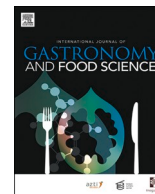# Central Lancashire Online Knowledge (CLoK)

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The rise of dark kitchens: Characteristics and operational challenges

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ABSTRACT

The dark kitchen model has gained popularity in recent years, with many choosing this model over traditional dine-in restaurants or takeaways. Despite its popularity, there remain limited studies on this type of food business operating model. This study aims to investigate why food business operators choose to adopt the dark kitchen model and the lessons learned from their operational experiences. An online survey was conducted among 123 Environmental Health Officers (EHOs) based in Local Authorities in England. Sixteen semi-structured interviews with dark kitchens were conducted of which 12 were dark kitchen tenants and 4 dark kitchen owners. The primary reasons for choosing this model include affordability, flexibility, and convenience. Social media platforms and online aggregators are essential for dark kitchens to advertise their food. However, some inconsistencies between different online aggregators occur when onboarding. A key issue raised by participants were the challenges of managing food safety and hygiene practices in shared spaces where several food businesses utilise the same space or resources. Other challenges faced when operating the dark kitchen model include competition, dependence on online aggregators, commission fees, and lack of visibility. In conclusion, the dark kitchen model presents both advantages and challenges for dark kitchen operators. While it offers cost-effectiveness, flexibility, and convenience, it also presents its own set of challenges. The operational challenges identified in this study offer practical implications and lessons learnt from dark kitchens' previous experiences of starting a delivery-only food business. The challenges outlined should be considered by policymakers, online aggregators and dark kitchens to support the development of more comprehensive guidelines and standardised practices.

1. Introduction

Dark kitchens refer to the lack of physical storefronts and dine-in areas and is one of the many names used to describe this model of food service (Khan, 2020). However, the name itself suggests hidden or clandestine operations and many will naturally associate this concept with negative connotations (Hakim et al., 2022). Dark kitchens operate under multiple different names which are used interchangeably, including ghost kitchens, cloud kitchens, virtual kitchens, shadow kitchens and cyber kitchens (Khan, 2020; Chatterjee et al., 2022). They include a range of food businesses including but not limited to fast food businesses, takeaways, cafes and pubs (Rinaldi et al., 2022).

The food industry is struggling with the variety and ambiguity of dark kitchens, as they encompass various operational models (Khan, 2020). One example is the 'home based dark kitchen.' This type of model is located in residential buildings such as houses/apartments as opposed to dedicated commercial spaces. This model is gaining much popularity

as it serves as a means of increasing income for individuals from the comfort of their own homes (Hakim et al., 2023). Rented dark kitchens are commercial kitchen facilities that are leased or rented by food businesses, with fully equipped necessary appliances. This model can be divided into two types, i.e., the first is the 'independent dark kitchen' which are rented exclusively by one brand and where the restaurant itself controls the entire process of receiving, producing and delivering the food. The second is the 'shared dark kitchen' where multiple food businesses offering multiple different cuisines will share the same location and often the same equipment (Rinaldi et al., 2022; Giousm-pasoglou et al., 2023; Shapiro, 2023). The concept of dark kitchens is constantly evolving to meet the ever-changing demands of the consumers. Despite the many different names and differences in their operational models, dark kitchens all share one common concept – food preparation facilities providing a delivery-only service. According to Nield et al. (under review), dark kitchens are defined as 'a tech-enabled commercial kitchen(s) operating primarily for delivery, to fulfil remote,

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on-demand, consumer online orders of food for immediate consumption.'

Dark kitchens have gained significant appeal for both consumers and operators alike, due to their many benefits. For the consumer, this type of food model offers convenience, a diverse menu selection, speed, accessibility and customised services (Khan, 2020). One of the main attractions for operators is the lower operating and maintenance costs in comparison to traditional restaurants. With no physical storefront, overhead costs of rent, utilities and staff are significantly reduced consequently increasing overall profit margins (Giousmpasoglou et al., 2023). Similarly, dark kitchens are typically located in low-rent areas further reducing costs. This in turn allows food businesses to maximise productivity and focus on efficiency to meet the growing demands for delivery services (Kulshreshtha and Sharma, 2022; Shapiro, 2023; Giousmpasoglou et al., 2023). Such cost saving measures enable dark kitchens to offer lower prices to their customers. In addition to this, the delivery only dark kitchen model offers flexibility such as the potential to offer different cuisines under multiple trading names, which means that food businesses can easily adapt and quickly respond to changes in consumer preferences, consequently increasing custom (Giousmpasoglou et al., 2023). Therefore, it is no surprise why a significant increase has been seen globally in dark kitchens. In fact, it is predicted that by 2030 dark kitchen models will make up 50% of all foodservices worldwide (Statista, 2023).

Most published studies to date have focused on identifying dark kitchen typologies, such as those presented by Hakim et al. (2023), who identified six different models of dark kitchens (e.g., independent; franchise; home-based etc.). Ashton et al. (2022) illustrated the typology for ghost (dark kitchen) production which captures the various sub-elements involved in food production process. Hakim et al. (2023) also examined the location and type of meals sold in Brazilian urban centres, revealing that dark kitchens were more dispersed and located further away from central urban areas. The most common foods offered by dark kitchens included local food, international cuisines, fast food, snacks and desserts (Hakim et al., 2023; Rinaldi et al., 2022; Vu et al., 2024). As dark kitchens are an emerging phenomenon, studies have sought to define this operating model, such as those by da Cunha et al. (2024) and Nield et al. (under review). Consumer awareness and willingness to buy from dark kitchens were explored by Hakim et al. (2022), who found that while more than 70% (n = 623) of participants had heard of the term 'dark kitchen', most could not describe what a dark kitchen is. However, they were willing to buy from dark kitchens due to their perceived sense of solidarity with the food service sector (Hakim et al., 2022). Additionally, studies by Vu et al. (2023, 2024) examined the resources, experiences and success factors within the dark kitchen industry. Some of the key contributors to success include cooking skills, sales & marketing skills, ability to understand product related demands and being adaptable and willingness to learn. Building on the existing literature, it is evident that while research has explored the definitions, typologies, location, consumer perceptions and success factors of dark kitchens, there remains a significant gap in understanding the motivations behind adopting this business model, the procedures involved in setting up a dark kitchen and operational challenges faced by food business operators.

