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# Growing online-to-offline platform businesses: How Vytal became the world-leading provider of smart reusable food packaging

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### Abstract

Online platform businesses can grow massively and rapidly. But what if a company's business model features both an online platform application and a physical product, as is the case in logistics (e.g. container distribution), consumer retail (e.g. food delivery), or mobility (e.g. booking of shared rental vehicles)? Online-to-offline platform businesses must synchronise online platform growth with offline product transaction growth because online platforms may attract users, but value generation and capture occur through offline product transactions. If one outpaces the other, either demand cannot be satisfied, or costs increase disproportionally. How do online-to-offline platform businesses navigate this dilemma? We report on the exemplary case of Vytal, an innovative startup that has managed to become the world-largest provider of smart reusable packaging solutions in the food retail sector. Vytal couples the distribution of offline food containers with an online transaction platform application that connects restaurants, canteens, and supermarkets with consumers. We trace how Vytal strategically organised and orchestrated their growth online and offline. Based on our analysis, we offer a framework containing practical lessons for how companies can grow online-to-offline platform business models and

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navigate the trade-offs between the online and offline components of such business models.

KEYWORDS

case study, digital innovation, growth, online-to-offline platform

### 1 | INTRODUCTION

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Many well-known businesses that revolve around online platform applications manage to achieve enormous growth. WeChat, for example, grew from about 5000 to 600 000 users in only eight months and has now reached over 1.2 billion users (Huang et al., 2017). Zoom grew by 2.2 million users *every month* in 2020 (Novet, 2020). Cases such as these have prompted several scholars to proclaim that the growth of digital businesses is fundamentally different from other firms (Giustiziero et al., 2023; Gregory et al., 2021; Huang et al., 2017).

But what if a company's business model does not only revolve around an online platform application but also features an 'offline', that is, physical product? Many companies including Vorwerk, Philipps, and others pursue so-called *online-to-offline business models* (Lee et al., 2022), meaning they use scalable online platform applications to attract consumers but also develop and sell a physical product that is connected to that platform. Vorwerk, for example, has been successful with their Thermomix product, which involves a physical cooking machine (TM6) that is connected to an online platform application (Cookidoo) for recipe creation and exchange (Kröper et al., 2017). In online-to-offline business models, value creation and capture not only occur on the online platform application but also through offline product transaction channels that feature physical interactions between customer, products, and third-party providers.

This situation presents a dilemma for online-to-offline platform businesses because it makes growth difficult: Traditional physical product-based businesses (such as car manufacturers) can grow by scaling production and distribution resources (Chandler, 1994; Nason & Wiklund, 2018; Penrose, 1995). Purely online platform business can grow by scaling their online platform or digital product (Giustiziero et al., 2023; Huang et al., 2017). Online-to-offline platform businesses have to pursue and successfully merge both growth strategies: they have to create scalable platform applications to grow *online transactions* so that they create demand and data network effects (Adner et al., 2019; Gregory et al., 2021; Huang et al., 2017). At the same time, they also have to scale their ability to execute physical product transactions, which requires capital investment in product-focused resources, such as production plants and distribution networks, and product-centric processes such as production, sales, and distribution (Nason & Wiklund, 2018).

This is not to say that growth is impossible to achieve for online-to-offline platform businesses. Firms such as Dianping.com or Domino's pizza have become household names in the food delivery industry (Benatar, 2021), SHARE NOW has become the European market leader for carsharing (Dillenberger & Nitschke, 2022), and Container xChange has become a market-leading online platform for container leasing and trading (Frese, 2021). But at the same time, stories also abound about companies that struggle with a disconnect between online and offline growth. Peloton, the once instantly-famous producer of digitalized home-fitness equipment has started to spiral toward bankruptcy (Heilweil, 2022). Lockitron, once one of the earliest success stories of entrepreneurial crowdfunding, later struggled to deliver their product to a rapidly growing online consumer base (Robertson, 2014).

The problem for online-to-offline platform businesses is that pursuing either an online or an offline growth strategy alone will be insufficient: Growing only the customer base of an online platform application can increase the pressure on physical product production, sales, and distribution. Conversely, growing production, sales, and distribution incurs substantial costs, which are difficult to cover if the business fails to attract a sufficient customer base on its online platform application. Therefore, not only must a company implement both an online and offline growth strategy, but also orchestrate both strategies such that growth across both channels is realised in a synchronised, interconnected fashion.

In this article, we shed light on how online-to-offline platform businesses can successfully navigate this dilemma. Our research question is: *How do online-to-offline platform businesses grow successfully*? To answer this question, we analyse the case of Vytal. Vytal has started to revolutionise the food packaging market by providing deposit-free reusable packaging services to eliminate disposable packaging waste from take-out food. Key to their business model is the production of machine-readable food packaging containers, and the orchestration of all container transactions through an online platform application that connects Vytal as the packaging operator with partner firms (food providers such as restaurants, canteens, and supermarkets) and consumers (Patmore, 2020). Vytal's case is revelatory because since its founding in 2019, it has grown to become the world's largest provider of deposit-free reusable packaging services for take-out food. We followed Vytal closely for four years since inception and collected data through observations, formal interviews, informal conversations, and document analysis. Our research procedures are described in the appendix.

We begin by differentiating online-to-offline platform businesses from other platform businesses, reviewing the literature on the relationship between digital and physical objects in platform businesses, and explaining the differences between growing online customer platform transactions and offline product transactions. We then describe the growth path of Vytal to illustrate the key strategic decisions they made to successfully grow both online and offline. We describe the lessons companies with similar business models can learn from Vytal's case through a framework that conceptualises three interdependent components (i.e. the online platform application, the offline product, and the user base of consumers and business partners) that must be managed through different yet interconnected strategic mechanisms<sup>1</sup> within boundaries set by geographical and resource constraints.

