2-29-2024

Rebel Foods' Cloud Kitchen Technologies: Food for Thought?

Saikat Lahiri
Indian Institute of Management Ahmedabad, saikatl@iima.ac.in

Indranil Bose
Indian Institute of Management Ahmedabad, indranil_bose@yahoo.com

Adrija Majumdar
Indian Institute of Management Ahmedabad, adrija@iima.ac.in

Rebel Foods' Cloud Kitchen Technologies: Food for Thought?

Cover Page Footnote

Rebel Foods' Cloud Kitchen Technologies: Food for Thought?

Saikat Lahiri

Indian Institute of Management Ahmedabad
saikatl@iima.ac.in

Indranil Bose*

Indian Institute of Management Ahmedabad
indranil_bose@yahoo.com

Adrija Majumdar

Indian Institute of Management Ahmedabad
adrija@iima.ac.in

Abstract:

This case study examines the India based cloud kitchens and food services provider Rebel Foods' technology platforms. We document the development of the company from its foundation in 2004 and the role played by technology in enabling its various lines of business. We describe in detail the technology stack that drives the operations at Rebel Foods. We also present various emerging technologies such as artificial intelligence (AI), machine learning (ML), robotic process automation (RPA), blockchain, and augmented reality (AR) that may be utilized by Rebel Foods to increase efficiency, build customer engagement, and improve sales growth and profitability. We critically examine Rebel Foods' current approach to technology and analyze the various technology options that the company may consider to drive its future strategy.

Keywords: Artificial Intelligence, Blockchain, Cloud Kitchen, Food Services, Machine Learning, Restaurants.

[Note: A teaching note in available upon request, please direct inquiries to Indranil Bose (*indranil_bose@yahoo.com*).]

1 Introduction

The global food and restaurant services industry is likely to double to over USD 5 trillion by 2029 (Plus Company Updates, 2022). In India, the industry was estimated at USD 41 billion in 2022 and is expected to grow to nearly 80 billion in 5 years (Business Standard, 2021). Rebel Foods, an Indian-born foodtech company, operated more than 450 cloud kitchens servicing 4,000 plus internet restaurants with over 40 brands in India and abroad. In an interview, Rebel Foods' CEO Jaydeep Barman said that the company's 'superpower' is, "Our operating system … it's a magical mix of culinary and technology"[1].

The Rebel Foods leadership believed that their kitchen and order management systems and supporting automation enabled them to start and scale new cloud kitchens very quickly and with minimal training needed for new staff. Their inventory management systems allowed them to optimize inputs and minimize stock outs. For delivery, apart from third party aggregators, Rebel Foods' own EatSure mobile platform hosted all of their available brands in a "food court on an app" model. Rebel Foods used digital and social media marketing heavily to build its brands. The firm leveraged analytics to decide on brand strategies and build operational efficiencies in its supply chain and used artificial intelligence (AI) and machine leaning (ML) to improve forecasting, quality control, and customer service. The tech platform "Rebel OS" enabled them to partner with other food entrepreneurs to host third party brands in their cloud kitchens, a model they dubbed Rebel Launcher.

Had Rebel Foods made the right investments in technology for their food services and cloud kitchen lifecycle (Financial Express, 2022)? Would their technology keep pace with the rapid addition of brands? As customers looked for food that matched their individual preferences, from vegan to keto, would Rebel Foods be able to bring a more personalized experience to discerning customers? How would they leverage emerging technology to chart their path forward?

2 The Faasos Story

In 2004, Jaydeep Barman and Kallol Banerjee [see Appendix A for an introduction to the people quoted in this case study] founded Faasos as a quick service restaurant (QSR) chain selling Indian wraps in the western Indian city of Pune. Their aim was to build a truly Indian food franchise along the lines of a McDonald's or a Domino's globally. They raised US$ 5 million series A funding led by Sequoia Capital in 2011 (Forbes India, 2016) and expanded Faasos to 18 outlets across 6 cities with their new headquarters in Mumbai. By 2014, Faasos had 50 locations in 8 cities, focused on small footprint restaurants with limited seating, and took orders mostly via phone for pickup or delivery.

2.1 The Internet Restaurant

By 2015, as local players Swiggy and Zomato started their food delivery businesses in India, Faasos already had their own website and mobile application for ordering. While their revenue and sales growth were good, they were struggling to be operationally profitable. Banerjee said,

> For a retail food business in India, the availability of high street locations was much lower than say, the US. In India, for Domino's, let's say, rent is 2 to 3 times as much of the cost structure as in the US. Good real estate is just not available.

A customer survey revealed that up to three quarters of the regular patrons had never seen a Faasos outlet. This led them to experiment with a "dark kitchen" model as a delivery only hub without a storefront or signage in Mumbai and Bengaluru. Sales continued to remain steady, costs came down and the kitchens quickly became operationally profitable, proving the viability of the model. Faasos decided to close its high street locations across the country and move to a delivery only model. To tap into a larger customer base, they partnered with food delivery aggregators in addition to their own website and app.

The new kitchens were bigger, located away from crowded high streets, at the back of buildings, and even on higher floors. Staff were focused on the kitchen tasks without the added responsibility of serving customers standing in line. Rebel Foods could open up a new kitchen rapidly since they did not need to scout for prime real estate or invest in seating, design, furniture, upholstery, and air conditioning for their customers. By the end of 2015, Faasos had moved completely to the Internet restaurant model without

---

[1] https://youtu.be/ojBhmaOKjwY

any physical storefronts. The same year, it raised an additional US$ 20 million in funding primarily from Lightbox Ventures and Sequoia Capital.[5]

2.2   Multi Brand Cloud Kitchens

From 2012 to 2016, Faasos launched new products such as pizzas in addition to their signature product, the wrap. However, none of the new products gained market acceptance. Customer surveys revealed that patrons associated Faasos with the wrap, and they went to the Faasos site or mobile app specifically to order wraps with prices usually in the range of INR 200 (approximately US$ 2.5). They began to appreciate that market segmentation in the restaurant business was not based on consumer segmentation. The same consumer might get a wrap for a quick lunch, order a pizza or a biryani[2] for a meal with friends and family in the evening, and, on occasion, go to an upscale restaurant for dinner. They considered the needs of each individual consumer as a food mission. Missions ranged from single or double service to large group meals along one dimension and regular meals to indulgent or luxurious meals along another dimension. See Figure 1 for a two-dimensional view of Rebel Foods' food missions.

To satisfy various missions, Rebel Foods decided to launch multiple brands from their existing cloud kitchens in 2016. Apart from menu items, recipes and culinary training which were internal to the brand, they created new packaging and marketing approaches for each brand. One of their successful new brands was Behrouz Biryani, branded "the Royal Biryani", an indulgent food mission targeted towards large groups. Oven Story Pizza, Sweet Truth for western desserts, Mandarin Oak for Chinese, Lunch Box for local lunch options, The Good Bowl for single bowl fusion dishes were some of their other popular brands. By 2020, the company, now branded Rebel Foods, was present in 35 Indian cities with over 300 locations and 9 brands.

2.3   Partner Brands and Rebel Launcher

One of the co-founders of Rebel Foods and current Head of Hosted and Acquired Brands Raghav Joshi said,

> Our endeavor was to target the leading twenty to thirty food missions. We wanted to be present in each. There were still several food missions in which we had no presence, such as sandwiches, coffee, ice creams, and Indian sweets. We asked ourselves if we needed to be in every space on our own? There were some rising brands with excellent product market fit and passionate promoters. Could we partner with them?

With this germ of an idea, they started an integrated offering titled "Rebel Launcher", where Rebel Foods provided their kitchen infrastructure, culinary development expertise, and full stack technology [see Figure 2] to help third party brands expand rapidly. SLAY Coffee, Natural Ice Cream, and Mad Over Donuts were some of their early Rebel Launcher partners. In late 2020, they penned an agreement with the American burger chain Wendy's to sell their products through internet restaurants across India, with a plan to open 250 locations over 3 years.

From 2019 on, Rebel Foods expanded into several new countries. They had 20 locations in the UAE and 25 kitchens in and around London in the UK. Some of their popular international brands included Sawa and The 500 Calorie Project in the UAE, Box and Chatori in the UK. By February 2023, Rebel Foods had 450 virtual kitchens in 70 cities globally, offering over 4,000 internet restaurants to customers with over 40 brands. Rebel Foods also invested in some of their partner brands such as SLAY Coffee and Biryani Blues.

Raghav Joshi said,

> Every restaurant is our competitor… Behrouz — we want it to be synonymous with Biryani. It competes with Biryani by Kilo, Paradise in Hyderabad, and Arsalan in Kolkata. Faasos has competition from Boxit, from roll stores in Kolkata, from Eat Side in Pune. Every region has their own favorite - on the supply side, with cloud kitchens Kitchen's Plus, Kitchen's@ in a few cities and others. Even Zomato and Swiggy have started their own cloud kitchens. Our differentiation is we don't just provide footprint. We are not like a landlord or mall operator. We also provide the full stack. We have our personal journey and experience of building brands and a cloud kitchen network. Others don't have that.

---

[2] An Indian dish made with highly seasoned rice and meat, fish, or vegetables.

3 Cloud kitchen Business and Operations

A cloud kitchen, also known as a ghost kitchen, dark kitchen, or virtual kitchen, was a commercial kitchen that operated solely for the purpose of fulfilling food orders for delivery or takeaway. Unlike traditional restaurants, cloud kitchens do not usually have a physical storefront, and customers only order from them via a food delivery app or website. According to some estimates, the cloud kitchen market could potentially grow to USD 1 trillion by 2030 (Restaurant Dive, 2020).