This study aims to address these gaps by exploring the reasons food business operators choose to adopt the dark kitchen model and the lessons learned from their operational experiences. Specifically, it seeks to answer the following research questions (RQ) through semi-structured interviews with dark kitchen operators.

RQ1: Why do you choose to operate your food business based on a dark kitchen model?
RQ2: What are the procedures for starting a dark kitchen business?
RQ3: What are the challenges faced when operating the dark kitchen model?

In addition to understanding the reasons, setup procedures and operational challenges of dark kitchens, food safety remains a critical concern for operators, consumers and regulatory bodies. Previous studies have highlighted consumer concerns about the hygiene standards of dark kitchens (Cai et al., 2022) with perceived food safety being a key factor influencing purchasing intention (Hakim et al., 2022). More recently, Laheri et al. (2025) explored the challenges of ensuring food safety, particularly in shared dark kitchen spaces where multiple food business operators use the same premises and facilities, as well as food safety during the delivery process. These findings highlight the complexities of regulating and ensuring food safety in dark kitchens. Given these concerns, this study also aims to answer the following research question by conducting an online survey with Environmental Health Officers.

RQ4: What are the challenges faced by Local Authorities in relation to dark kitchens?

2. Methodology

2.1. Online survey with environmental health officers

The methodology was based on Laheri et al. (2025). A cross-sectional online survey was conducted among 123 Environmental Health Officers (EHOs) based in 91 Local Authorities in England. The online survey was distributed through the Local Government Association (LGA) and Environmental Health Officers' online forum. Qualitative responses from EHOs to the survey question "Can you describe any examples of problems that you have experienced when inspecting dark kitchens?" were thematically analysed, coded and grouped into relevant themes.

2.2. Online semi-structured interview with dark kitchen operators

The semi-structured interview topic guide was checked for face and content validity with the research team. For face validity, the team reviewed the guide for clarity and ensured that the questions were appropriate for dark kitchen operators. For content validity, one dark kitchen participant was recruited to a pilot semi-structured interview test and the guide was shared with our Patient and Public Involvement and Engagement (PPIE) group. The dark kitchen operators were recruited from social media and interested participants were provided with participant information sheet and informed consent were obtained. Sixteen semi-structured interviews with dark kitchens were conducted of which 12 were dark kitchen tenants and 4 dark kitchen owners (including home-based owners) (Table 1). The semi-structured interviews lasted 30–45 min and were conducted using MS Teams. A copy of the semi-structured interview is available in Supplementary Material 1. The confidentiality and voluntary participation were emphasised to dark kitchen operators prior to starting the interviews. The study received ethical approval from the NHS Health Research Authority, granted by the London – Fulham Research Ethics Committee (24/PR/0280).

2.3. Thematic analysis

All online interviews were recorded and transcribed. Thematic analysis was used to analyse the data based on Braun and Clarke's six step framework (Braun and Clarke, 2006). This method was selected as it provides a systematic approach to identifying and analysing the themes within qualitative data. It also allows for inductive approach to explore themes that emerge from the data. In step 1, the process involved reading and re-reading the transcripts to familiarise with the data. Next, initial codes were generated from the data using Nvivo 14 where all transcriptions were imported into the software and categorised into relevant groups. Each transcript was reviewed to ensure no data were overlooked, while employing an inductive approach. In step

Table 1
Challenges faced by Environmental Health Officers when inspecting dark kitchens (n = 123).

No.	Items	Frequencies (%)
1	Years working as Environmental Health Officer	
	1–5 years	24 (19.5)
	6–10 years	12 (9.8)
	11–15 years	14 (11.4)
	More than 15 years	73 (59.3)
2	Have you inspected a dark kitchen?	
	Yes	94 (76.4)
	No	29 (23.6)
3	What are the challenges faced by your Local Authority when inspecting a dark kitchen?[a]	
i	Uncertain or sporadic operating hours which makes unannounced inspections difficult	83 (67.5)
ii	Several different food businesses sharing the same kitchen space at the same time	74 (60.2)
iii	Same food business operator registered with different brand names using the same kitchen space	74 (60.2)
iv	Several different food businesses sharing the same kitchen space but operates at different times	73 (59.3)
v	Dark kitchens that purchased from other food businesses and sells the food	43 (35.0)

[a] Participants could select more than one response.

3, the initial codes were grouped into potential themes, followed by step 4 which involved reviewing and refining the initial themes to form more comprehensive themes and sub-themes. In step 5, the themes were clearly defined, and thematic maps were created to provide a visual representation of the themes. The final step was writing up the results.

3. Results

The online survey received 123 responses from 91 Local Authorities in England. EHOs faced challenges when inspecting the dark kitchens (Table 1). The biggest challenge expressed was the uncertain or sporadic operating hours which make it difficult for EHOs to visit and inspect the dark kitchens. Another main challenge was the inspection of shared dark kitchen space. For example, several different food business operators that use the same dark kitchen space at the same time. This makes the inspection more challenging, especially in determining responsibilities and how the staff from different FBOs ensure hygiene, especially in communal spaces. Meanwhile, the inspection of several different food businesses sharing the same kitchen space but operates at different times posed a challenge as it increases the number of visits to the same premises.

Table 2 details the demographic characteristics of the dark kitchen operators (n = 16).

3.1. Qualitative findings – dark kitchen operators

3.1.1. Why choose the dark kitchen model?

The dark kitchen model has gained much popularity in recent years and many are opting for this model over the traditional dine in restaurant. Following a series of interviews, dark kitchen owners and tenants highlighted their primary reasons for choosing this food model, which were categorised into two main themes (Fig. 1). Firstly, the affordability of dark kitchens was consistently mentioned by participants. Participants felt that this model provided a cost-effective way to start and grow a food business, in particular for those with limited resources. Although many aspired to open a traditional restaurant, the high costs and manpower associated with this model was a deterring factor. Rather the dark kitchen model offered a means of entering the food industry without the significant financial burden of opening a traditional restaurant.