### 2 | BACKGROUND

### 2.1 | Online-to-offline platform business models

Digital technologies, such as internet, cloud, or mobile computing, have helped firms transform into platform businesses, that is, firms whose business models are organised around an online platform application. Online platform applications allow such firms to match supply and demand in cost-effective ways (Gawer, 2022; Rietveld & Schilling, 2021). But not all platform applications serve the same purpose (Cennamo, 2021). Transaction platform applications allow firms such as Uber, Airbnb, or Alibaba to serve as intermediaries between buyers and sellers (Cusumano et al., 2019). Innovation platform applications serve firms such as Apple, Google, or SAP as technological building blocks for innovators to develop complementary products or services (Karhu et al., 2018; Schreieck et al., 2022). Vytal, the case we report on this paper, is a business revolving around a transaction platform.

However, transaction platforms are not all the same either. Many businesses use transaction platform applications to facilitate transactions between providers and consumers regarding purely digital products or services such as social media content (e.g. Li & Agarwal, 2017) or video games (e.g. Boudreau & Jeppesen, 2015). Key to these business models is that digital products can be transacted, redistributed, scaled, or customised at close to zero marginal costs (Adner et al., 2019; Giustiziero et al., 2023; Huang et al., 2022). Conversely, Vytal operates an online platform application to orchestrate offline product transactions (Li et al., 2018; Wan et al., 2023). Online-to-offline transaction platform applications connect online consumers with offline product transaction providers, these being canteens, restaurants, or container delivery fleets in the case of Vytal.

<sup>&</sup>lt;sup>1</sup>Throughout the paper, we use the term strategic mechanism to coin the higher-order design choices firms make as economic agents to achieve a desired market outcomes (Börgers & Li, 2019). Known strategic mechanisms are, for example, price discrimination, transaction cost optimization, or demand-side return increase.

Online-to-offline transaction platforms are important because they substantially lower search costs, they can be scaled to attract more consumers (and thus increase demand) for offline product transactions, and they provide informational advantages about offline product transactions that can be leveraged for data-driven product innovation or process optimization. But they remain a special kind of transaction platform because online activity on the platform application is always closely interconnected with a corresponding offline activity occurring in the physical world (Phang et al., 2014; Wan & Chen, 2019). Thus, firms like Vytal must optimise and fuse both online (e.g. creating a scalable platform architecture and attracting more partners and consumers onto the platform) and offline components (e.g. operating and growing product development, distribution, logistics, or storage) of their business model to achieve growth.

Finally, not even all online-to-offline transaction platform businesses are equal. Firms such as Groupon, Dianping, or Didi, for example, act as intermediaries between online customers and third-party physical product or service providers (e.g. local merchants in the case of Groupon, or delivery partners in the case of Didi). Similarly, Uber and Airbnb operate online platform applications to orchestrate transactions of offline products (car or accommodations) that are operated by independent third-party providers (e.g. car or apartment owners). Conversely, Vytal owns and operates both its own physical products (food containers) and its online platform application.

### 2.2 | Physical aspects in digital business models

Vytal's case draws attention to physical aspects of online-to-offline platform business models. These aspects include the product itself as well as the product-related processes and resources involved in product sourcing, distribution, or logistics. These aspects are important because physical product transactions always imply a constraint known as location-boundedness (Banalieva & Dhanaraj, 2019), meaning that they occur in particular constellations of space and time and involve matter and motion (Goebeler, 2022; Yoo, 2010).

Such physical aspects have often been overlooked in the literature surrounding digital businesses (Yoo & Euchner, 2020). Studies have often focused on the advantages that digital technologies and resources provide, such as their reproducibility at negligible marginal costs (Adner et al., 2019), their versatility to be used as templates for new offerings and replications (Giustiziero et al., 2023; Huang et al., 2022), their generativity for repurposing and adjustments (Amit & Han, 2017), and their ability to trigger product-based learning and innovation (Gregory et al., 2021; Werder et al., 2020). But regardless of what product or service becomes mediated or implemented by digital technologies, value creation still occurs as part of a socially and physically embodied activity in the real world (Lyytinen, 2022; Yoo, 2010), whether it involves a trade on Amazon marketplace (Greve & Song, 2017), a ride in a shared vehicle facilitated by Uber (Garud et al., 2022), or indeed the transportation of food through a container supplied by Vytal.

Physical aspects are particularly important in online-to-offline platform business models because in these settings value creation and capture occurs through closely interconnected online and offline elements of the business model. Some parts of the value are created on online platform applications, for example, through efficient search and matching of supply and demand for food containers. Other parts of the value are created in the physical world and depend on shape, volume, mass, or location of a particular food container. Imagine a customer being able to quickly and conveniently order hot soup in a soup container online but in the physical world all soup containers are already in use and only pizza containers are available at the relevant location.

And while physical aspects can play multiple roles in the digital innovation of value creation (Goebeler, 2022) including that of *social objects* that are reified as digital objects (e.g. Østerlie & Monteiro, 2020), or *social and physical activities* that act as the spatiotemporal setting in which digitally mediated value creation is carried out (e.g. Westmattelmann et al., 2021), in the case of Vytal the food containers play the more fundamental role as actual *physical objects* whose spatial attributes directly shape value creation because they are interconnected with the digitally-mediated and boundary- and frictionless interactions, occurring on an online platform. Simply put, even if

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Vytal manages to attract millions of customers demanding hot soup containers in a city such as Berlin, physical aspects such as type, volume, shape, or location of such containers, or the traffic congestion that might impact container delivery, will always impact how valuable the product transaction will ultimately be.