A cloud kitchen could be single brand or multi brand, sometimes even with associated dine in brands. Some of them reheated and finished precooked (from a central hub) or packaged food while some others cooked full meals on site. Compared to traditional restaurants, cloud kitchens usually benefit from lower overheads, faster food preparation, economies of scale in inputs and staffing, and the ability to scale faster with lesser capital and business risk. At the same time, the lack of recognized dine-in brands and the missing experience and ambiance of a restaurant made brand loyalty and stickiness a challenge. As more businesses adopted the cloud kitchen model, it became harder for individual cloud kitchen brands, especially those without any physical presence, to stand out.

3.1 Operational Considerations

3.1.1 Procurement, Inventory and Storage

Like any restaurant kitchen, a cloud kitchen needs a reliable and high-quality supply chain. The most important factors for choosing a vendor were the ability to deliver on time, as per demand, and at the right level of freshness and temperature. Since cloud kitchens, especially multi-brand ones, had more volumes than traditional kitchens, they were usually better placed to leverage economies of scale in their supply chain. The inventory management system should be integrated with the company's global enterprise resource planning (ERP) system and enable easy onboarding of new vendors. Vendor performance data collected by the system should be used to provide feedback to the vendors and, if needed, to blacklist them for repeated non-performance.

Most cloud kitchens had sophisticated inventory management software, with real-time integrations to the kitchen and order management systems for an instant view of demand. Purchase orders were generated based on forecasts using real-time data. Inventory was updated as and when delivery trucks came in. While manual data entry was still the norm, especially in developing countries, QR or bar code scanners and Radio-frequency Identification (RFID) based automated inventory updates had become more common to save time and reduce errors. Increasingly, as sustainable eating practices became more mainstream, inventory data included more detailed sourcing information (farm, field, and route) that established full traceability between farm and fork.

Once the inventory arrived it was stored in the appropriate storage containers. In some cases, vacuum sealing of inputs was necessary to ensure freshness and hygiene. Three temperature storages (frozen, chilled, and room temperature) were in use. Smart storage containers were equipped with sensors that detected temperature, humidity, and other environmental factors to ensure optimal storage conditions. These containers could also track inventory levels using RFID trackers and weighing scales. They were capable of providing alerts for unusual temperature fluctuations or when food was approaching expiration dates, thereby reducing waste, and helping staff to efficiently manage inventory.

3.1.2 Cooking and Kitchen Management

Cloud kitchens usually received orders that were passed through from food delivery aggregators that received orders on their mobile apps or websites. Some cloud kitchen providers also had their own ordering apps or websites. Orders made through all channels typically land on the home screen of a kitchen management software generally called a kitchen display system (KDS).

There were two common cloud kitchen setups, one with separate stations for each brand, and the other with common cooking stations handling multiple brands. In practice, many cloud kitchens operated as a hybrid of the two, with some brands given their own stations due to factors like heavy demand, specific cooking requirements, and chef skills, while other brands' menu items were cooked from shared stations. Cloud kitchens often had multiple types of cooking equipment ranging from cooktops and microwaves to industrial scale ovens, fryers, skillets, woks, and grills, depending on the range of cuisines served from the

kitchen and the degree of cooking done in the kitchen (see Section 3 above on cloud kitchen business models).

Some cloud kitchens ran using the old-fashioned manual model, where orders coming in on the kitchen management system were printed and given to a kitchen "pass" manager who instructed various line chefs on what to cook. Most used KDSs displaying incoming orders and their expected completion times. The software either automatically or through manual inputs from a supervisor allocated each order in whole or in part to various line chefs at cooking stations. Each line chef then prepared the item using the appropriate inputs and equipment, usually prompted by textual or audio-visual aids that ensured cooking was done consistently and correctly. Ingredients were weighed using scales so that the end product was exactly as promised to the customer. Once done, the line chef marked the item as cooked on the KDS.

The finished item was usually sent to the quality control station where a quality control specialist checked it for visual appeal, temperature, and weight. Next, the item proceeded to the packaging table where it was packed along with other items that were part of the same order and finally sent to the pickup point for a delivery driver or rider. The right packaging to keep food at the right temperature and freshness and prevent leakage during delivery was key to customer satisfaction. Once the item was handed over to a rider, the item would be marked as dispatched on the KDS and taken off the pending list.

3.1.3   Order Tracking and Delivery

The delivery rider picked up the order from the pickup point in the kitchen. The rider allocation software assigned the best possible rider based on their location, delivery destination, route maps, real-time traffic data, weather data, and forecast, the rider's vehicle, and ability to make three temperature deliveries. The rider was equipped with a mobile app that gave them a close estimate of the pickup time so that they could utilize their available time efficiently.

Routing software typically uses third party maps and real-time traffic information from services such as Google, Waze, or MapMyIndia to build route recommendations. Geocoding algorithms were used to identify locations precisely, especially in crowded urban zones. Customer instructions, such as floor details, entry information, and directions on calling or ringing the bell were typically integrated into the delivery software. Routes were usually optimized for minimizing fuel costs and maintaining timeliness of delivery. The rider was prompted by visual maps and audio cues to guide them to the destination safely and quickly. In multilingual societies, the ability to provide instructions in multiple languages was a priority. Once delivered, the driver marked the order completed.

3.1.4   Customer Feedback and Support

Customer feedback and complaints were usually collected via the customer facing ordering platform. For third-party aggregators, this would be fed back through the customer service division of the cloud kitchen operator. For large cloud kitchen providers, they were typically routed to the centralized customer relationship management (CRM) system of the company and addressed via established escalation matrices. For small standalone cloud kitchens, customer feedback and complaints were usually handled directly by the kitchen or restaurant staff. Most commonly, customer feedback was first handled by automated chatbots.

3.1.5   Staffing and Skilling

Most cloud kitchens were set up to run with minimal staff, who were used across brands and dishes. While manual allocation of cooking tasks on the KDS was still commonplace, analytics driven algorithms were increasingly used to automatically assign tasks to stations and optimize the time of each line chef. Such algorithms took daily ordering trends, inputs on events, and weather into consideration to predict loads by menu items, while allowing the kitchen to determine their overall staffing plan and shifts in an economic manner.

Training for line chefs, team leaders, and managers was a key consideration for running a cloud kitchen efficiently. Most companies use a combination of centralized training facilities and on-the-job training in live kitchens to bring their staff up to speed. The use of modular, standardized, and fully documented recipes and kitchen processes helped reduce training time substantially, as did the use of kitchen automation, robotics, and audio-visual aids during the cooking process.

4   Emerging Technology

AI and ML algorithms were increasingly being used to personalize customer experiences, predict demand, forecast inventory needs, and control internet of things (IoT) enabled kitchen and supply chain automation. Digital twins (DTs) were used to virtually model and optimize kitchen workflows while robotic process automation (RPA) helped automate legacy applications. Blockchain distributed ledgers were providing greater transparency and traceability along the food services supply chain and augmented reality (AR) was aiming to bring the customer closer to the food preparation process.

Fully autonomous restaurants had been launched and autonomous food delivery was being piloted. Food services companies across the globe have embraced emerging technology to transform customer experience, improve efficiency and profitability, and achieve nonlinear growth. See Appendix B for a more detailed outlook on the emerging technologies in the food services business.

5   Rebel OS

Over the years, Rebel Foods continued to invest in technology. The company was always an early adopter, taking orders on Twitter in 2013, as well as developing web-based and mobile app-based ordering by 2015. Raghav Joshi said, "*We understood quite early that our problems were unique and needed unique solutions. We put together chefs and technology experts to create a "transformer" team to address some of these problems*". The transformer team was tasked with building software, hardware, and infrastructure to create a platform that combined kitchen equipment, robotics, and automation with software applications to manage and track every process from supply chain to delivery. They examined various out-of-the-box software solutions but did not find anything with the capabilities that they were looking for. Therefore, they developed the entire stack of software in-house, apart from their customized SAP ERP system which was integrated with their culinary stack.

Rebel Foods dubbed their culinary processes, technology, and supply chain expertise Rebel OS, which consisted of three components, namely, full-stack technology from inventory and kitchen management all the way to demand management and fulfillment, robust supply chain capabilities for sourcing, warehousing, and moving input materials safely in any shape and form, and culinary expertise and capabilities to break down menus into small SOP-driven steps that did not require any additional skill.

Chief Technology Officer Amit Kumar Gupta said,

> We also have several horizontals. Our data scientists work with different verticals to solve problems How do you cross-sell or up-sell for demand generation and how do you optimize the supply chain and inventory? In food, we have sales plus delivery parameters. Efficient usage of riders on the logistics side is key. We have forecasting models for each vertical to provide a real-time view of data. We have many dashboards across verticals and so decision makers can slice and dice data. Brand managers can change discounts and prices at the click of a button. Of course, we have an audit trail for financial reconciliation and compliance.

5.1   The Three Pillars of Rebel OS

The first pillar of Rebel OS was culinary innovation to craft menus and products suited to the food missions, with customized recipes by region for varying dietary habits. They broke down each of their product recipes into a series of repeatable steps. This modularization of the cooking process also lent itself to automation.

The second pillar of Rebel OS consisted of their kitchen management technology. The core of this was the kitchen management software supported by a set of IoT-enabled automation tools. A smart fryer that was able to determine cooking time, temperature, and the volume of oil released based on the item being cooked, was one such tool. Another was an automated wok, which rotated and tossed the food simulating the stir-frying process, dispensed oil in the right volume, controlled temperature, and even prompted the line chef to add ingredients based on customer customization requests at specific times.

With innovations such as these, Rebel Foods was able to launch a range of consistently cooked products across locations without the need to invest heavily in trained chefs. Closed circuit cameras in the kitchen were used to audit adherence to processes.

Pavan Joshi said,

> We developed a SWAT machine where each item before going out of the kitchen was analyzed using video, temperature, and weight sensors for Size, Weight, Appearance, and Temperature to make sure it met our standards. You order a Behrouz in Ahmedabad or in Mumbai and it tastes just the same. This is because the standardization of recipes, processes, and tools was entirely enabled by technology and machine learning models.