Table 2
Dark kitchen participants (n = 16).

| Participant Number	Location	Tenant/Owner
Dark Kitchen 1	Multiple DKs – Manchester, London	Female (Rented DK)
Dark Kitchen 2	London	Male (Rented DK)
Dark Kitchen 3	London	Female (Rented DK)
Dark Kitchen 4	Birmingham	Female (Shared DK)
Dark Kitchen 5	London	Male (Shared DK)
Dark Kitchen 6	Southampton	Female (Rented DK)
Dark Kitchen 7	Plymouth	Female (Rented DK)
Dark Kitchen 8	Multiple DK's - Birmingham, Manchester, London	Female (Multiple DK's – Rented, Owned and Shared)
Dark Kitchen 9	Bristol	Female (Shared DK)
Dark Kitchen 10	Leicester	Male (Shared DK)
Dark Kitchen 11	Portsmouth	Male (Shared DK)
Dark Kitchen 12	Manchester	Male (Owner of DK)
Dark Kitchen 13	London	Male (Owner of DK)
Dark Kitchen 14	Liverpool	Male (Home Based DK)
Dark Kitchen 15	London	Male (Rented DK)
Dark Kitchen 16	Peterborough	Male (Home Based DK - *previous experience of sharing a DK*)
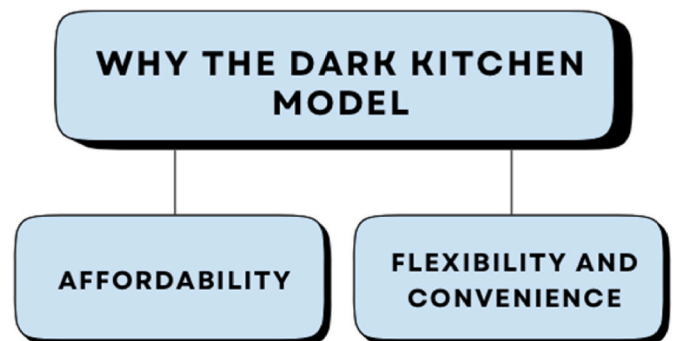
Fig. 1. Why choose the dark kitchen model?.

Well, the dark kitchen, it's much easier to set up and you don't need much capital to start the business (DK 5, Tenant, London)

Because starting a restaurant is quite expensive and it involves more manpower and labour. So, it's something I couldn't really afford at the time (DK 16, Home-Based, Peterborough)

Secondly, dark kitchen owners and tenants repeatedly emphasised the flexibility and convenience which dark kitchens offered, thus making them more appealing. This included the ease of setting up in non-prime locations and operating during unconventional hours to meet late-night demands. It was further mentioned how this model can accommodate individual circumstances allowing individuals the option of working from home and balancing personal commitments.

And we also do late night, so some of our locations operate until 2 am (DK 1, Tenant, Multiple DKs)

I'm a single parent, so that was one of the preferences why I decided to run a home-based dark kitchen. (DK 14, Home-Based, Liverpool)

3.1.2. Renting a dark kitchen

In particular for the dark kitchen concept, the practice of renting a premises to produce food for delivery-only services has become increasingly prevalent. Of the 16 participants who took part in this

study, 12 were renting spaces for their dark kitchen food business. The primary reason for opting for this type of operating model included reduced costs and financial flexibility especially when sharing the premises with another food business.

> *It doesn't have to be in a primary location. It doesn't have to be on a high street. You're probably not in the most polished environment but it's food safe (DK 1, Tenant, Multiple DKs)*

> *Well, it was quite affordable because since it was shared, so we have to share the rent equally (DK 16, Home-Based (with previous experience of sharing) Peterborough)*

3.1.3. The procedure

Participants also shared their experiences on the procedure for renting a dark kitchen space. This includes (i) finding a suitable space; (ii) engagement and communication with landowners or agents; and (iii) contract negotiation and licensing documents.

3.1.3.1. Finding a suitable space.

This involved various steps including firstly finding a suitable space. Participants mentioned how they initially searched online platforms and used personal networks to gauge information on available rental spaces that met their business needs and complied with health and safety regulations. Affordability was also key in finding a suitable space.

> *I did a lot of research for space ... actually I asked some friends. I also checked online through social medias and other websites. (DK 4, Tenant, Birmingham)*

> *Well, it was quite affordable because since it was shared, we have to share the rent equally. Before I came, it was on the high side since he was paying it alone. (DK 16, Home-Based [with previous experience of sharing], Peterborough)*

> *The rent is a bit on the high side, but it's manageable and something I could afford (DK 11, Tenant, Portsmouth)*

3.1.3.2. Engagement and communication with landowners or agents.

After this, communication with landowners was a key step in the process of renting a space. The level of engagement varied among participants. While some dark kitchen tenants mentioned directly interacting with their landowners, others had no communication and instead interacted through intermediaries or shared partners.

> *We kind of had a meeting, we had an agreement on how to maintain hygiene and food preparation safety. Even the landowner was also present in the meeting so that we were able to make certain decision (DK 9, Tenant, Bristol)*

> *Communication with the landowner wasn't really something I did frequently, because most of the information I had was through an intermediary (DK 16, Home-Based, Peterborough)*

The responsibility of the landowners also varied widely among participants. While some specialised in providing kitchen spaces for the dark kitchen model, others were not as experienced. The level of existing infrastructure also varied significantly. In some instances, participants mentioned being provided with a fully equipped space, while other participants were required to bring in their own equipment.