### 2.3 | Online and offline business growth

The growth of businesses operating purely online platform business models can be traced to their ability to scale the digital resources that constitute the offering (Giustiziero et al., 2023; Huang et al., 2022). Digital market offerings are inherently scalable because they are expandable and versatile, meaning that they can be (re-) produced and (re-) executed almost instantaneously at close to zero marginal costs, which offsets traditional resource constraints of (re-) production and distribution (Adner et al., 2019; Reuber et al., 2021). Moreover, digital offerings themselves automatically generate data during transaction and use, which can fuel product-based learning and innovation (Werder et al., 2020) and in turn generate data network effects that can further propel growth (Gregory et al., 2021; Schilling, 2009). To that end, online platform businesses typically grow by investing in the scalability of their platform application to support increasing volumes of interactions and numbers of users and complementors, for example by making architectural choices regarding APIs and SDKs (Karhu et al., 2018), by implementing controls (Boudreau, 2010), or by making licensing arrangements (Parker & Van Alstyne, 2018).

Business growth by increasing physical product transactions, on the other hand, requires capital investments typically in employees, sales outlets, production or distribution capacities, and other firm assets (Nason & Wiklund, 2018). Firms typically attempt to lower transaction costs per unit (Barney, 1991; Chandler Jr., 1994; Penrose, 1995), by developing and deploying competitively superior resources and capabilities, including information technology, to enable more scalable and economical value chain transactions. But aside from having to set up new production, distribution, and sales resources to create and actualize productive opportunities (Bradley et al., 2011; Diewert & Fox, 2008), which must be created in specific locations and staffed by employees with relevant skills (Knudsen et al., 2014), traditional growth is also typically limited by the rate at which managers can be recruited and trained to manage the growth process itself (Lockett et al., 2011).

The unique dilemma of online-to-offline platform business growth, therefore, is that firms must successfully leverage different yet closely interconnected strategic mechanisms for online and offline growth. Moreover, they also need to manage the emergent interdependencies between these strategic mechanisms and orchestrate the growth sequence across both interconnected business model components such that growth in one component reinforces but not hinders growth of the other.

### 3 | HOW VYTAL MANAGED TO GROW BOTH ONLINE AND OFFLINE

### 3.1 | Vytal searched for a digital solution to solve the food packaging problem

Vytal was founded in 2019 based on a business idea that addressed two fundamental problems in the food packaging industry: first, traditional food packaging and delivery poses substantial environmental sustainability problems. For example, consumer beverage packaging alone accounts for up to 48% of urban solid waste and 26% of marine garbage (Zhou et al., 2020), and many food packaging solutions in use involve non-reusable containers with a low recyclability potential (MacKerron, 2015). Second, existing reusable food packaging solutions typically rely on recycling schemes via cash deposits that turn out to be largely ineffective (Gallego-Schmid et al., 2019). The plastic packaging waste recycling rate in Europe in 2020 was 38% and declining (Eurostat., 2022).

Vytal sought to provide a novel, sustainable, circular, and deposit-free packaging system. By introducing a set of reusable food containers to the market, including small and large bowls, compartmentalised bowls, pizza boxes, sushi

trays, and coffee cups, Vytal encourages more sustainable and cost-efficient take-out behaviour by consumers. Consumers pick up their desired take-out meals in Vytal's reusable containers at partner restaurants or supermarkets by scanning the container with their Vytal app and returning used containers free of charge at any other partner restaurant within 14 days. Customers benefit from reduced trash production without incurred costs and with little effort since used containers can be returned without washing and at any participating partner site. Partner restaurants pay a small fee for each used container but in turn benefit from a reduced need for plastic packaging, lower packaging costs compared to single-use containers, and data insights on consumer behaviour provided to them via Vytal's online platform. This is important because Vytal can only optimise its revenue when they achieve fast container turnaround whilst minimising the need to introduce additional containers.

One important aspect of their business model is that Vytal is not acting as an intermediary between consumers and third-party suppliers of food packaging solutions. Instead, Vytal is the owner of its containers, which they source from production partners mainly located in Germany and the Czech Republic. In total, Vytal operates more than 480 000 reusable packaging containers between over 6500 partners and 450 000 registered users (Figure 1). Since October 2019, more than 6.2 million reusable containers have been checked out by Vytal users, thereby avoiding the equivalent amount of disposable packaging containers.

Key to Vytal's approach is that their offline products – the packaging containers – can be digitally linked to an online transaction platform application that connects Vytal's user base – consisting of partners (food providers such as restaurants and canteens) and consumers (people shopping for take-out food). Vytal establishes this connection by lasering or gluing digitally readable QR codes on their packaging containers (Figure 2). The containers are sourced from production partners that manufacture the packaging containers to Vytal's material and design specifications. The QR codes allow containers to be uniquely identifiable and traceable, which allows Vytal to track and analyse



FIGURE 1 Vytal's distribution of partner restaurants in Europe (Vytal, 2022).

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relevant data from the product-in-use to understand take-out behaviours, delivery and return logistics data, utilisation rates, quality issues, and product mobility data.

Vytal's consumers benefit because they produce less food packaging waste and avoid the costs and efforts that traditional reuse-by-cash-deposit schemes incur. This is because consumers are only charged if they do not return used containers within 14 days. Moreover, food packing containers can be returned uncleaned at any participating partner site. This presents a marked difference from traditional reuse by cash deposits schemes that increase the perceived product price (e.g. Viscusi et al., 2011). Such schemes present zero value-added tax for partners and require them to manage payment handling on a margin-free product, which increases their risk of loss (e.g. Tura et al., 2019). In addition, they do not strongly incentivise customers to return containers quickly. This is however important because reusable containers consume more resources than single-use containers during production, which must be offset by achieving substantial return and reuse rates (e.g. Coelho et al., 2020).