The third pillar of Rebel OS was their pan-India supply chain that consisted of procurement, warehousing, storage, and inventory logistics, which enabled them to keep kitchens running optimally. They used forecasting models that predicted how much to procure for each kitchen and these amounts were linked back to their various vendors' systems. When the vendor's trucks came in, items and quantities were verified against the orders manually and the inventory was updated in real-time.

5.2   Brands, Marketing, and Customer Service

While Rebel Foods did a television spot for Behrouz and sometimes used banner advertisements and flyers in some geographies, digital and social media formed the core of their marketing approach. Their style was mostly quirky advertisements and promotions on Instagram, Facebook, and so on. They used text messaging and push notifications on their EatSure app to target customers at specific times of day with offers and reminders. Banerjee said, "*You may get an SMS at lunch time reminding you to order your Faasos wrap… in the evening for your Behrouz Biryani … based on how the brands are positioned*".

Sagar Kochhar said,

> We vary our marketing strategy by brand. For Behrouz, we did an eight-episode web series, Royal Palate, with celebrity chef Kunal Kapoor who traveled the country to palaces, collected recipes and spoke to chefs to discover the essence of the Royal Biryani. We grew awareness 7 to 8% month-on-month according to surveys. For Sweet Truth, we went big on Instagram and Facebook with stories, from celebrity chefs to mother-daughter personal conversations and even stage performances. When Sacred Games was popular on Netflix, we created "sacred wraps" for Faasos and order volumes doubled. In 2022, on Valentine's Day, we created Tinder profiles for six or seven "hero wraps" for Faasos and invited folks to connect and hang out with them.

Debprotim Dutta, Vice President, Product Management, added that understanding customer feedback well and taking corrective action was another key to Rebel Foods' customer-centric approach. He said,

> All customer feedback goes to a central customer service team and not to the kitchen team. If we provide it directly to the kitchen, the kitchen staff will be overwhelmed. They are also not trained to handle customers since this needs empathy and refinement. At times the customer service team gets in touch with the kitchen team to respond to the customer.

5.3   Rebel Plus

Rebel Plus was the company's integrated software platform consisting of their restaurant and catalog management, inventory management, kitchen operations management, and delivery fleet management modules [see Figure 3]. Rebel Plus also had Rebel Connect which was used by Rebel Launcher partners.

5.3.1   Store Front: Restaurant Configuration

Store Front was the restaurant management system used to set up restaurants and configure menus for each restaurant [see Figure 4]. Opening and closing times, locations, and other details were updated for each restaurant or brand. For instance, multiple menus (product lists) could be set up for one restaurant, one for lunch, another for dinner, and a different one for the weekend. Distinct menus could also be mapped to different delivery channels. So a restaurant could have one menu for customer pickup, one for Deliveroo, and a third for Uber Eats. Menu items could be clustered under various categories, such as promotions of the day, biryani buckets, and combo meals with multiple dishes under one item. Various customization options could be configured for each menu item, such as sides and beverage options for a combo meal or the choices of sauce for a wrap. Prices could be set for each menu item taking this customization into account. Ingredients lists for each restaurant could also be entered into Store Front.

Delivery channels for each restaurant were configured in Store Front and turned on and off as needed. It was fully integrated with Rebel Foods' food delivery application EatSure. It also came with built-in

integrations to major third-party food delivery aggregators such as Swiggy, Zomato, and Dunzo in India, Deliveroo or UberEats in the UAE, and Grab in Southeast Asia. It used dynamic polygon creation algorithms to mark delivery zones for each store based on location, weather, traffic, and other factors. Store Front also included user access management for Rebel Plus.

5.3.2 Dash: Kitchen and Order Management

When an order came in through any channel, it landed in their kitchen and order management system called Dash [see Figure 5]. The Customer Delight Officer (CDO) who managed the kitchen would have a full view of all the orders coming in on the Order Listing tab. She could see the channel the order had come in on, the time elapsed, and the delivery rider details once assigned. She could turn on and off certain menu items and channels manually based on order volumes, inventory levels, and staff availability. Dutta reminded, "*We have to account for uncertainties. If someone doesn't turn up one day, in a kitchen with only a small staff, it may affect the ability to service customers*".

Each kitchen had one or more brand stations with KDS monitors running Dash and each station serving one or more brands. For instance, the same brand station could be configured in Dash for both Behrouz and Faasos and the chef at that station could see orders from both. The KDS contained detailed recipes, fetched from a Recipe Master application with step-by-step instructions for the chef to cook the dish aided by the robotics in the kitchen. Timers on Dash indicated how much time had elapsed since the order came in and the expected completion time. Once the dish was completed the chef marked the item as done, and then the order was ready to go to quality control and then the delivery station.

Dash also had the options for viewing past orders, and filtering orders by various criteria such as date, time, channel, and order reference number. For customer service purposes, full details of the order including customer information, channel information, prices, and rider details for past orders were visible on the order card. Dash was fully integrated with Spark, the inventory management system.

5.3.3 Spark: Inventory Management System

As products went out of the kitchen and inputs depleted, Spark constantly updated the stock. If stocks of a product went below a threshold, warnings were issued for additional inventory to be ordered. If the stocks fell below a critical level, then all menu items that required those inputs would be automatically disabled. This would reflect in all the delivery channels and those menu items would become invisible to the customer.

Pavan Joshi said,

> *While we would like to fulfill every wish of the customer, we would prefer not to keep them waiting for their food or not deliver the order. We have an automatic deactivation algorithm where, based on stocks and order patterns, we can automatically deactivate menu items. Order drops have come down by 3X since this was implemented. We also have auto activation, when items come into the inventory management systems. We are moving towards a tracking and traceability solution using bar codes, both for inputs and outputs.*

Spark also had purchase orders (PO) for ordering goods and goods received note (GRN) workflows for updating inventory as supply came in. It was integrated with Rebel Food's SAP-based ERP systems.

5.3.4 Trax: Order Delivery and Tracking System

For orders that came in through a third-party channel, rider or driver allocation was usually done by the third party. However, for EatSure orders, rider allocation and tracking were done through the Trax system for delivery fleet management [see Figure 6]. Trax also had third party integrations, so that restaurants, such as Rebel Foods' partners in the UK, could use third party delivery services even though the order came in over the phone or through their own website or app. Trax had a simple mobile front-end for the delivery rider to accept orders, map pickup, and delivery addresses, and update the order status during the process.

5.3.5 Rebel Connect: Rebel Launcher Integration

Dutta said, "*Some Rebel Launcher brands have existing software platforms, which we need to integrate with, while some use our Rebel Plus partially or wholly*". Every Rebel Launcher partner had the option to utilize various components of Rebel Plus. The final component of Rebel Plus was Rebel Connect which

helped partners to easily adopt Rebel Foods' kitchen and software systems through self-service onboarding. It provided documentation, analytics, and real-time support through an inbuilt ticketing system. As more partners adopted their platforms, the need to provide partner support became more important.

Gupta said,

> *We have embedded a plethora of technology solutions in every aspect of our business. We used machine learning models to improve our estimated time of arrival on EatSure, reducing customer contacts looking for orders by 35%. We used AI based automated chatbot solutions extensively to address customer issues and feedback and up to 65% of queries are directly handled by bots.*

5.3.6 EatSure: Direct to Customer (D2C) Food Delivery App

In the middle of 2020, during the Coronavirus pandemic, the restaurant business was limping back to normal in India. Post the initial peak and lockdowns in 2020, food delivery volumes were picking up slowly since most dine-in restaurants were closed or offered limited seating. The Rebel Foods team felt that giving customers an assurance of health and safety would encourage them to order more, and this was best done on their own platform rather than on a third party one. While the existing Faasos app had a loyal customer base of 5 million, they felt that a reboot was in order.

EatSure was launched in 2020. It was based on the Faasos app but with a new interface and some added features. One innovation was to provide more information about the delivery rider, their body temperature, hand washing and sanitization history, and once the vaccination program took off in India in 2021, their vaccination status. Kochhar believed they were the first food delivery app to provide this kind of information, and others soon followed suit.

EatSure had several other differences from the aggregator apps. While it did not have the large number of brands that an aggregator could provide, it offered all of Rebel Foods' range of owned and partner brands under a single umbrella. Customers could include food from different brands in a single order, and have the entire order arrive at the same time. This eliminated the need to place multiple orders for multiple brands, paying fees for each, and then having dessert arrive before the main course. There were no delivery fees beyond a small order value threshold. Kochhar felt this "*food court on an app*" formulation was sufficient for people to keep EatSure on their phones as a second food app after one of the aggregators. For large orders, the margins were better on EatSure in comparison to third party delivery platforms.

Raghav Joshi said,

> *Another unique aspect of EatSure is that every dish is described in detail so that the customer knows exactly what they are consuming. We have even been experimenting with live kitchen views on EatSure where the customer can see how their food was prepared and cooked.*

Gupta added:

> *One of the challenges with live streaming food preparation to the customer is that our kitchens are arranged by process and not by brand. So the cooking does not necessarily happen at one place. It gets tricky. We are thinking about how best to scale this. We are also thinking if it is possible to allow the customer to control some part of the process using IoT.*

Rebel Foods started EatSure exclusives where some new products were available only on EatSure and not on third parties.

Kochhar said,

> *We are also experimenting with a loyalty program that spans across brands, and hopefully we will be able to roll them out for our own and partner brand brick and mortar outlets as well. Our goal is to keep driving more volumes to EatSure. This is not only cost effective, but it also helps us build greater connections with customers. This is key for us to provide greater Personalization for each customer in the future.*

By 2022, EatSure was available in all geographies in India where Rebel Foods operated, as a component of Rebel OS. See Figure 7 for some snapshots of the EatSure app.