> *You have everything in the spectrum. You have the landowner that maybe have domestic fridges in there with a couple of metal tables to like much more proper structure. So, we are partnering with one particular landowner who literally does this for a living. He looks for the location, sets them up, he knows how much power electricity is required (DK 1, Tenant, Multiple DKs)*

> *Yeah, actually, I was lucky enough. The landowner provided most of the things, so the things I brought were not that much. (DK 5, Tenant, London)*

> *The only thing the landowner did was just to provide the space and then make sure it had running water. It was up to standard. Every equipment we have to bring it ourselves. (DK 4, Tenant, Birmingham)*

Similarly, landowner's responsibilities differed. Some participants mentioned the proactive nature of their landowners who would readily address infrastructure needs; for example, power requirements and pest control. In contrast, some participants also highlighted the difficult relationship with their landowners, who were often reluctant in taking ownership of structural maintenance and issues such as severe pest infestations, leaving this responsibility with the dark kitchen tenants themselves.

> *In terms of the structure of the building, it depends if it's within the kitchen and it depends also that from the contract, the lease that you sign, you know there's all the clauses. So, the landowner may say you are responsible for, you know maintaining the premises clean and tidy. If there's any paint flaking, it's your responsibility (DK 1, Tenant, Multiple DKs)*

> *But the equipment was not up to standard and some of it were outdated and some were broken. So, I have to replace some personally because the landowner didn't say anything wrong with most of it (DK 3, Tenant, London)*

> *The ceiling completely opened, and it started raining through and that obviously is a landowner responsibility. But the landowner has constantly refused to fix it. When you go into these remote, a bit darker area and you know the landowners just want to make loads of money. They just want to rent it out and they just want to invest at least possible. So that's why it's really, really, important to choose a good partner (DK 1, Tenant, Multiple DKs)*

3.1.3.3. Contract negotiation and licensing documents.

Finally, a key aspect of renting dark kitchens also included negotiating terms and conditions of the rental agreement with the landowners. Dark kitchen tenants were able to verify the operational standards of the kitchen, ensuring structural standards were appropriate for their operational needs. This step also included potential dark kitchen tenants demonstrating their business legitimacy through showing their registration documents.

> *I contacted the providers which took me to the space. They gave me the rental rates and the terms of agreement. They gave me the review of the rental agreement which I went through carefully to understand the terms and conditions, and which include the renting duration, the payment terms and additional fees and charges (DK 15, Tenant, London)*

> *So, one of the processes was actually showing that yes, this is what I'm doing. I showed the registration and I also brought a lot of papers. There was a lot of paperwork. They had to confirm a lot of things. And I also had to verify if the space was good enough, if it had everything I would need and all of that.' (DK 3, Tenant, London)*

Much variability exists when renting a dark kitchen and it seems that this experience can be quite unpredictable. Due diligence on the part of the dark kitchen tenants is therefore necessary. They have an individual responsibility to screen potential landowners and rental spaces, to ensure that adequate infrastructure is in place and complies with health and safety regulations. Under article 3.3. of Reg 178/2002 it defines a 'food business operator' as "the natural or legal persons responsible for ensuring that the requirements of food law are met within the food business under their control" (Regulation No. 178/2002, 2002). Potentially, the FBO could seek to avail themselves of the due diligence defence, arguing that non-compliance was due to the fault of another

party if they could provide clear evidence of whose responsibility certain jobs were. However, if an FBO (in this case dark kitchens) knowingly operates under unsuitable conditions, it is unlikely that such a defense would absolve them of liability. Equally the terms of the contract must clearly define responsibilities and expectations. This proactive approach is fundamental in fostering a successful relationship with the landowners and thus driving food safety in all aspects of dark kitchen operations, consequently ensuring long-term success of the food business.

3.1.4. Use of online aggregators

Online aggregators are digital food ordering platforms such as JustEat, Ubereats and Deliveroo that aggregate menus from multiple providers or sellers such as restaurants, takeaways and dark kitchens in a single interface. It allows users to browse menus, compare options and place order for delivery or collection (Goffe et al., 2020). The reliance of dark kitchens on online aggregators is a significant aspect of the dark kitchen concept. This relationship allows for dark kitchens to efficiently manage orders, increase visibility and therefore, reach a broader customer base. As such, online aggregators are key in ensuring the growth and sustainability of dark kitchens. Our study found that our dark kitchen participants used a diverse range of online aggregators. This included Just Eat, Uber Eats, Deliveroo, Hungry Panda, Food Panda, Door Dash, Amazon Restaurant and Takeaway.com. From amongst each of these online aggregators, Just Eat and Uber Eats were the most frequently used platforms suggesting their effectiveness in meeting the specific needs of the dark kitchen operations. Despite the dominant use of Just Eat and Uber Eats, a variety of other platforms were also commonly used by the participants. Often dark kitchens will utilise multiple aggregators to maximise their visibility.

At the time of the study, our findings reveal some inconsistencies between different online aggregators when onboarding. Participants reported that some would conduct onsite inspections and there were also other onboarding requirements. In some cases, comprehensive criteria were demanded, including business registration, food safety permits, food hygiene ratings, contracts agreement, waste management protocols and documented training. Some online aggregators asked for only a subset of these requirements while others were limited to a commission fee. This varied approach by online aggregators suggests a lack of standardised method to onboarding on some of the platforms. Since online aggregators are not 'food business operators' but a digital food ordering platform, the responsibility for food safety lies with the FBO. The lack of legal obligation to ensure food safety prior to onboarding may have contributed to the inconsistencies when onboarding. Overall, the partnership between dark kitchens and online aggregators is one of necessity. However, the current lack of uniformity stresses the need for clearer guidelines and a greater level of consistency, in the hopes of improving and maintaining food safety standards across the rapidly growing dark kitchen sector.

3.1.5. Use of social media platforms

Dark kitchen owners and tenants frequently utilise social media platforms to advertise their food business. Social media is an invaluable tool for dark kitchen owners/tenants and participants in this study repeatedly highlighted the benefits. Participants mentioned the ease of directly communicating with customers and receiving customer feedback – both of which are essential in improving services, meeting standards and building trust, thus improving customer loyalty. Additionally, dark kitchen owners and tenants emphasised how social media was an effective advertising tool and as such, was beneficial in raising awareness of their food business and increasing visibility of their food brand, ultimately reaching and expanding their customer base.