### 3.2 | Vytal started with a simple app and 1000 deposit-free bowls

Vytal began its journey by building an innovative digitally-enabled circular solution for reusable containers in food retail, instead of building on the incumbent deposit-refund system typical for the food packaging industry. To incentivise consumers to participate, Vytal needed to build a system that would be free of charge if consumers respected a particular return period. Like a library system, where books can be borrowed, consumers only pay a fine in case they do not return their containers on time. From a psychological perspective, this makes a substantial difference to traditional recycling schemes via cash deposits because consumers perceive Vytal's solution as completely free-of-charge.

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But without monetary incentives, Vytal's system can only successfully operate if they nudge consumers to return containers promptly such that they can be reused because container utilisation is an imminent issue:

You have containers lying around somewhere at 3,000 partners. And it's super time-consuming to collect them again, because people don't want to give them away because they say, no, I need them again. And they have no incentive, the containers cost them nothing. And that is actually our challenge now, that we have too high deadstock, as we call it, containers that have not been used for 30 days. Exactly for this reason we are in the process of introducing a non-usage fee [...] We don't want to make money with this, but only create an incentive to return the containers free of charge.

(Chief operations executive)

At the same time, minimum threshold levels for participating partners and containers-in-use must exist such that consumers have sufficient convenient options available to return a container and enough containers are available for partners to hand out.

To achieve this, Vytal began developing an online platform application that would be capable of orchestrating food container transactions between partner restaurants, canteens, supermarkets, and end users. Vytal's initial platform application was basic and offered only digital functionality to check-in and check-out food containers through QR-code scanning at a provider's point of sale. However, from the start, the platform application was designed to be easy, user-friendly, and quick to use, which eased adoption and diffusion to consumers, but also different provider segments, from high-end restaurants to mom-and-pop fast food take-out stores. Opportunities to increase the quality and functionality of the platform application came later:

At the very beginning, the tech solution was still quite a rudimentary thing [...]. But I think that, especially in the beginning, we put a lot of focus on making sure that the part just works smoothly in order to really be able to grow.

(Online operations specialist)

Following the engineering of its online platform application and a purchase of an initial set of 1000 bowls, Vytal initially grew through the cold acquisition of consumers and partners in three markets (Cologne, Munich, and Berlin), which they selected based on offline partner density and online network effect potential. Whereas consumers were easily convinced of the advantages of Vytal's online-to-offline platform, signing on partners to the online platform application was more challenging due to the lack of available digital infrastructure in Germany's restaurants, canteens, and take-out shops. Before the Covid-19 pandemic in 2020, many restaurants, take-out shops, and canteens in Germany lacked smart devices or online point of sale systems equipped with the functionality to scan QR codes or operate the online platform application at the point of sale. Simply put, many providers simply could not connect to the platform application.

### 3.3 | New laws and regulatory changes boosted Vytal's growth

Two changes in the regulatory environment became important enablers for Vytal's growth (Davidsson et al., 2021). First, the governmental regulations and physical distancing measures during the Covid-19 pandemic led to a rapid spurt of digitalization in the German restaurant sector and also led to a surge in demand for take-out food delivery (Strotmann et al., 2022). In response, Vytal increased the distribution of its online platform application in the restaurant network in its key cities. Consumers experienced rapidly increasing access to Vytal's services at partner food providers of their choice.

Second, the arrival of a new federal regulation (the Packaging Act), which stipulates take-out food packaging to become reusable from 2023 onwards (Preußer, 2021), boosted Vytal's ability to acquire business partners. They successfully closed a partnership deal with the largest food delivery chain in Germany, which further propelled adoption by consumers and provided additional leverage in convincing further restaurants to join Vytal's partner network. Within three months since the introduction of the Packaging Act, Vytal grew its user base by 3000 partner restaurants.

To finance this growth that went hand in hand with higher demand for reusable containers, Vytal secured a Series A financing deal that eased their initial resource constraints. They acquired additional suppliers responsible for container production to match the surging demand for physical food containers with the rise in online platform users, both in terms of partner restaurants and consumers. In addition, Vytal acquired a team of digital engineers from another startup, which allowed them to develop new functionality for their online platform.

### 3.4 | Vytal started to systematically use data analytics to improve its operations

With these developments, the rapid increase in their user base of providers and consumers started to provide Vytal with increasingly large amounts of transaction data. In consequence, the ability to leverage data-based insights became a prime focus for Vytal's management team, which grew in parallel to their revenue growth. Correctly forecasting container demand volumes at each partner's site became critical to Vytal's growth. Capital expenditure for container acquisition is substantial, the shelf space to stack spare packaging at restaurants, take-out shops, or canteens is limited, and daily delivery of new bowls or boxes is costly.

Vytal decided to tackle this challenge algorithmically. They created a new product team to engage more seriously in big data analytics. This team is using algorithmic analytics to optimise container operations, including the sourcing and expansion of different bowl and packaging types, but also to examine consumer and partner data to fuel product innovations. Figure 3 shows an example from Vytal's analytics dashboard for container tracking, which can be used to forecast container demand volumes, optimise distribution route planning, and manage delivery fleets.

This strategic decision was effective. Predicting the amount and type of required packaging and the consumer return behaviours of used containers more accurately allows Vytal to extend the overall utilisation of containers, minimise manual labour, and reduce their total lifetime environmental impact. It allowed Vytal to substantially reduce



FIGURE 3 Screenshot of Vytal's algorithmic tracking of packaging containers.

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the ad-hoc reshuffling between close-by partners whilst also optimising the utilisation of Vytal's fleet of cargo bike carriers.