6   Challenges

6.1   Dynamic Forecasting

For certain products like biryani, the team at Rebel Foods struggled to get the balance right in terms of how much rice and of what type to order and prepare daily so that they did not run out but also did not over prepare, resulting in wastage.

Gupta said,

> *We used machine learning models with a lot of attributes such as staff availability in the kitchen for the brand, rider availability, recent orders, campaign data, last year's heuristics, and most importantly, how items are moving today compared to last week or month. With all these variables, we have reached 80% accuracy. We have expanded this to key SKUs like rice, pizza base, etc. First, we want to target 20% of SKUs such as chicken tikka, mutton etc. which are expensive and have low shelf life to minimize variance.*

Pavan Joshi added, "*With these models, we are seeing a great reduction in wastage of products which have low shelf life. At an aggregate level, we have improved significantly since the time individual kitchen staff were making informed guesses*".

6.2   Kitchen Optimization and Brand Capacity

Gupta noted:

> *We are rethinking how to best utilize our kitchens, how to achieve more throughput with fixed resources like real estate, kitchen staff, rider staff, etc. Opening new kitchens takes longer and more money. Expanding through technology is faster and cheaper. Restaurants that have space can take our brands as franchises. We have to provide our supply chain and culinary expertise. We are experimenting with all sorts of technology to try and expand faster and cheaper.*

Their process engineering team was using computer aided design (CAD) models and experimenting with more efficient kitchen layouts and even using vertical space where possible.

6.3   Systems Consolidation

In 2022, Rebel Foods standardized all their brand webpages and mobile applications by bringing them onto a common platform, each with a different front-end.

Pavan Joshi said,

> *All the brand websites were different transacting sites, checkout and search were not efficient or consistent. To put the bandwidth behind each was wasteful. Post-Covid, we moved to EatSure with a common backend because we wanted to consolidate our offerings and experience.*

This allowed them to apply best practices to every brand application and consolidate the IT team. The company expected that future development efforts should be substantially lower.

6.4   New Technology Adoption

Gupta said,

> *We have done some Proofs of Concept (POCs) with home devices, voice ordering, but not much traction so far. In the future, there is a possibility of integrating with autonomous delivery using drones in some countries if they are approved, where labor is more expensive. We keep an eye on all technologies, but it has to make sense for our customers and business. We draw our energy and clarity from our mission statement — "Building a platform to bring great quality brands for all consumer food missions in every neighborhood of the world".*

6.5   Modularization and Interoperability

In a partner conference in 2022, the Rebel Foods leadership showcased their technology platform and discovered that there was great interest from various global food brands in their technology. "*We asked ourselves, was it essential that our technology had to come coupled with our kitchens and physical*

infrastructure?" asked Dutta. Many in the engineering team felt that any restaurant or chain should be able to leverage their suite of products with or without their kitchens. Using sandboxing and tenant-based architecture, they aimed to provide independent restaurants and chains the option of using various modules from their technology stack.

Gupta said,

> *We have rearchitected all systems as separate components — demand generation, food preparation, logistics, supply chain, and delivery. Someone may want only logistics, only POS, etc. or someone wants a mix, or a D2C platform. We have built the architecture. We have scaled these systems in other countries. In India, we are doing the same right now. In the future, we are definitely thinking of how to empower partners to adopt our technology. As a spin-off or additional revenue source, we are already working on it. We will need some changes in our functional organization to provide the right kind of support, pre-sales, post-sales, etc. We plan to build a dedicated capability around this business.*

They were working to make their systems interoperable with existing POS systems, inventory management systems, and food delivery apps. Dutta said,

> *In the tech space for restaurants, there are POS systems, such as Vista, Posist, Petpooja, and supply chain and inventory management systems from Oracle and SAP. There are few players with technology across the board from inventory, kitchen, and order management to delivery logistics. One of our greatest value propositions is that we are already integrated with various delivery partners. Anyone adopting our kitchen management systems would be able to use these integrations out of the box. We can also enable an instance of EatSure for a restaurant chain, so they can get their own delivery system at a low cost.*

Banerjee believed that while they were ready from an engineering point of view, and there was plenty of interest from potential clients, becoming a technology provider for restaurants was not in the cards for Rebel Foods. He said,

> *At best, we may provide our software to some specific partner brands in their kitchens. We have spoken to RBI, which has 3 brands. They have now started their first cloud kitchen with our platform. If we just do software, without a brand on top, it doesn't fit our vision. It is a different business and a different kind of customer service. We have said no to a couple of these opportunities. I don't think we will be doing this as a pureplay any time soon except for the Launcher partners.*

6.6   Personalization

Across industries, consumers were looking for a more personalized experience. McKinsey indicated that companies who excelled at personalization generated 40% more revenue from those activities than average players (Byoun & Lee, 2020). Banerjee said, "*Personalization is relatively new in the food industry … but it is the future, I believe. We want to be early movers in this game*".

Personalization required a cloud kitchen to capture not only order details but also every customer interaction with the application interface from what menu items they were browsing and when, which offers they clicked, how they responded to push notifications, to discounts, etc. Geospatial cluster analysis could be used to understand local preferences. Customer feedback and complaints were another source of insights for future development. Gupta said, "*All of this feeds into our recommendation engines which use both content based and collaborative filtering. We are also looking to apply local learning algorithms. This is an area of major active interest for us*".

Using analytics and AI models, Rebel Foods was able to provide a customized landing page on EatSure for each customer, highlighting food and offers that the customer was more likely to be interested in. They were also looking to capture customer specific customization requests better on the ordering interface. Using natural language processors (NLPs) and AI, they could potentially convert textual instructions into actionable cooking directions.

A related trend was healthy and mindful eating. Customers were more vigilant about what they ate, and when (Reynolds, 2020). Banerjee felt that the time had come to think of special dietary needs and customer preferences around mindful eating as a new dimension in developing food missions. They were running pilots for subscription models for individuals (salads, daily meals at work, health plans etc.) and

family meal kit subscriptions. One of Rebel Foods' successful international launches was The 500 Calorie Project in the UAE which served healthy salads and sandwiches. See Figure 8 for a conceptual view of Rebel Foods' thinking on how food has evolved to include special dietary needs.

7 Conclusion

In the eyes of the Rebel Foods team, their Rebel OS technology stack had helped them operationalize new locations quickly, run their kitchens more efficiently, ensure consistently cooked high-quality and hygienic products, and provide a superior customer experience. They were focused on further streamlining their operations with better demand forecasting, adding more automation in the supply chain and kitchen, using existing kitchen space better to add more brands, and ultimately satisfying more food missions. They felt new technology could help them provide more personalized experiences to customers and help drive future growth.

As Rebel Foods added brands at a rapid rate, especially with their Launcher partners, would their technology scale? Would they need to invest more in their partner support teams? Most of Rebel Foods' markets were developing countries with lower wage costs. What was the cost benefit of adopting more automation in such markets? How should they balance investments in new technology with profitability? Which specific emerging technologies might deliver greater return on investment in the short- and long-terms?

Would personalization and mindful eating, enabled by EatSure, drive Rebel Foods' dream of becoming a global leader in food? Or, would their now tried and tested cloud kitchen platform, via Rebel Launcher, steer them ahead? Would it be useful to monetize their technology capabilities beyond their launcher partners? Would they reshape themselves into a technology company that specializes in kitchen technology?

Customers move across all food missions within a short span of time

**Figure 1. Rebel Foods, Brands by Food Missions
(Source: Information provided by Rebel Foods)**

End to end tech platform	A culinary innovation centre led by a chef team	Pan India supply chain + logistics backbone	Robust operating DNA and infrastructure
⑩Integrated supply, inventory, kitchen and last mile management ⑩Increasing automation / IOT / robotics ⑩Own app / brand websites ⑩Deeply integrated with aggregators	• A • B • C • D	⑩Raw Material Vendors ⑩Warehousing ⑩Logistics ⑩Cloud kitchens ⑩Customers	⑩450+ cloud kitchens ⑩Completely de-skilled ⑩Entrepreneurship at the core

**Figure 2. Rebel Launcher Operating Model
(Source: https://www.rebelfoods.com/blogs/topic/introducing-rebel-launcher-launchpad-for-entrepreneurs-with-delightful-food-brands)**
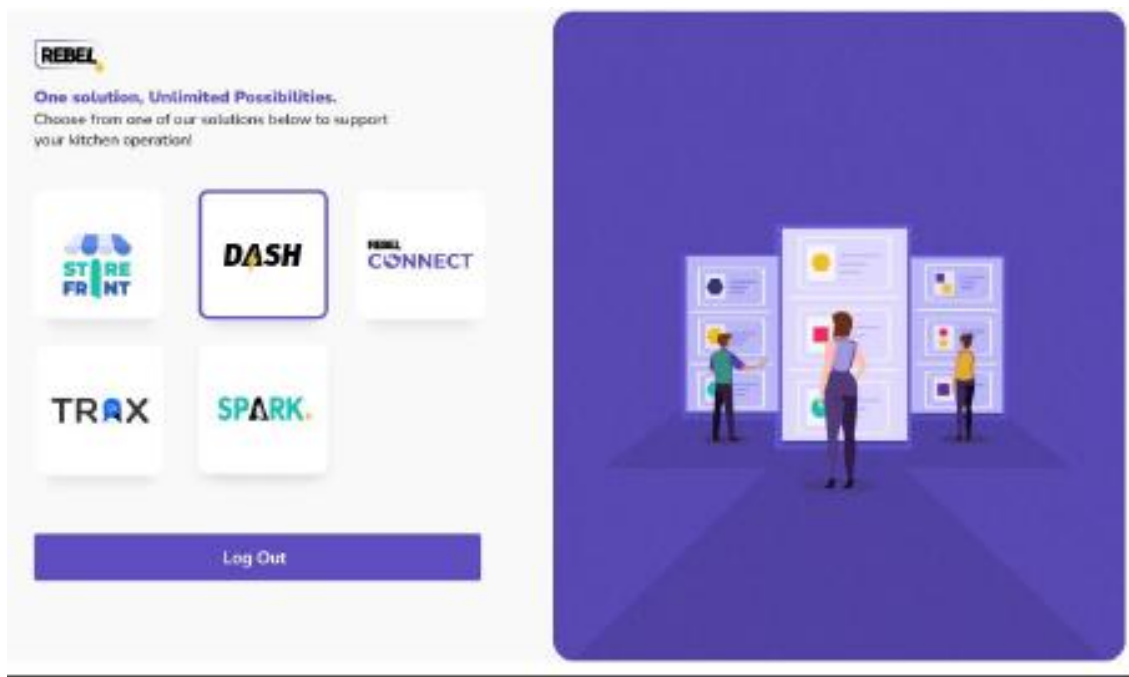
Figure 3. Snapshot of Rebel Plus Components
(Source: Information provided by Rebel Foods)

