern living spaces. This trend is not only a response to residential needs but also aligns with broader socio-economic changes, such as the rise of higher education and the flourishing of creative and high-tech industries (Sałański, 2009). As these young, well-educated individuals settle in Zabłocie, they increasingly seek modern amenities, such as FSAs, to reduce food waste and support sustainability. Białołęka in Warsaw, like Zabłocie in Krakow, is undergoing significant urban regeneration and development, with new housing estates such as Osiedle Głębocka and

Tarasy Dionizosa attracting young, well-educated residents (National Statistical Office in Warszawa, 2023). The growth of FSAs in these areas highlights how catering facilities are adapting to both residential demand and urban regeneration initiatives, facilitating more sustainable consumption practices. This pattern of innovation and sustainability is closely tied to the shift in lifestyles and social behaviour seen among educated young people (Jaska et al., 2024), whose preferences for cutting-edge, socially responsible solutions like FSAs might reshape urban development.

Several districts lack FSA coverage, suggesting local catering facilities are not utilizing this technology to mitigate food waste, though it remains unclear whether these establishments employ alternative food waste reduction strategies not captured in our analysis. While reasons remain unclear, FSAs may not align with business models or operational needs, similar to concerns about delivery apps reducing profits (Dunn, 2018). Barriers include low demand, food safety concerns, and lack of integration knowledge (Too Good To Go, 2020). Limited FSA presence occurs mainly in peripheral areas with fewer catering facilities. Consumer adoption depends on perceived usefulness and ease of use, while risk concerns reduce engagement (Fraccascia & Nastasi, 2023). Further research is needed to identify barriers to wider FSA adoption, which could improve food access equity and expand waste reduction efforts.

To enhance suburban FSA access, effective strategies include business partnerships with community centres and logistical innovations. These approaches can streamline distribution while addressing challenges of lower population densities. Too Good To Go has successfully partnered with FoodCycle Los Angeles and Shell in Poland (Too Good To Go, 2024), demonstrating how such collaborations can improve food availability in suburban areas.

FSA-shared food reflects urban waste patterns, with pastries and desserts dominating, followed by ready-to-eat meals and short-shelf-life items. Bakeries often produce in excess to meet unpredictable demand, creating a surplus suitable for FSA distribution. Restaurants similarly share forecast-based surplus meals at discounts to reduce loss. Short-shelf-life products are shared near “best before” dates, while made-to-order items like pizza and sushi appear less frequently.

Analysis of FSA data reveals establishments using these apps exist in both central metropolitan districts and residential peripheries, providing food waste reduction tools to diverse urban residents. This suggests pro-environmental attitudes among business owners, with younger generations (Millennials and Gen Y) likely being primary users. The rapid uptake indicates strong demand, consistent with findings from Choi et al. (2019), Ganglbauer et al. (2014), Mazzucchelli et al. (2021), and Schanes and Stagl (2019).

7. Conclusions

The analysis of FSAs in Warsaw, Krakow, Prague, and Brno highlights key patterns in spatial distribution and adoption. FSA usage is highest in multifunctional city centres with dense food service activity, showing a clear central-to-peripheral gradient. Expansion into peripheral areas could further enhance food waste reduction and access to discounted food. Polish cities show higher adoption rates (Warsaw 22.7%, Krakow 32%) than Czech cities (Prague 2.4%, Brno 9.6%), reflecting different market maturity levels. Pastries (29%) and desserts (28%) dominate shared food types, with opportunities to expand prepared meals (18%) and short-shelf-life products (16%). FSAs are also emerging in revitalized residential areas, especially in Warsaw and Krakow, indicating growth potential beyond city centres.

The topic of FSAs' role in mitigating food waste, with examples from Poland and Czechia, presents several potential theoretical, practical, and managerial implications. FSAs play a transformative role in mitigating food waste, shifting from linear food supply models to network-based redistribution systems (Harvey et al., 2019). This challenges traditional food supply chain theories by emphasizing decentralized, tech-mediated interactions and innovation in food waste management (Harvey et al., 2014, 2019; Mazzucchelli et al., 2021). Additionally, using GIS tools to analyze spatial food waste distribution offers new insights into the impact of urban socio-demographic factors, adding complexity to urban sustainability theories.

FSAs provide practical, scalable solutions for reducing urban food waste by connecting surplus food with consumers, adaptable to cities with similar socio-demographic profiles. Optimizing their deployment through spatial and consumer behaviour analysis can enhance effectiveness, especially in underserved areas. Consumer attitudes should guide app design and engagement strategies to expand reach. By tailoring interventions based on spatial and behavioural data, FSAs can more effectively address food waste challenges in urban environments. For policymakers, promoting FSA adoption involves business incentives, grants, designated food-sharing spaces (as in Warsaw), educational campaigns, and integrating FSAs into urban food policies. Additionally, educational campaigns and integrating FSAs into urban food policies can raise awareness and ensure equitable distribution across city districts. Creators of the FSA should expand beyond bakeries and cafes, target suburban areas with tailored marketing, offer features like longer pickup windows, and partner with local business associations to address low-participation zones. Managerially, FSAs help businesses reduce waste, generate revenue, and enhance CSR efforts, strengthening their brand image and aligning with sustainability goals. For urban planners, understanding spatial food waste dynamics supports targeted interventions. Overall, FSAs play a key role in advancing urban food waste reduction and sustainable food systems.

A limitation of this study is the lack of a deeper analysis of the benefits, drawbacks, and motivations behind FSA participation. While we examine spatial distribution patterns, understanding varied motivations remains crucial, as some businesses join FSAs for ethical reasons while others pursue financial gain, potentially creating tensions and mismatched expectations. Future research should explore common drivers encouraging businesses to support food waste reduction while balancing ethical and economic goals.

Open questions remain about FSAs' role in food sharing and what motivates catering entrepreneurs to join, especially those valuing pro-environmental responsibility. Future research should explore evolving motivations and the impact of cultural and regulatory contexts. The clustering of gastronomic facilities suggests policy diffusion, warranting comparative studies. Insights could highlight shared motives balancing ethical and economic goals, encouraging wider adoption by businesses and consumers in reducing food waste.

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Conflict of Interests

The authors declare no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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