Moreover, the capabilities for data analytics also helped Vytal with partner management, for example, the identification of new restaurants or the acquisition of new bowl producers as suppliers. For example, a popular fast-food chain is planning the Germany-wide roll-out of Vytal's online-to-offline platform in 2023 after a successful pilot. A partner manager explained:

We receive a lot of orders via our app and then we have a heat map. It looks like a Google Apps map and then we can really see in which areas in Cologne, or for example in Hamburg, there is a delivery area one, which is the city center, and then delivery area two. And then we can look in our own app, where are the most orders coming from? And we also get that information from the delivery services. And they give us the data, but some of it is also freely accessible. We have data analysts in our team who actually pull this data from the web.

(Partner manager)

#### 3.5 Franchising the digital platform application means Vytal now goes international

As their partner network in main German cities became more saturated, Vytal also started to develop a franchising model for their online platform, which is now in use on four international pilot markets (Ireland, Norway, Sweden, and Mexico) with further franchising deals in development. Risks and costs of international expansion are minimal because the responsibility for the capital-intensive production or purchasing of packing containers rests with the franchisees. Franchising only the online platform application means Vytal is not required to tie up capital for offline product components, and their overall production capacity is bolstered through the international franchise partners, which expands the popularity and reach of their online-to-offline business model.

#### A FRAMEWORK TO MANAGE ONLINE-TO-OFFLINE PLATFORM 4 **BUSINESS GROWTH**

Figure 4 presents a framework to capture the strategic lessons that can be learned from Vytal's case. We conceptualise Vytal's approach to online-to-offline platform business growth as the orchestrated optimization of three interdependent components:

- 1. The online platform application: the platform software technology that connects consumers and partners and provides the ability to track both product and user data.
- 2. The offline product: the production and distribution of different kinds and volumes of food containers.
- 3. The user base: the network of partners (take-out food providers) and consumers (take-out food shoppers).

All three components are tightly interconnected, meaning that multiple linkages exist that a company must make strategic decisions about. Moreover, firms such as Vytal also operate in business environments that are geographically (e.g. they operate in mainland Europe but not overseas) or financially bounded (e.g. as a startup company, Vytal had to operate initially within the bounds of the financial investments they were able to secure).

In what follows, we provide three main lessons for online-to-offline businesses that can be distilled from Vytal's case. Each lesson introduces two strategic mechanisms that Vytal used to manage the interdependencies between its user base, offline product, and online platform application, within the constraints their business model operates in.



FIGURE 4 A framework for managing online-to-offline platform business growth.

### 4.1 | Jointly develop user base and offline product

Because firms with physical products are initially constrained by resource availability for production and distribution, trade-offs in growing online-to-offline platform business models must be made from the outset. Vytal dealt with this dilemma in two interdependent ways. First, from the start they invested in the growth of users on their online platform application to increase demand for physical product transactions. We label this first strategic mechanism as *demand-side expansion*, that is, growing the user base of an online platform application to increase demand for the offline product.

Demand-side expansion is a cost-efficient way to deal with resource constraints because growing the number of users on online platforms can be achieved more readily (Gawer, 2009) and quickly (Huang et al., 2017) than growing product transactions. Online platforms are reprogrammable digital resources (Yoo et al., 2010), meaning that they can initially be designed simply with only some core functionality and extended after launch in parallel, not before, starting to grow (Lehmann & Recker, 2022).

To achieve demand-side expansion, Vytal relied on *iterative development* (the incremental implementation of additional functionality) of their online platform. Initially, their platform only consisted of a basic check-out functionality but because the platform architecture was modular, Vytal extended this basic functionality with advanced features, such as routing and analytics modules, only as time progressed and more resources became available. Similarly, the initial consumer interfaces of the platform application only provided basic functionality such as check-out and payment but over time Vytal implemented additional features such as food pre-ordering, gamification, and the possibility to extend container rental periods for a small fee.

Iterative development keeps initial investment costs relatively low. Nevertheless, in online-to-offline platform business models, demand-side extension by growing online platform application usage needs to be matched with the availability of the offline product to the degree that users experience offline product transaction value and actively seek for more usage opportunities. Only then does increasing the number of online platform users create positive spillover effects. In Vytal's case, increasing the number of consumers by convincing them of their gains and creating a sensibility for environmentally friendly behaviour increased the pressure on food providers to join the platform as partners, just as a growing availability of partner restaurants visible on the online platform (Figure 1) made the platform more attractive for consumers.

Second, hand in hand with demand-side expansion, Vytal engaged in a strategic mechanism we call cost-effective product design, that is, the development of the offline product precisely to the specifications of the user base whilst

maintaining a focus on total costs of ownership and operation considering their financial constraints. Since building an offline product initially is more capital-intensive than building an online platform (von Briel et al., 2018), doing it right the first time matters. While an online platform is reprogrammable and can be deployed as a minimum viable digital product to be developed further after launch (Lehmann & Recker, 2022), ensuring the enduring quality of an offline product is critical at launch. For Vytal, creating precise material and design specifications that match the requirements of their user base (both partners and consumers) was essential for designing a quality offline product. One key design choice was to identify the right type of durable material for their containers that would withstand heavy use whilst minimising total environmental and economic costs over its lifetime, which were key requirements of Vytal's consumers. Another key design choice was deciding on product digitalization options in a way that would balance environmental and durability considerations in a cost-effective manner. For example, one key decision made by Vytal was to have bowls manufactured with guaranteed usability for up to 200 return cycles. Likewise, a decision was made to imprint bowls with microwave and dishwasher safe QR codes instead of the digitally more powerful but less durable and more costly RFID chips. Both requirements were critical to Vytal's partners.