Figure 4(a). Restaurant Management System Store Front Showing Product List
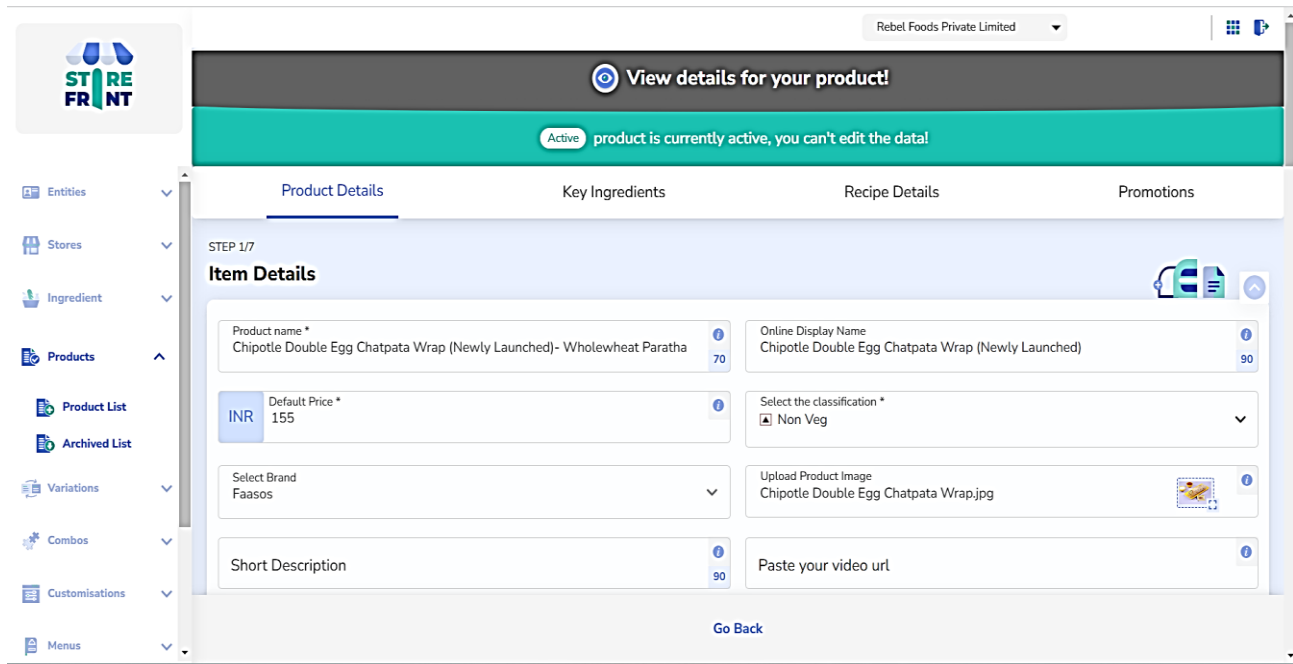
Figure 4(b). Restaurant Management System Store Front Showing Product Details
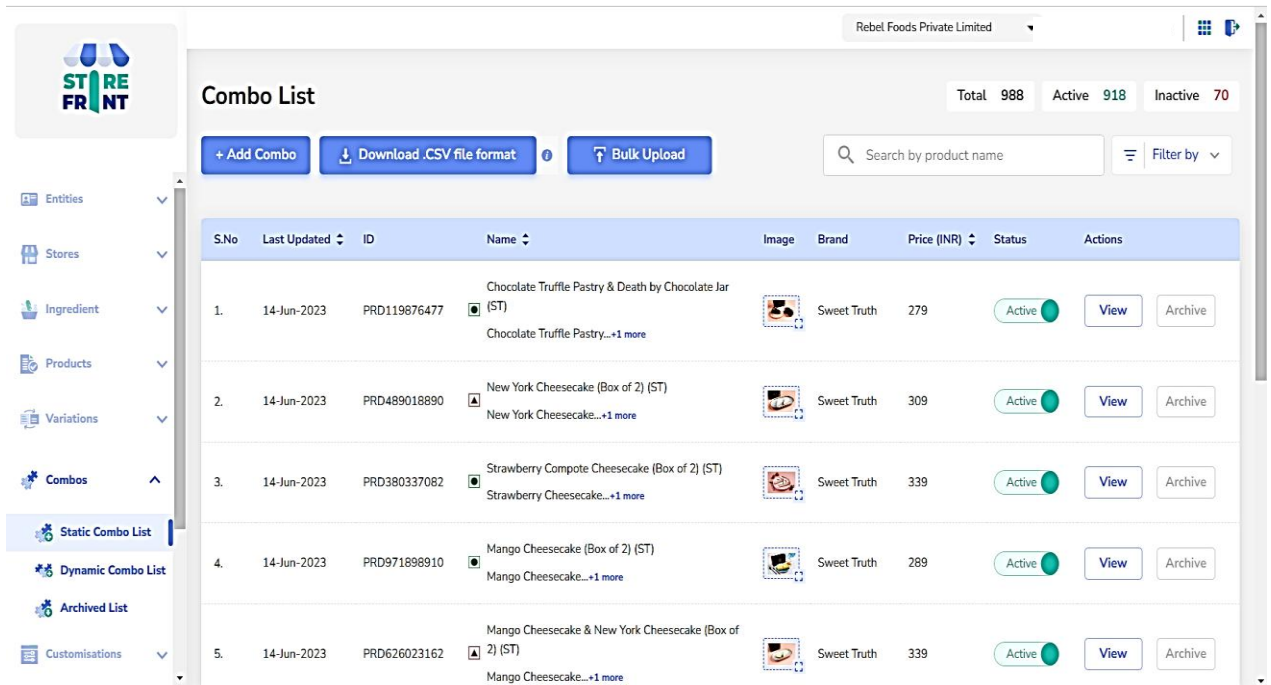
Figure 4(c). Restaurant Management system Store Front Showing Combo Meal Lists

Figure 4(d). Restaurant Management System Store Front Showing Meal Customization Options
(Source: Information provided by Rebel Foods)