People don't just buy from me because of what I sell, they buy from me because they feel comfortable and they trust that I know what I'm doing and they feel safe and that way I get customer feedback directly. So I

know how to improve and I know what customers expect and what they didn't like (DK 10, Tenant, Leicester)

My business could quickly be noticed or reached by a lot of people if I actually do more of posting on social media (DK 4, Tenant, Birmingham)

In this study, dark kitchen owners and tenants used Facebook, Instagram, Twitter and TikTok as the main social media platforms to communicate with their customers. Facebook was the most commonly used platform among participants, followed by Instagram and Twitter, while TikTok was not a popular choice for dark kitchen owners and tenants. These findings indicate a preference among dark kitchen owners and tenants for more established platforms like Facebook, Instagram and Twitter. Furthermore, they suggest how certain platforms are more effective and can maximise reach and engagement with existing and new customers.

3.1.6. Challenges experienced when operating the dark kitchen model

Despite the affordable, flexible and convenient nature of dark kitchens, this model does present numerous challenges. Dark kitchen owners and tenants outlined the main challenges they face and following thematic analysis, three themes and six sub-themes were highlighted in Fig. 2.

3.1.6.1. Attracting customers.

Dark kitchen owners and tenants mentioned difficulty in retaining a steady customer base when operating the dark kitchen model. This was due to the intense competition faced by owners and tenants, as dark kitchen becomes an increasingly popular model. This surge in competition therefore requires those operating dark kitchens to consistently perform at their best, providing a high standard of food and offering competitive prices in order to retain customers.

There are other people too that run the same business. So, there's more competition. Who wants to be the best, who has more client, who has more orders and that way you have to be doing so, it's more like you have to make sure that your price is favourable (DK 7, Tenant, Plymouth)

One of the major challenges is competition people doing dark kitchen businesses increasing daily and everyone is moving towards that direction. (DK 9, Tenant, Bristol)

The lack of physical visibility owing to the absence of a front-facing presence also poses challenges in attracting and retaining customers. Participants noted how their location, which was often hidden away with no clear signage made it difficult to reach customers and environmental health officers alike. Increased efforts in marketing were therefore needed to inform and convince customers, particular in the case of startups who were attempting to establish their presence amongst the growing food industry market. It also makes them heavily reliant on the online aggregators for their custom.

You know dark kitchen sometimes the fact that it's not visible to customers. They don't have a physical storefront. It it really makes it challenging to attract new customers (DK 15, Tenant, London)

I think marketing was actually a challenge and the visibility because when I started it was a bit difficult for me to market my product and make people know (DK 4, Tenant, Birmingham)

3.1.6.2. Dependence on online aggregators.

Dependence on online aggregators, though vital for this model to work, was also acknowledged as a significant challenge for the dark kitchen model. Participants mentioned two main reasons associated with using online aggregators.

i) Delays in Updating Online Platforms

One of the issues was the dependence on online aggregators for updating and communicating with customers through their platforms
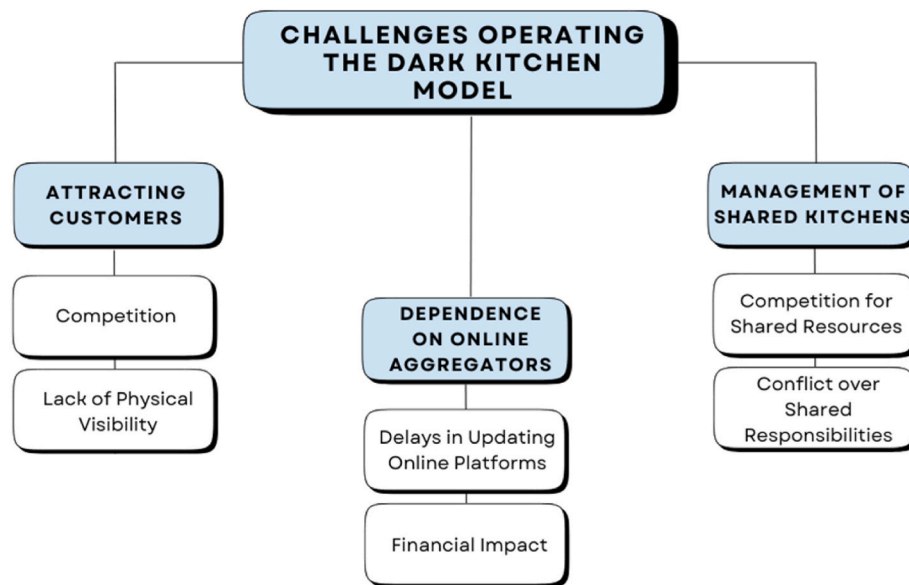
Fig. 2. Challenges associated with dark kitchen model.

and the variability in the speed of updates. While some online aggregators provide facilities such as app-based tools that enable rapid updates on allergen information or menu changes, others may experience delays ranging from as little as a few hours to several days. For example, Deliveroo offers onboarded FBOs to update allergen information using the *Menu Manager* which allows FBOs to add allergen information or to add tailored information to link to their own business and allergens information webpage (Deliveroo, 2024). Participants noted that when delays occur, they often resort to their social media channels to quickly inform customers of any changes. This adds to the operational burden of staff investing additional time in managing multiple communication streams to ensure consistency across platforms.

> *It takes longer time for it to be updated – around 2 days. That's why I don't completely rely on them. I also make my updates on social media handles that way. I'm directly informing my customers on the new developments (DK 9, Tenant, Bristol)*

> *Usually allergen free food issues where our delivery platforms are not really swift in updating and also making sure that information is being circulated so that also a major issue (DK 16, Home-Based, Petrborough)*

ii) Financial Impact

In addition to a lag time in updating key information, dark kitchen owners and tenants also felt that the financial impact of using online aggregators posed a challenge. Participants highlighted how relying heavily on these delivery platforms can lead to high commission fees. This coupled with operational costs of rent and utilities can adversely impact profitability, which in the long run can make sustaining dark kitchen operations a challenge.