Because this growth in offline product transactions requires higher capital investments than the iterative development of the online platform application, Vytal had to manage its financial assets very carefully and strategically. Growing the demand-side through initial investments in the online demand-side extension, allowed to control the financial risk and use their constrained financial resources in a more controlled fashion. Because QR code imprinting allowed Vytal to interconnect online platform application usage and offline container usage, Vytal was able to pursue *product flow optimization*, meaning that Vytal used analytics to minimise the number of food containers they needed to source by maximising the utilisation ratio for each food container in use. One of the executives explained:

By far the most important factor [for us] is capital need - we pre-finance the containers and therefore have to invest a lot of capital expenditure. These are paid back over the term (container break-even after approx. 20 uses). If we manage our partners' inventories better, this will have two effects: First, we need less containers and therefore less capital expenditure. Second, the containers rotate faster and thus achieve a better pay-back time (and thus yield per annum). But there is a capital-operational expenditure trade-off: If we reduce the inventories too much, we have to constantly deliver more and thus have high driver costs.

This interconnected optimization problem was difficult. In the beginning, Vytal managed this problem by operating only in selected high-density areas of major cities to minimise operational costs of container re-distribution whilst also maximising their potential to attract online platform application users. As they grew, Vytal then invested in advanced analytics to algorithmically optimise the balance between resource idle time, container utilisation ratio, demand, and routing choices.

### 4.2 | Leverage the insights from offline product transactions for online platform design

As an online-to-offline platform business, Vytal has to deal with geographical constraints because physical product transactions always involve movement and matter across time and space (Goebeler, 2022). In Vytal's case, these geographical constraints manifest primarily in the *location-boundedness* of product transactions (Banalieva & Dhanaraj, 2019). This means that Vytal had to make specific operational choices for re-distributing containers between partners within or across different cities or regions. Within high-density city regions, for example, Vytal owns small delivery fleets to redistribute containers between partners; however, inter-city transfers are managed through third-party logistics providers, which adds operational costs and complexity. Also, Vytal had to *strategically select* its user base. For example, they initially decided to offer their services only in selected high-density large cities.

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To deal with the dilemma that online platform transactions are location- and frictionless but offline product transactions are not, we learned from Vytal a third key strategic mechanism that we call *product and process datafication*. With this term, we mean that firms maintain a connection between offline product transactions and online platform application such that product and transaction data can be obtained and leveraged as soon as possible to address the challenge between expected and actual product flows allowing for an optimised availability of offline products through data analytics. For example, product and process datafication allowed Vytal to strategically select new partner food providers to onboard based on the location data of their consumer base and the most frequent container movements.

To enforce product and process datafication Vytal imprinted their food containers with digitally-readable QR codes and equipped their platform partners with software applications that allowed them to scan food containers upon distribution and return. And by starting in only three high-density city markets (Cologne, Munich, and Berlin), Vytal was able to quickly obtain product and transactional data in substantial volume. This helped them with the development and training of their forecasting algorithms but also with the improvement of operational excellence in their physical transactions, in particular distribution and routing of containers, because these were trackable (Figure 3). This linkage of product and product transactions to algorithms implemented in the online platform (e.g. for tracking, routing, and distribution) meant that Vytal could algorithmically optimise continuous offline product deployment based on the data captured through their online platform application. Vytal started automating most product handling processes, which allows them to manage its 6500 partner food providers with only eight full-time equivalent staff. Between April 2022 and April 2023, Vytal reduced its operational resource capacity needs per 100 partners by more than 50 percent.

A second way in which Vytal leveraged the interconnectedness between offline product transactions and online platform transactions was through a strategic mechanism we call *product-led platform design*. With this term, we mean that Vytal designed and adapted its online platform to the requirements of its offline product transactions. Having to deal with physical products means that production, distribution, and handling logistics need to be carefully optimised. For Vytal, consumers must be able to receive and return their used containers at as many partner restaurants as possible. At the same time, Vytal had to minimise bowl distribution through its cargo bicycle fleet to minimise the costs of physical operations. Moreover, container volume and container usage had to be perfectly balanced to minimise the total environmental footprint. Container turning time should be maximised to enable circular economy benefits. Digitalizing the product through QR code imprinting was thus key for Vytal to be able to learn from its product-in-use, which they did by equipping their online platform application early on with features for tracking and process analytics. Over time, they extended these features with advanced machine learning algorithms that would provide robust, precise, and timely forecasting capabilities to guarantee container availability levels that ensure partners' and customers' satisfaction whilst minimising physical distribution effort and total environmental footprint.

### 4.3 | Create a scalable online platform application that activates the user base

Strategically leveraging the interconnectedness between the online platform application and the firm's user base meant for Vytal that they engaged concertedly in *digital infrastructure scaling*. With this term, we mean that Vytal focused on building a robust and stable digital infrastructure that would enable scalable usage growth. Even though their business model involved offline products, Vytal realised that leveraging available digitalized product transaction data through their online platform application would be a key lever to activate the user base and increase online interaction frequency between partners and consumers. For example, through its online platform application Vytal offers advanced consumer analytics to their partners that prove helpful for the partner businesses to improve their own product-market-fit. Similarly, Vytal uses both gamification (Basten, 2017) and digital nudging mechanisms (Schneider et al., 2018) in its consumer-centric platform application to algorithmically influence its consumers to return used containers promptly.

A second way in which Vytal leveraged the connection between the online platform and the user base for growth is through what we call *user-based learning*, that is, the use of customer analytics functionality through the online platform applications about the demands and desires of their user base. Vytal uses its online platform application to systematically gain insights about their users about new product functionalities that would guarantee continued product-market fit and sustained consumer engagement. For example, Vytal uses algorithms to detect change patterns in user behaviour (e.g. patterns in the acquisition and return of food containers) and to analyse comments and ratings provided by consumers and partners. This ability is especially important in the food business because consumer demand and behaviour patterns are extremely volatile. Through user-based learning, Vytal was able to gain these insights, for example, for the decision to add new container types (such as for pizzas). They also leveraged user feedback analytics to continuously redesign key functionality of their application (e.g. the container check-out function) to improve usability and ensure continued consumer loyalty.