Figure 5(a). Kitchen Display System DASH Showing Product List
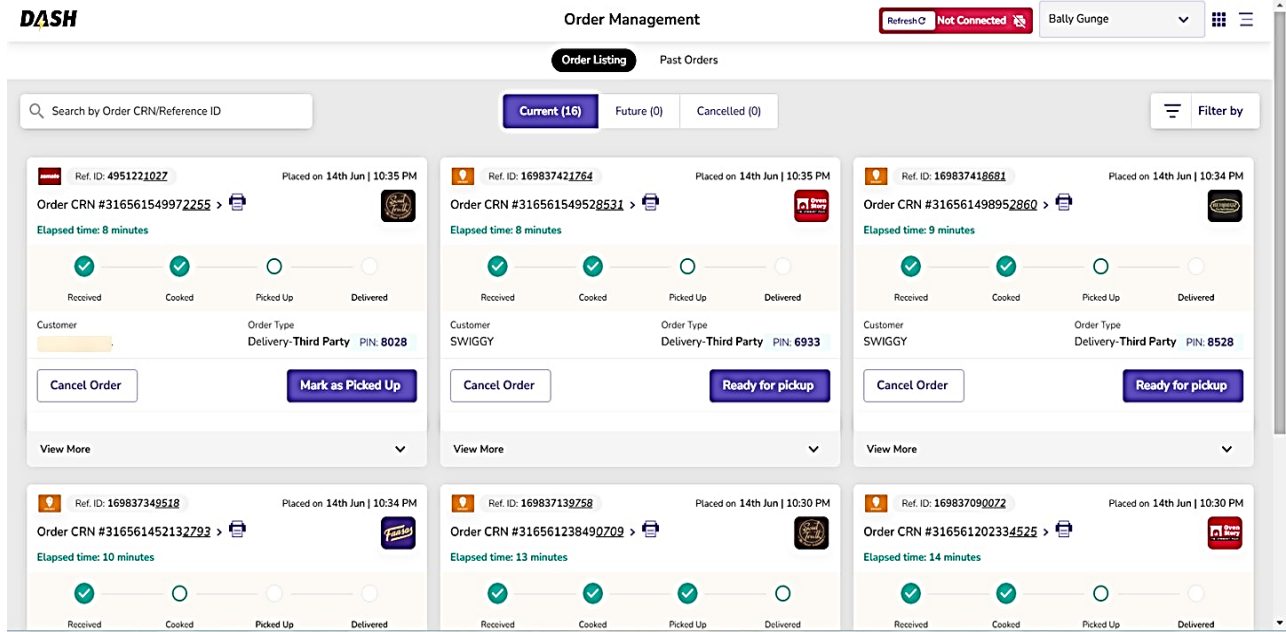
Figure 5(b). Kitchen Display System DASH Showing the Order Management Dashboard
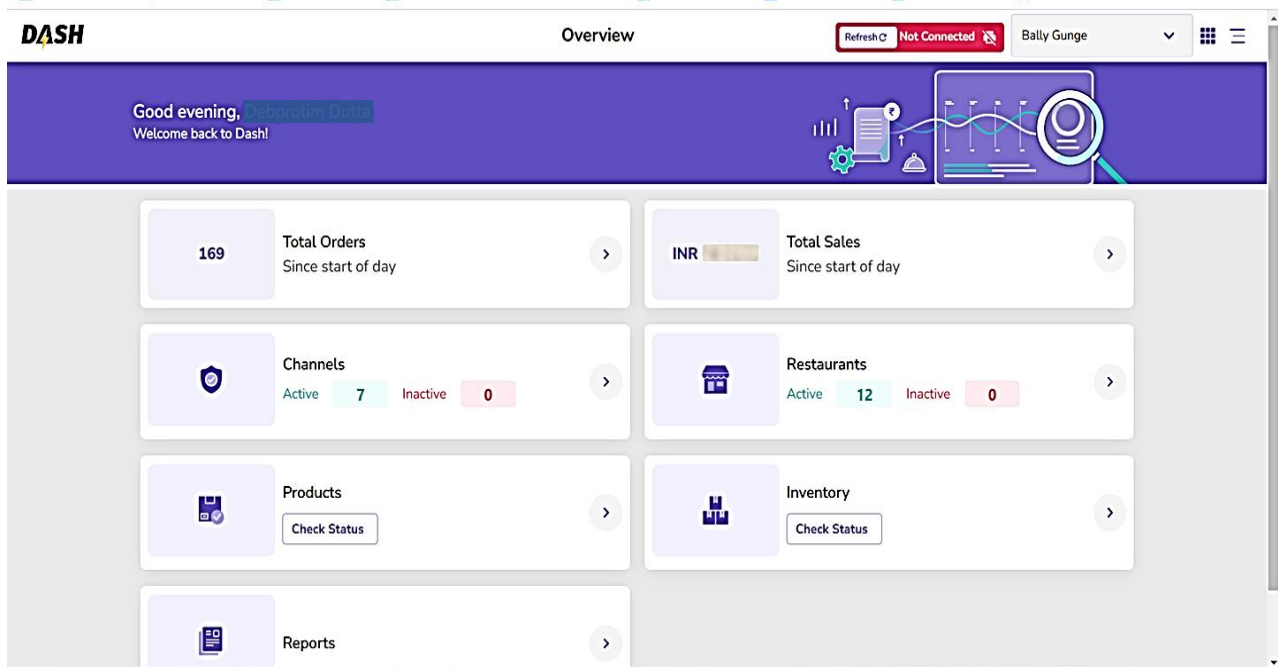
Figure 5(c). Kitchen Display System DASH Showing the Main Dashboard

Figure 5(d). Kitchen Display System DASH Showing the Channel Configuration
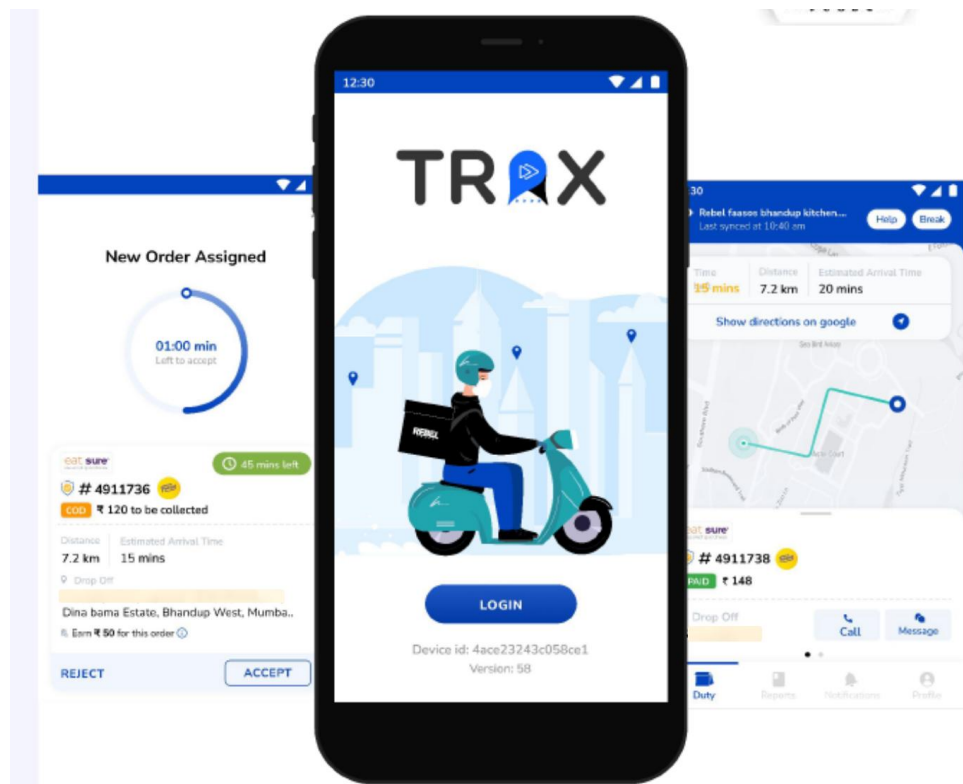**(Source: Information provided by Rebel Foods)**

Figure 6(a). Delivery Logistics Application TRAX User Interface
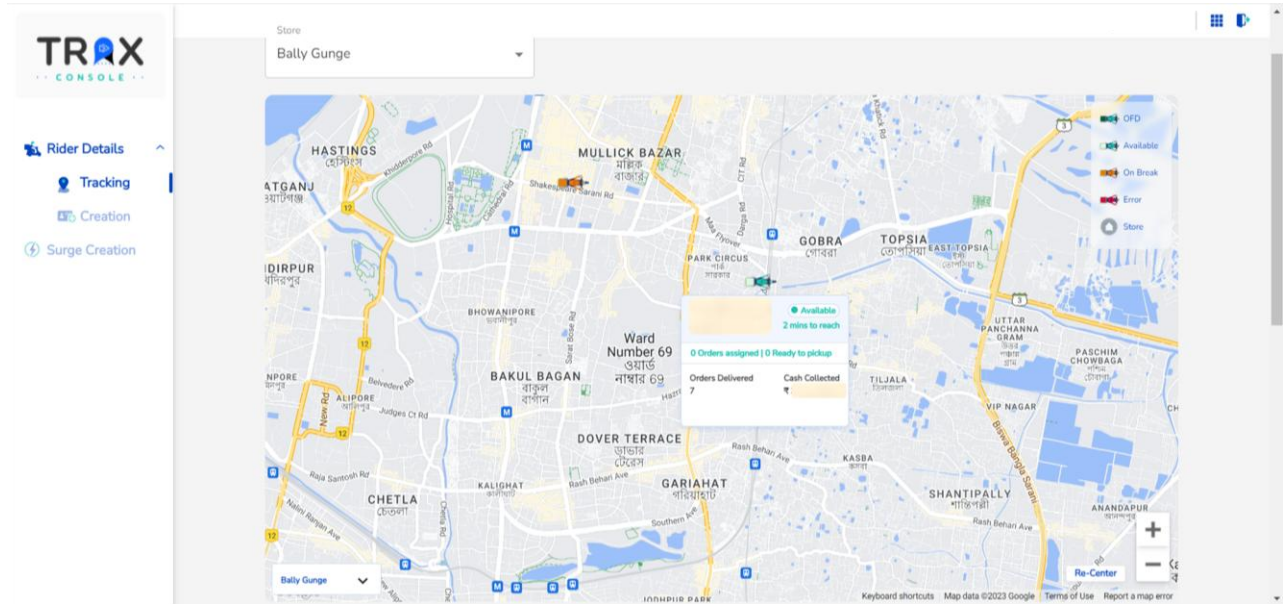**(Source: Information provided by Rebel Foods)**