> *You know, I often rely on 3rd party delivery platform for order fulfilment and customer acquisition and this resulted in high commission fees (DK 13, Owner, London)*

> *Managing this cost while maintaining profits, profitability has been quite challenging, especially for startups … I still incurred significant expenses for rent, utilities, equipment and staff management (DK 13, Owner, London)*

3.1.6.3. Management of shared kitchens. Many of the dark kitchens

noted the challenges of managing food safety in shared dark kitchens. Shared spaces include multiple food business operators using the space concurrently or at different times of the day/week. The challenges were due to shared resources and conflicts over responsibility pertaining to pest control and cleaning communal space. Collectively these issues can impact the ability to effectively maintain food safety standards and in some instances, participants mentioned how these difficulties prompted them to relocate or establish their own independent dark kitchens. The challenges highlighted in maintaining food safety in dark kitchens stresses the need for more robust management systems to allow for operational harmony in shared kitchen environments. Some participants mentioned how competition for equipment and storage spaces in shared kitchens further poses issues and adds to the operational complexities and increases the challenge to maintain efficiency and high food safety standards.

> *We had competition for kitchen equipment, storage space and all this. And sometime this results in temporary conflicts in coordinating operations and also there is limited controls. It gave me limited control over the kitchen environment, including cleaning standards. You can have maintenance and hygiene practices but still it also impacted the quality and consistencies of your food production (DK 13, Owner, London)*

> *Yeah, that was in the previous kitchen, which I shared. That was one of the reasons I had to relocate. The person I was sharing was not that hygienic and wasn't really cooperating at times … we had a lot of issues, pests, rodents and a whole lot of things (DK 11, Tenant, Portsmouth)*

When issues of pests or rodents arose in the case of shared spaces, prompt communication with the landowners and other businesses were required.

> *I just go to the landowner and to the other party and say we have a pest problem. So you either fix it or I'm going to call the local authority right now, and I'm going to expose you both (DK 1, Tenant, Multiple DKs)*

However, as demonstrated by DK1, it is possible to foster a collaborative approach when sharing dark kitchen spaces. This included establishing and enforcing clear ground rules and conducting regular inspections of premises. Participants mentioned how these practices fostered understanding and awareness among all parties and helped to ensure a safer food environment. This collaborative approach will not only enhance the enforcement of food safety regulations, but allow for continuous improvement of operations in dark kitchens.

But we have a location where we share it with another two food businesses. So that is all about how you manage the relationship with those businesses, and you know, how do you eliminate the risk of contamination, how do you manage hygiene? … I have spoken to the landowner and to the managers of each business. And we've literally set the ground rules (DK 1, Tenant, Multiple DKs)

3.2. Qualitative findings – environmental health officers

The findings below detailed the themes identified from the EHOs' responses to the qualitative question "Can you describe any examples of problems that you have experienced when inspecting dark kitchens?'

3.2.1. Challenges relating to dark kitchens

The unique nature of dark kitchens encompasses various concepts, which have led to many challenges. The challenges relating to dark kitchens as mentioned by environmental health officers (EHOs) were categorised into three distinct themes (Fig. 3).

3.2.1.1. Identifying the food business.
Local authorities rely heavily on the duty of FBOs' to inform them of the establishment of a new business via an online registration process. However, one of the primary issues concerning dark kitchens that were frequently highlighted by the EHOs was dark kitchens not being registered in their local authority. For instance, one officer mentioned how they would often receive *'complaints about businesses we have no previous knowledge of'* while another reported *'allegations made about food being provided from homes without being registered with the local authority'*. This lack of registration will hinder the ability of EHOs to monitor and regulate dark kitchens effectively. This in turn may increase the risk of food safety issues, as it will be harder to enforce food hygiene standards and ensure the compliance of food safety regulations.

It is important to note that the lack of registration is not unique to dark kitchens only. Dark kitchens posed an additional layer of complexity as these businesses do not rely on passing trade since they are located in places that are less visible thus making them much harder to identify. Additionally, EHOs have reported that many businesses operate under multiple trading names on online aggregators to reach more customer, thus making it more challenging to identify the business. This practice complicates the process of verifying whether multiple food businesses were operating from the same premises or whether a single

business was using multiple trading names. Investigating these scenarios also has significant resource implications for local authorities, further complicating efforts to ensure compliance and verify the existence of dark kitchens. Additionally, there is a lack of transparency from dark kitchens who often fail to provide adequate information and communication about their operations. As one EHO mentioned, *'Complaints regarding the fact that the dark kitchen wasn't included on the FHRS (Food Hygiene Rating Scheme) and that the customer could not verify whether the premises were actually registered at that time - the dark kitchen was only offering delivery and would not tell the customer where they were based.'*. This further adds to customer confusion and distrust in dark kitchen operations.

3.2.1.2. Food safety and operational issues.
Food safety concerns were also a major theme mentioned by EHOs. For example, there were reports of *'concerns in relation to poor hygiene – including undercooking,' 'lack of information provided regarding allergens,' 'foreign objects in food'* and *'alleged food poisoning.'*. These issues as outlined by the EHOs highlight significant challenges that need to be addressed to ensure the safety and trust of consumers. EHOs also outlined the operational issues of dark kitchens, which present significant challenges that undermine the food safety, transparency and overall customer satisfaction. Two primary problem areas were highlighted: (i) location and facility concerns, and (ii) delivery and service problems. Complaints in relation to location and facility concerns were common. Dark kitchens often operate from both unconventional and sometimes inadequate locations, which can raise numerous issues. EHOs mentioned complaints relating to dark kitchens operating *'from a cupboard off a stairwell'* and *'food delivery services being run from student accommodation … '* and *'operating out of a car wash.'*. These improvised set ups often will lack proper facilities further complicating compliance with food safety and health standards. Issues with delivery and service are also prevalent in dark kitchens. EHOs reported multiple complaints in relation to *'late deliveries, and 'cold food'*. These complaints in relation to the quality and condition of the food from dark kitchens reflects poorly on their delivery standards.