### 5 | IMPLICATIONS

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Vytal's case is not only a story about successful entrepreneurial growth. It is also a story about the interconnectedness between digital and physical elements in business, a friction that remains overlooked in much of the literature (Goebeler, 2022; Lyytinen, 2022; von Briel et al., 2018). The case not only shows that digital and physical elements are strongly interconnected in different ways, but it also highlights that this interconnectedness is at the core of strategic decisions both at the beginning of the entrepreneurial venture and during the remainder of the venture's path that follows. For example, Vytal's recent move to internationalise its business model through franchising agreements again involved strategic decisions about whether to franchise the online platform application only or to franchise product development and operation facilities as well.

Interconnectedness between online platform transactions and offline product transactions can be a dilemma for firms, such as when online demand for a food container – or a car (Uber) or an apartment (Airbnb) – cannot be met in the physical world because spatial properties such as location, time, size, volume, or other qualities do not match expectations or online promises. On the other hand, Vytal's story also demonstrates that the same interconnectedness, if properly leveraged, can also yield benefits to the business, such as when product and process datafication allows firms to analytically optimise offline operations or provide additional value-add services to online consumers.

In dissecting which of the lessons and strategic mechanisms present in Vytal's case might translate to other firms, it might be helpful to be reminded about the nature of different platform applications and the business models they spawn. Not all online-to-offline platform applications or business models are equal and so the interconnected-ness or constraints such firms face will vary from case to case. For example, firms such as Groupon, Uber, or Airbnb also experience interconnectedness between online platform transactions and offline product transactions that will for the most part be similar to Vytal. However, they cannot necessarily benefit from this interconnectedness in the same way: product and process datafication can be used by them to improve their platform application but not the product itself. Likewise, they can foster demand-side expansion by activating users on their online platform, but they have little control over scaling the offline product because they are operated by third parties. Because they own and operate both online platform application and offline products, Vytal was able to use agile, incremental approaches to continuously develop both product components and thereby continuously improve product-market-fit.

The case of Vytal not only yields valuable lessons for businesses operating online and offline, but it also provides several insights that are valuable for ongoing academic conversations. For example, the emerging literature on digital firm growth is providing several arguments for the assertion that digital business growth is different from traditional firm growth (e.g. Giustiziero et al., 2023; Huang et al., 2022; Piaskowska et al., 2021). Several studies show that online platform businesses can grow their user base exponentially and rapidly without equally growing their firm-level resource base (Huang et al., 2017; Josefy et al., 2015). Vytal achieved similar success given that they continue

to operate their business with a very limited number of staff. However, Vytal and many other firms do not exclusively operate in digital environments. Many businesses need to synchronise both offline and online resources, channels, or other business model components, not only during product development (von Briel et al., 2018) but also during use (Henfridsson et al., 2018). Our analysis of Vytal's case adds important insights into how the interconnected physical (offline) and digital (online) components of a business model can be managed in an orchestrated manner for firm growth. Our analysis suggests that neither online nor offline growth alone is sufficient because growth in one component inevitably increases operational pressure on the other. For example, when Vytal managed to boost acquisitions of restaurant partners and consumers on its online platform, it put considerable strain on physical container availability, utilisation, and distribution logistics. Likewise, when Vytal used the newly acquired funding to source new container types and volumes, they realised that they also had to invest in online analytics and algorithms because container tracking and distribution could no longer be handled manually.

A second contribution is that the framework in Figure 4 adds contextual nuance to already known mechanisms such as demand-side expansion (Parker et al., 2016), digital infrastructure scaling (Henfridsson & Bygstad, 2013), or user-based learning (Werder et al., 2020); thereby opening up avenues for further research at the critical junction between the literature on digital firm growth (e.g. Giustiziero et al., 2023; Huang et al., 2022; Piaskowska et al., 2021) and the digital transformation of traditional industrial-age product manufacturing and distribution firms (Cennamo et al., 2020; Chanias et al., 2019; Reinartz et al., 2019). For example, one of the lessons learned from the Vytal case is the importance of product-led platform design and cost-effective product design for firms working with offline products, but more research is required to understand how both design processes could be managed such that they beneficially reinforce each other. Furthermore, resource and geographical constraints affect the highlighted strategic mechanisms to different degrees, which future research should address further.

A third key implication that flows from our analysis is a need to pay more attention to the physical aspects of digital businesses. We are not the first to make this point (Goebeler, 2022; Lyytinen, 2022; von Briel et al., 2018) but our case adds substantial nuance to the idea that 'physical aspects still matter in the digital business world'. Vytal's case draws attention to how much volume, mass, location, and other spatial attributes matter to many aspects of their business. Their continuous challenge is to digitally optimise the right number and the right type of container at the right location and the right point in time. Whereas such a constraint may be easier to deal with by online platform businesses such as Bumble that can simply choose to operate only in regions where both the demand and supply side of the market are sufficient, Vytal must deliberately and consciously design their market, product, and platform strategies in light of such constraints. Moreover, for a company like Vytal, operational efficiency through product flow optimization is fundamentally important, as is the fact that their product design must meet multiple potentially conflicting requirements – scalable and powerful machine readability on the one hand, and durability during reuse and cleaning through dishwashers on the other hand.

A fourth implication concerns the question of the extent to which the lessons learned from Vytal's case can be generalised. As we explained above, Vytal is a special kind of online-to-offline transaction platform, which itself is only one kind of platform relevant to businesses. In turn, the insights about growth depicted here may not readily translate to other firms that operate online transaction platforms. For example, Netflix's use of online streaming platforms is not fully comparable even though they, too, at some stage included offline products (mail-order DVDs) in their business model (Dau & Wesley, 2012). On the other hand, we believe several of the lessons learned from the case of Vytal can be important to industrial-age manufacturing firms (think of Philipp's HealthSuite, Vorwerk's Thermomix offering, or Volvo's Connected Car initiative as examples) that have taken steps to expand into the online platform market.