Figure 6(b). Delivery Logistics Application TRAX User Interface
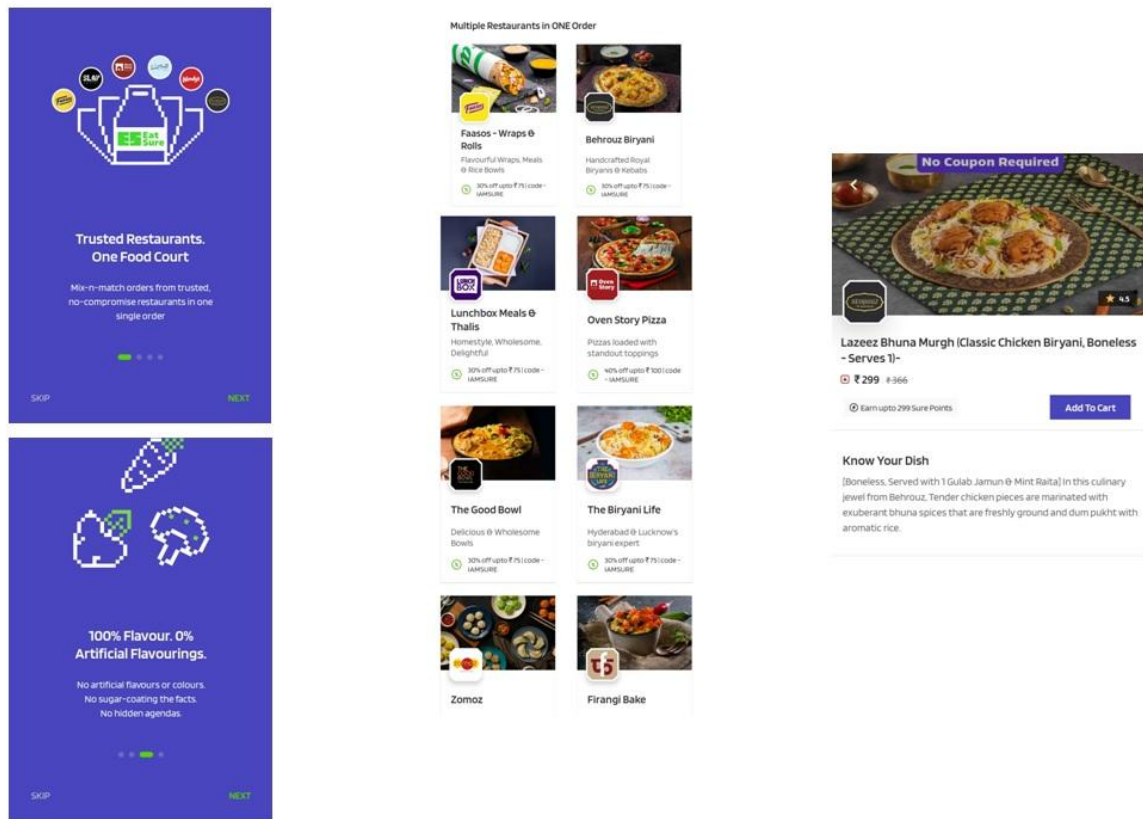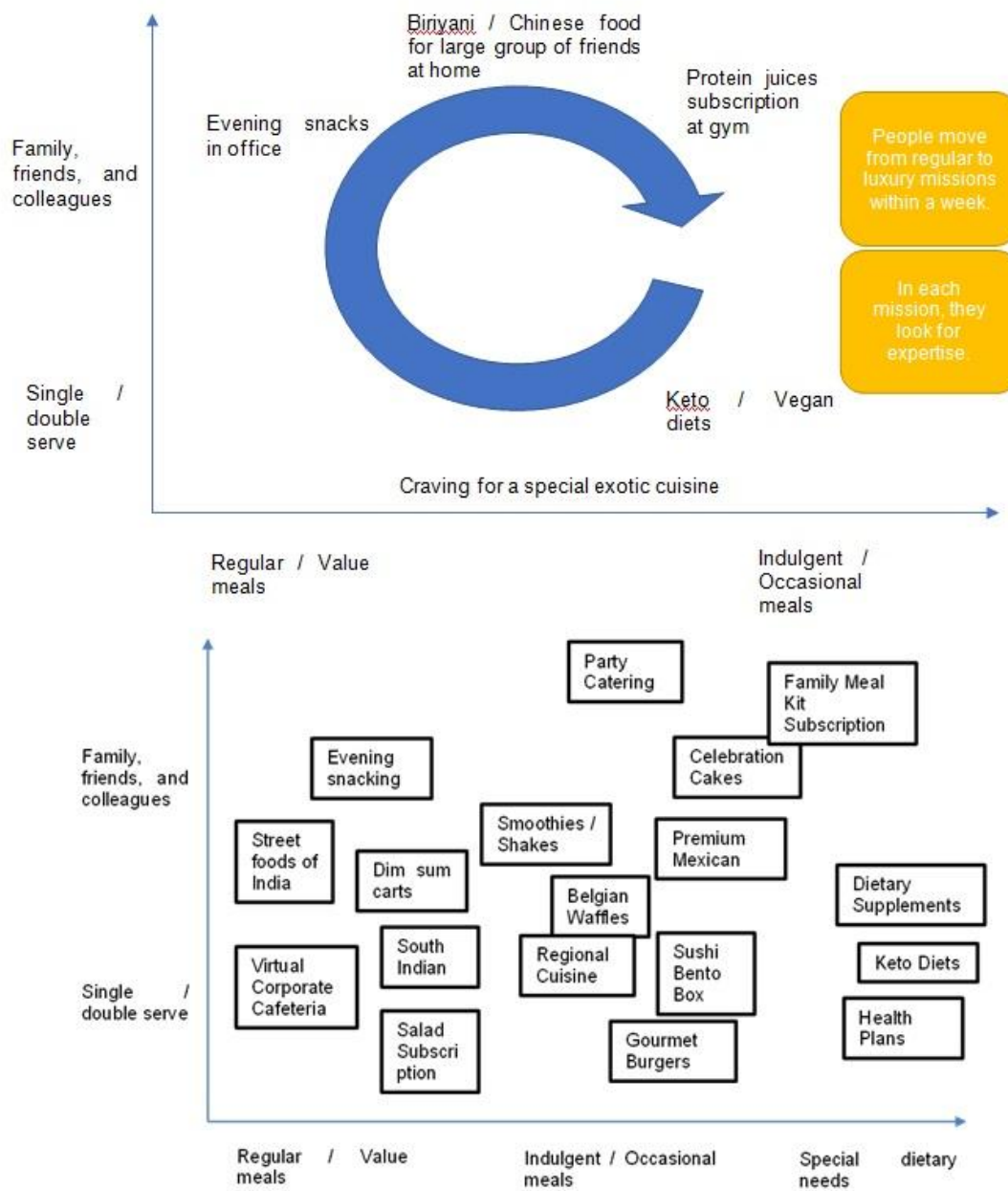**(Source: Information provided by Rebel Foods)**

Figure 7. EatSure User Interface
(Source: EatSure Mobile Application)

Figure 8. Rebel Foods Customer Food Missions and Opportunities, Including Special Needs and Customizations
(Source: Information provided by Rebel Foods)

References

Bellan, R. (2022). *Uber Eats pilots autonomous delivery with Serve Robotics*. TechCrunch. Retrieved from https://techcrunch.com/2022/05/15/uber-eats-pilots-autonomous-delivery-with-serve-robotics-motional/

Business Standard. (2021, December 22). *India's food service market to reach $79.65 bn by 2028, says report*. Retrieved from https://www.business-standard.com/article/economy-policy/india-s-food-service-market-to-reach-79-65-bn-by-2028-says-report-122112100665_1.html

Byoun, S., & Lee, Y. (2020, August 6). *The value of getting personalization right (or wrong) is multiplying*. McKinsey & Company. Retrieved from https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/the-value-of-getting-personalization-right-or-wrong-is-multiplying

Eshghi, B. (2021). *RPA in food industry: Robotic process automation in food & beverage*. AI Multiple. Retrieved from https://research.aimultiple.com/rpa-in-food-industry/

Financial Express. (2022, April 8). *Rebel Foods losses up 55% in FY22; revenue more than doubles*. Retrieved from https://www.financialexpress.com/industry/rebel-foods-losses-up-55-in-fy22-revenue-more-than-doubles/2913503/

Forbes India. (2016, May 9). *Faasos: The integrated food company*. Retrieved from https://www.forbesindia.com/article/work-in-progress/faasos-the-integrated-food-company/41647/1

Kotsopoulos, S., & Lappas, T. (2022). A machine learning approach for personalized menu recommendations in restaurant environments. *Procedia Computer Science*, *203*, 445-450.

Kovalenko, O. (2022). *Machine learning and AI in food industry*. SPD Group. Retrieved from https://spd.group/machine-learning/machine-learning-and-ai-in-food-industry/

Marques, M., & Sousa, E. (2021). *Blockchain in food safety: Use cases and prospects*. BuiltIn. Retrieved from https://builtin.com/blockchain/food-safety-supply-chain

Matthieu, V. (2022). *Personalisation: Future of food?* DigitalFoodLab. Retrieved from https://www.digitalfoodlab.com/%F0%9F%92%8A-personalisation-future-food/

Muller, A. (2021). *Why AI and ML are key ingredients for quick service restaurants*. QSR Magazine. Retrieved from https://www.qsrmagazine.com/outside-insights/why-ai-and-ml-are-key-ingredients-quick-service-restaurants

Plus Company Updates. (2022, January 20). *Food service market worth USD 2,386.0 billion by 2028 | Global Food Service Industry Share, Manufactures, and Development Report*. Fortune Business Insights. Retrieved from https://www.globenewswire.com/en/news-release/2022/01/18/2368113/0/en/Food-Service-Market-Worth-USD-2-386-0-Billion-by-2028-Global-Food-Service-Industry-Share-Manufactures-and-Development-Report-by-Fortune-Business-Insights.html

Ponteville, S. (2021). *Food personalization: A new key competitive advantage to F&B companies*. Forward Fooding. Retrieved from https://forwardfooding.com/blog/foodtech-trends-and-insights/food-personalization-a-new-key-competitive-advantage-to-fb-companies/

Restaurant Dive. (2020, June 2). *Ghost kitchens global market forecasted to reach $1T by 2030*. Retrieved from https://www.restaurantdive.com/news/ghost-kitchens-global-market-euromonitor/581374/

Reynolds, H. (2020, November 24). *COVID-19 fuels interest in personalized nutrition and products to support physical, emotional health*. FoodNavigator-USA. Retrieved from https://www.foodnavigator-usa.com/Article/2020/11/24/COVID-19-fuels-interest-in-personalized-nutrition-and-products-to-support-physical-emotional-health

Appendix A: Personnel Quoted in the Case Study

Kallol Banerjee: Co-founder of Rebel Foods (as Faasos in 2004).

Raghav Joshi: Co-founder (joined 2012). Formerly COO and CEO of India business. Currently Head of Hosted and Acquired Brands (Rebel Launcher).

Amit Kumar Gupta: Chief Technology Officer (joined 2020).

Sagar Kochhar: Co-founder. Currently leads the omni-channel D2C charter of Rebel Foods which includes EatSure

Pavan Joshi: VP, D2C Product and Tech

Debprotim Dutta: VP, Product Management (joined 2022).