3.2.1.3. Community impact.
The final theme regarding complaints relating to dark kitchens was the negative impact on the community. This theme encompassed two sub-themes: environmental impact and the antisocial behaviour of riders/drivers. EHOs mentioned environmental concerns raised by landowners and neighbours, which included
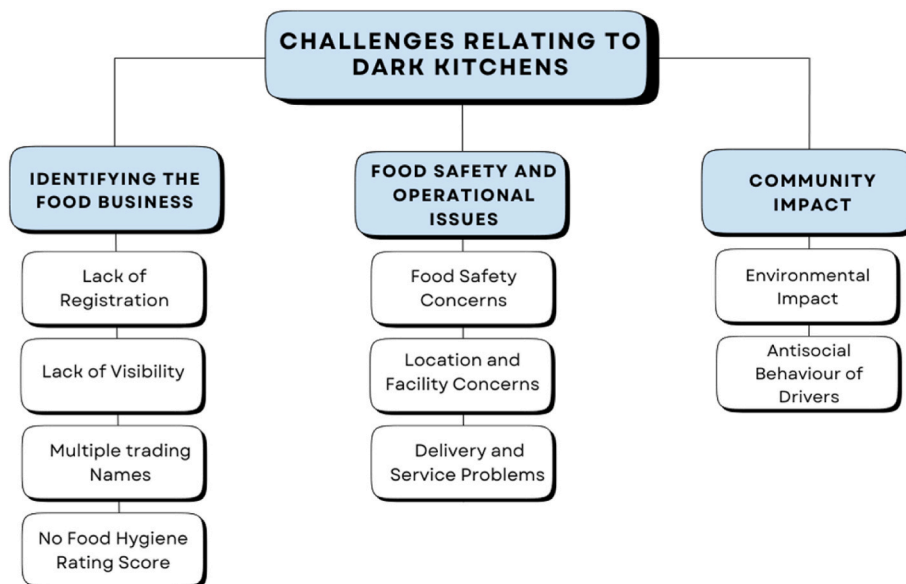
Fig. 3. Challenges associated with dark kitchens.

issues surrounding *'waste oil disposal,'* *'excessive waste build up'* and *'smells'* which consequently led to serious issues such as *'increased mice activity … and rats.'* The behaviour of delivery riders/drivers who are associated with dark kitchens also contributes to community concerns. Reports of *'nuisance from scooters,'* *'deliveries late in the evening'* and *'antisocial behaviour of drivers' (EHO, survey response)* will disrupt the peace and tranquillity of residential areas. This negative impact on the community further raises safety concerns and questions the responsibility of dark kitchen operations.

4. Discussion

The findings from this study provide a unique insight into the operational nature of dark kitchens. An understanding of the operational challenges and food safety concerns associated with dark kitchens was highlighted, from the unique perspectives of EHOs, dark kitchen owners and tenants. One of the primary reasons for the increased inclination towards opening a dark kitchen is their affordability and flexibility. According to Dephna (2024), the cost of renting a commercial kitchen space range from £750 - £3000 per month depending on size, number of kitchens, location and if additional facilities are required. For example, in London, the average cost starts at £2400 per month for a 380 sq ft kitchen unit (£2000) and a cold storage unit (£400) (Dephna, 2024). Both Rinaldi et al. (2022) and Hakim et al. (2023) also identified dark kitchens as an appealing option for those seeking flexibility. Ghazanfar et al. (2023) further mention how the rise of dark kitchens has accelerated post-covid due to the shift in consumer behaviour where more people are ordering food for delivery and staying home. The dark kitchen model offers convenience without the financial burden that is associated with a traditional restaurant. These findings align with existing literature that mentioned how operating dark kitchens can reduce overhead costs associated with maintaining a conventional restaurant or café in the high street (Li et al., 2020; Giousmpasoglou et al., 2023).

Despite the advantages that dark kitchens offer, the findings from this study highlight several critical challenges associated with the dark kitchen model. Participants in this study highlighted the stiff competition they face due to the dark kitchen model gaining popularity. In particular, competition in relation to customers and resources were mentioned by participants. Such challenges have also been highlighted by Kulshreshtha and Sharma (2022) who mentioned the importance of ensuring competitive prices and optimising dark kitchen processes to reduce costs – an essential aspect of allowing businesses to stay competitive in the growing food delivery market. These findings indicated that although dark kitchens offer financial advantages and increased operational flexibility, their increasing popularity naturally intensifies competition. This could potentially drive food businesses to operate at reduced hours, reduced investment in improving facilities and staff training. Dark kitchens may prioritise maximising profits at the cost of working conditions (Davies, 2021; Giousmpasoglou et al., 2023), which can further exacerbate these issues.

Additionally, one of the significant concerns mentioned in this study was the sharing of kitchen spaces. At present, no previous research has delved into the insights of how shared kitchen spaces impact the operational and allergen control in dark kitchens. Thus, this research contributes to filling the gap in our understanding of the unique risks and management needs in such environment. In the context of dark kitchens, the challenges of sharing spaces are likely to be amplified due to the lack of clear protocols and potential for allergen contamination due to lack of awareness of what dishes were prepared by other food business operators (FBOs). This challenge was echoed by EHOs in this study, especially as dark kitchen operators are more inclined to share spaces to reduce costs. Therefore, this highlights the need for more comprehensive and tailored guidelines on how to implement food hygiene practices in shared spaces and how to inspect units shared by multiple FBOs. A recent study by Na et al. (2024) revealed that the microbial and

chemical hazards of foods prepared in shared kitchen facilities were within the standard specifications and were significantly lower than regular restaurants. Their shared kitchen facilities also reported better hygiene management. The improved food safety and hygiene standards of shared kitchen facilities in Korea can be attributed to the stringent requirements mandated by Korea Food Sanitation Act. These include compulsory employment of a hygiene manager, completion of hygiene training at least once a year and mandatory insurance subscriptions. In the UK, FBOs are required to comply with the Food Safety Act (1990) which ensures that food is safe for consumption. FBOs must also adhere to Regulation (EC) No. 852/2004 on the hygiene of foodstuffs which was retained in UK law after Brexit which sets out the general hygiene requirements for FBOs. It is also a legal requirement for FBOs to register their business with their Local Authority 28 days before trading (FSA, 2024).