### 6 | CONCLUSIONS

In a world where more and more traditional physical products are being digitalized and connected with online platform applications, companies must learn how to grow both online and offline. Vytal's story serves as a revelatory

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case about how the dilemma of joint online and offline growth can be managed successfully. And while not all sectors are comparable to the food delivery sector in which Vytal operates, we hope that the lessons that we can draw from this case will also serve other companies well.

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### APPENDIX. RESEARCH PROCEDURES A

### A.1 | Design

Our case study blends academic (etic) and contextualised (emic) knowledge perspectives (Davison, 2021). One member of the author team is the cofounder and head of operations and logistics at Vytal. One other member of the author team is an information systems researcher with a focus on digital innovation and entrepreneurship who has had a close relationship with Vytal ever since the launch of the company in 2019 (as a formal academic advisor during the initial founding rounding and as independent mentor and researcher since then). The third member of the author team worked on digital innovation and entrepreneurship topics including the study of Vytal as a post-doctoral research fellow during 2021 and 2022 and is now pursuing their own digital venture idea as an entrepreneur.

### A.2 | Data collection

During the initial stages of venture creation and growth between 2019 and 2020, the interactions of the academic members of the author team with Vytal were frequent but primarily informal and irregular. During that time, we jointly developed primarily emic knowledge of and familiarity with the context of Vytal, its business model, and operations practices. Specifically, the executive leadership team of Vytal and one of the academic members of the author team had several meetings, email exchanges, and phone conversations.

Since 2021 and with the addition of the third member of the author team, we moved toward academic (etic) knowledge creation practices. The two academic members of the author team engaged in formalised data collection involving semi-structured protocols and systematic collection and analysis of Vytal's operations. We performed eight semi-structured interviews with all key management personnel at Vytal, spanning roles such as co-founder, head of operations, head of partner management, product manager, project manager, and head of business intelligence. Interviews were on average 46 min in length, recorded and transcribed, amassing 108 pages, and followed a semi-structured interview protocol, which evolved throughout data collection as the focus of data collection iteratively shifted from understanding the offline and online components of Vytal's business model in general toward understanding the specific growth strategies involved in growing both components. We designed all protocols with a set of pre-planned questions to cover the subject area (Rubin & Rubin, 2004), in four parts: First, the context and role of the interviewe; second, how Vytal managed the offline and online product components of its business model. Third, Vytal's growth part and relevant growth success factors; and fourth, strategic levers used to grow online and offline. During the interviews, follow-up inquiries were used in addition to the protocol to gain a deeper understanding of the subject matter or to clarify individual responses.

The formal recorded interviews were complemented by dozens of informal telephone conversations and email exchanges to clarify and validate various aspects of Vytal's operations, in particular container sourcing, distribution, and fleet management.

Additionally, the two academic members collected internal materials from Vytal, such as consumer feedback reports and extracts from internal platform and analytics reports. We also scraped 37 pages of publicly available information such as press releases, interviews, case reports, and LinkedIn posts about the operations and achievements of Vytal. Finally, the co-founder of Vytal as part of our author team familiarised the remaining authors with the project and product management and business intelligence tools used at Vytal. We stored all data in a research database (Table A1).

### A.2.1. | Data analysis

Our data analysis strategy was primarily inductive (Miles et al., 2014). We aimed to develop deeper insights into why Vytal's growth path was successful and how they executed their growth path in the online and offline component

### TABLE A1 Emic research data collected from academic author team members.

Primary data						Total
Interviews	3	2	1	1	1	8
Key informants	Co-founders and executives	Operations specialists, online and offline processes	Product owner	Partner manager	Supplier	
Length (minutes)	123	101	55	44	28	351
Length (pages)	34	36	19	21	8	118
Secondary data						Total
Press releases, case reports, and public interviews						
Memos and notes						5 pages
Product and software demos						2
Code inspections						1

domains of their business model. We primarily used thematic data analysis to build a data structure that aggregated and grouped the identified first-order concepts adhering to the interviewees' terms into three second-order conceptual themes that feature in our framework, plus the seven linkages between them. Table A2 provides example illustrations of our data analysis process.

### TABLE A2 Illustrations for inductive coding of data.

First-order concept	second-order aggregate theme
Usage- and environmentally conscious design of features	Cost-effective product design
Management of two-sided platform markets	Product and process datafication
Demand expansion and production increase in certain areas	Demand-side expansion
Franchising agreements to grow usage of online platform internationally	Digital infrastructure scaling
	First-order conceptUsage- and environmentally conscious design of featuresManagement of two-sided platform marketsDemand expansion and production increase in certain areasFranchising agreements to grow usage of online platform internationally

(Continues)

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### TABLE A2 (Continued)

Example quote	First-order concept	second-order aggregate theme
We stood in front of the stores to address people and draw their attention to the issue. And the problem was that we had too few containers. Now we have the issue again that user activation is simply difficult, because we are now so big that you can no longer stand in front of a store to address people. It just does not make a significant difference anymore. We have 320 000 registered users now, do just about 10 000 borrows a day. It does not matter if you put someone in front of the store and they do five more interviews. Or ten.	Activating users and getting sign- on and feedback about platform	User-based learning

*Note*: We validated our findings and the recommendations we concluded in an iterative process. First, the two academic members of our author team drafted the analysis and a description of the findings. Next, we involved the third co-author, co-founder and head of operations and logistics at Vytal, and iterated the drafts of analysis and findings among us until we reached a broad consensus. Then, we reached out to the other members of Vytal's board of directors for their feedback and confirmation. This paper reports the outcomes of this iterative process of feedback and revision of analysis and findings. We used the same process also to validate our framework and the strategic mechanisms we propose.