Source: Information provided by Rebel Foods.

Appendix B: Emerging Technology in the Food Services Industry

Internet of things (IoT) usage is ubiquitous in the food services supply chain (Kotsopoulos, & Lappas, 2022) and the modern kitchen. This ranged from RFID-based automated inventory updates to smart storage containers that kept track of food stock, condition, and expiration dates, to shelves that could automatically place orders. Smart fryers, intelligent woks and ovens, which could be remotely monitored (for oil levels, temperatures, etc.), ensured faster and more consistent cooking with minimal human supervision. For example, Panda Express in the US developed the Panda Automated Wok starting in 2015 and deployed it across many of their kitchens, reducing cook times by 25%[3]. IoT-enabled food scrubber machines and automatic quality control devices helped maintain hygiene and quality. [4]

Delivery containers with sensors for temperature and humidity, capable of adjusting container parameters based on ambient weather, ensured freshness of food on delivery. Voice ordering on home devices, with Alexa or Google Home, was becoming more common. Several companies were experimenting with autonomous food delivery, both with drones[5] and on the ground, such as the recent Uber Eats pilot with Serve Robotics (Bellan, 2022).

AI software analyzed aggregate and individual customer data (purchase history, browsing behavior, etc.) to identify trends and preferences that were used to design new products, rationalize menus, and create personalized recommendations for consumers. Increasingly, AI software used analytics to forecast demand accurately, based on a range of inputs including historical data, special event prompts (such as sporting events like cricket matches or festivals like Holi), seasonal patterns (such as school holidays), and local preferences (Muller, 2021).

Recommendation engines made personalized meal suggestions to individual customers based on eating habits, pre-created diet plans, and even activity logs from smart watches (Kovalenko, 2022). Companies such as Italy based Feat Food, US based Splendid Spoon and Ngx delivered tailored meal kits and subscriptions to their customers (Ponteville, 2021) (Matthieu, 2022). Chatbots were commonly used to provide quick and efficient customer service, answer queries, and resolve issues in real-time, improving customer service and creating brand loyalty, while reducing staff involvement. Dynamic delivery route optimization, including multiple stops in one route, was another application for AI and ML.

Digital twin (DT) technology to create a virtual model of the kitchen armed with sensors could be used to optimize the kitchen layout for maximum efficiency and capacity. DTs could also be used to monitor kitchen and warehouse appliances for timely preventive maintenance. IBM and Siemens, among others, had developed DT solutions with specific applications in the food industry supply chain and inventory management domains.[6] Robotic Process Automation (RPA) software was used to reduce manual effort by interacting with legacy systems for functions such as finance, payroll, human resources, inventory, management reporting as well as kitchen automation tasks ranging from automatic catalog updates to controlling kitchen robotics (Eshghi, 2021).

Blockchain and distributed ledger technology made supply chain updates faster and cheaper, and the data more complete, transparent, and immutable. This helped to reduce fraud and provide full traceability including to the consumer who might scan a QR code and discover every detail of where their food was grown, how and under what conditions it was transported, and where and when it was cooked for their consumption (Marques, & Sousa, 2021). Globally, companies such as Nestle, Walmart and Tyson Foods were known to use blockchain extensively in their food supply chains.

---

[3]   Restaurant   Business.   (2021,   March   18).   Panda   Express   unveils   robotic   wok. https://www.restaurantbusinessonline.com/technology/panda-express-unveils-robotic-wok
[4] Finoit Technologies. (2021, August 17). Top 10 ways Internet of Things can be used by restaurants. https://www.finoit.com/blog/top-10-ways-internet-of-things-can-be-used-by-restaurants/
[5] Restaurantware. (2022, June 16). How do drone food delivery services work? [Blog post]. https://www.restaurantware.com/blog/post/how-do-drone-food-delivery-services-work/
[6] Brillio. (2021, February 17). Digital Twins in the QSR industry: A disruptive force. https://www.brillio.com/blog/digital-twins-in-the-qsr-industry-a-disruptive-force/
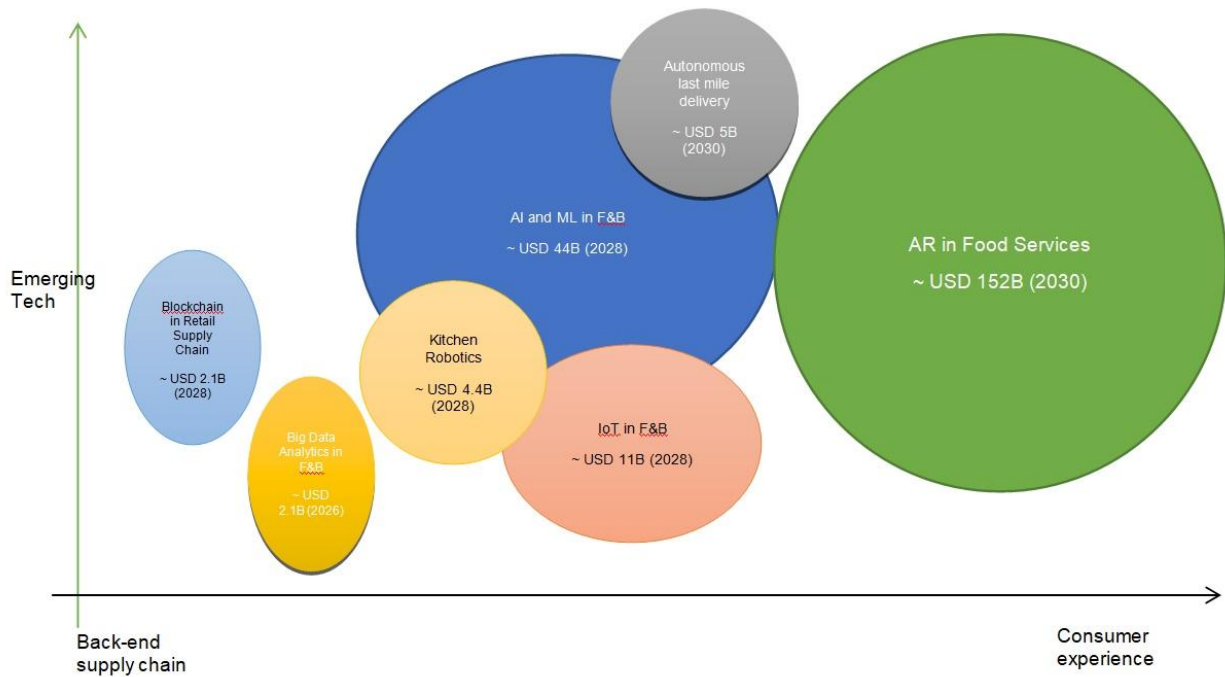
Figure A1. Projected Market Size for Various Emerging Technologies related to the Food Services Industry (indicative, not to scale, projection dates and sources vary)
(Source: Authors, with information from –
https://www.imarcgroup.com/artificial-intelligence-in-food-beverages-market

https://www.databridgemarketresearch.com/reports/global-internet-of-things-iot-in-food-market

https://www.industryarc.com/Report/17922/big-data-market-in-food-beverages-industry.html

https://www.technologyforyou.org/the-applications-for-augmented-reality-in-the-foodservice-industry-are-endless-with-the-market-set-to-reach-152-billion-by-2030/

https://www.verifiedmarketresearch.com/product/robot-kitchen-market/

https://www.insightaceanalytic.com/report/global-blockchain-in-the-agriculture-and-food-supply-chain-market/1436)

About the Authors

Saikat Lahiri writes business case studies for management schools and advises start-ups on finance and strategy. He has written a dozen case studies on diverse subjects such as technology, strategy, and marketing in association with the Indian Institute of Management Calcutta (IIMC) and the Indian Institute of Management Ahmedabad (IIMA). He was also the first head of IIMC's Case Research Centre. He has over 16 years of experience in the information technology industry, playing program and project management roles in IT services and in corporate learning.

Indranil Bose is the Nykaa Chair in Consumer Technology and Professor of Information Systems at the Indian Institute of Management Ahmedabad. He holds a BTech from the Indian Institute of Technology, MS from the University of Iowa, and MS and PhD from Purdue University. His research interests are in business analytics, digital transformation, information security, and management of emerging technologies. His publications have appeared in MIS Quarterly, Journal of the MIS, Communications of the ACM, Communications of the AIS, Computers and Operations Research, Decision Support Systems, European Journal of Operational Research, IEEE Transactions on Engineering Management, Information & Management, International Journal of Production Economics, Journal of the American Society for Information Science and Technology, Operations Research Letters, Technological Forecasting and Social Change, Tourism Management etc. He serves as Senior Editor of Decision Support Systems, Journal of Organizational Computing and Electronic Commerce, and Pacific Asia Journal of the AIS; as Associate Editor of Communications of the AIS and Information & Management; and as Editorial Board Member of Information Systems Research.

Adrija Majumdar is an Assistant Professor in the Information Systems area, at IIM Ahmedabad. She completed her PhD from the Indian Institute of Management Calcutta in Management Information Systems. Her research interests include social media, information disclosures, information privacy, and text mining. Her research articles have been published in reputed international journals such as the Information & Management, International Journal of Information Management, Transportation Research Part E, Technology Forecasting and Social Change, International Journal of Production Economics, Industrial Management & Data Systems, Journal of Retailing and Consumer Services, Journal of Organizational Computing and Electronic Commerce, and Annals of Operations Research, etc. She has presented her work at several international and national conferences and has won several best paper awards for her dissertation work. Her research articles have appeared in conference proceedings of IEEE, ACM, etc. She has developed several teaching cases in the past. She holds a Bachelor of Technology degree in Information Technology. She has earlier worked as a senior research assistant at the City University of Hong Kong, Kowloon, and in Cognizant Technology and Solutions.