Likewise, the reliance on online aggregators was recognised as a key issue for dark kitchen operators despite it being an essential aspect of the model itself. This was namely due to the financial burden of onboarding and keeping consumers updated with key changes. These findings mirror that of previous research (Ghazanfar et al., 2023) and highlight the important role of online aggregators in 'aggregating' and facilitating the availability of food from multiple food businesses. This study further revealed how dark kitchen operators face variability in inspections and criteria when onboarding with aggregators. Just Eat requires a minimum FHRS rating of 3* and requires evidence that FBOs have registered with their local authorities before working with them. Just Eat also offers free, accredited food hygiene training to FBOs that sign up with them and offers a range of measures to help FBOs in improving their food hygiene standards (JustEat, n.d.; 2024). Deliveroo and Ubereats require a minimum rating of 2* to onboard with them (Deliveroo, 2024; Whitworth, 2021).

Additional challenges faced by dark kitchen operators included both attracting and retaining customers due to the lack of visibility owing to no physical store front. Moreover, the lack of customer feedback due to minimal interaction with customers made it difficult for dark kitchen operators to address customer concerns, build trust and improve services. This disconnection can make it increasingly difficult to establish a loyal customer base which can hinder efforts of successfully sustaining the dark kitchen model. These findings are consistent with previous research which found that dark kitchens may struggle to maintain consistent quality and customer satisfaction because of their inherent remoteness and limited interaction with customers (Belarmino et al., 2021; Jiang et al., 2024). The lack of direct customer interaction is a fundamental aspect of the model, yet it also represents one of its greatest challenges. This reinforces the idea that for dark kitchen owners and tenants, building customer trust and loyalty is a critical challenge which is exacerbated by the operational model.

While few studies have addressed the food safety of dark kitchens, some previous research has noted how dark kitchens face challenges in maintaining food safety (Crawford and Benjamin, 2019; Li et al., 2020; Belarmino et al., 2021), further suggesting that some dark kitchens struggle in implementing and maintaining food safety measures. Given that many dark kitchens rely heavily on online aggregators for their existence, online aggregators may have a role in ensuring all food businesses advertising on their platforms meet reasonable standards of hygiene. Although not a legal requirement for online aggregators, however such measures would protect consumer health.

5. Conclusion

Overall, this study provides important insights into the operational nature of dark kitchens operators. What is clear is that despite the appealing nature of dark kitchens and the significant advantages they can offer for businesses, this model also presents challenges. Key issues identified in the study was the unique challenges of shared kitchen spaces and different onboarding requirements of online aggregators that

could ranged from comprehensive criteria (e.g., onsite food safety inspections) to no other requirements other than payment of the commission fees. To ensure their sustainable and equitable growth in the food services, the challenges outlined should be considered by policymakers, online aggregators and dark kitchens to support the development of more comprehensive guidelines and standardised practices. Several practical implications are identified in this study. Firstly, it highlights the need for standardised inspection and food safety guidelines for dark kitchen operators especially in shared spaces. The guidelines will help Local Authorities to carry out inspections of multiple FBOs sharing the same premises. Similarly, standardised onboarding requirements with online aggregators will ensure consistency across the sector. Another practical implication is that dark kitchen operators may benefit from enhanced training on food safety practices, especially in maintaining hygiene in shared spaces. In this study only a small sample of dark kitchen owners/tenants took part – likely those who were more invested in food safety, while those with poor food hygiene practices may not have taken part. This limitation underscores the need for more comprehensive studies to address any potential gaps in compliance on the part of dark operators and consequently ensure that food safety standards are consistent across this sector of the food industry. Such studies could utilise a mixed-method approach and incorporate observational studies and microbiological analysis. It is recommended that further studies be conducted in identifying the food safety challenges of shared units to develop tailored guidelines in implementation of food hygiene practices and inspection procedures. With improved guidelines, dark kitchens can continue to provide flexibility and affordable foods while maintaining high food safety standards and operational efficiency, thus ensuring their long-term viability in food services.

CRediT authorship contribution statement

Zainab Laheri: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Iain Ferris:** Writing – review & editing, Supervision, Investigation, Funding acquisition. **Jan Mei Soon-Sinclair:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

Implications for gastronomy

The dark kitchen model showcased an innovative approach to gastronomy. This study has identified the key protocols for starting a dark kitchen business. The affordability, flexibility and convenience of dark kitchens are key attractions, but challenges such as dependency on online aggregators and resource sharing in shared dark kitchens can offset the benefits. The operational challenges identified in this study offer practical implications and lessons learnt from dark kitchens' previous experiences. Future dark kitchen professionals operating in shared spaces should establish clear agreements on roles and responsibilities of each food business operators within the shared space especially when sharing resources, equipment use, communal cleaning practices and pest control. This study also highlights the need for standardised inspection protocols and food safety guidelines for dark kitchen operators, particularly in shared spaces. These guidelines would assist local authorities in inspecting multiple FBOs operating within the same premises. Additionally, establishing standardised onboarding requirements with online aggregators would promote consistency across the sector. Addressing these operational challenges requires coordinated efforts between all stakeholders, including dark kitchen operators, local authorities and online aggregators.

Declaration of competing interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijgfs.2025.101142. Supporting documents are also accessible for review via the Open Science Framework (OSF): NIHR159200 Food safety in dark kitchens. https://doi.org/10.17605/OSF.IO/6EGR2

Data availability

Data will be made available on request.

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