

Big data analytics for developing sustainable capabilities of digital business ecosystems

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<a> INTRODUCTION

Achieving sustainable development is a complex challenge that has to be solved. Organizations are frequently on the frontline of such efforts, as addressing the sustainability demands of the increasingly aware customers, policymakers, and employees becomes a matter of survival. In their attempts to tackle sustainability challenges and keep up with the times, many organizations turn their attention to novel technologies (Hazas & Nathan, 2017; George et al., 2020), which has long been viewed not only as the grail of organizational competitive advantage but also as an essential catalyst for change and sustainable development (Newell, 2010; Grubb, 2004).

Lately, novel advanced *digital technology* has received particular attention. There are strong indications that they have a potential to positively support and enable organizational and societal transformation toward sustainability (Hazas & Nathan, 2017; Kewell et al., 2017; Höjer et al., 2018). For instance, Adams et al. (2018) discussed potential applications of blockchain, a form of distributed ledger technology, to deliver positive social and environmental outcomes. Salam (2020) examined the role of the Internet of Things (IoT) in building sustainable, resilient communities. Loy et al. (2016) explored 3D printing capabilities in supporting sociocultural sustainability. However, despite the increasing evidence on positive synergies between innovative digital technologies and sustainable development, knowledge of the phenomena remains fragmented and incomplete. This seems to be the case partially because much of the existing literature in this research area is conceptual in nature. In-depth empirical studies remain scant. Consequently, there is no deep understanding of how exactly digital innovation can be used for good, and what are the enabling processes, players, conditions, and mechanisms.

By drawing on the emerging literature on digital business ecosystems, this empirical study aims to address this gap by exploring the role of digital innovation, namely, (big) data analytics and related technologies (DAT), in the development of sustainable capabilities and using the industry of last-mile food delivery as the empirical setting. DAT lies at the heart of the digital business ecosystem of food delivery, enabling delivery firms' ongoing operations as well as short- and long-term decision-making. In particular, in this chapter, I explore the role of DAT in enabling various organizational functions and its implications for the sustainable capabilities of not only the delivery organization but also its wider business ecosystem, comprising partners, customers, and contractors. The two questions this chapter

aims to answer are as follows: “*How do organizations use data analytics and related technologies? What are their implications for sustainable capabilities of the digital business ecosystem?*”

Altogether, this study points to the important pathways toward more sustainable business practices paved by DAT and shows the crucial role of the *circular participation* and purposeful actions of ecosystem members in reaching such positive outcomes. Moreover, the findings of my work illuminate nonhuman actors (i.e., AI) as key decision makers, who play a critical role in the increasing sustainable capabilities of the digital business ecosystem.

In the following sections, I will first discuss the theoretical underpinning and key inferences from the existing relevant literature followed by the introduction of the empirical setting, methodological approaches, and findings. I will conclude this chapter by discussing contributions of this work to the literature as well as theoretical and practical implications.

<a> THEORY BACKGROUND

** Organizational sustainable capabilities**

Resolving global challenges such as climate change, social inequalities, and resource scarcity is becoming increasingly urgent. In fact, whole industries are under pressure to become more sustainable. One such example is the petroleum industry, which, in the age of renewable energy, is becoming increasingly pressurized and even stigmatized (Welin, 2020) by activists, governments, and the public. Reducing carbon emission, tapping into renewable energy, and building an overall more sustainability-oriented business model are some of the major goals on the agenda of many of these organizations. Another example is pharmaceutical organizations, which are required to address issues related to pollution and protect natural resources and wildlife from “pharma waste”. Increasingly, existing means of creating value, which frequently prioritize organizations’ bottom line over sustainability, are becoming obsolete, and many organizations face an urgent need to reinvent themselves. Consequently, developing sustainable capabilities is on the agenda of many organizations that would otherwise risk alienating their stakeholders (Soppe & Pershina, 2019) and jeopardizing their very existence.

Sustainable capabilities can be described as the ability to orchestrate resources effectively to achieve sustainable goals and develop more sustainable practices (Singh & El-Kassar, 2019). In the organizational context, sustainable capabilities often become integral to a strategy or a business model and frequently imply the creation of innovative solutions that address stakeholder needs and environmental imperatives (Liboni et al., 2017; Gabler et al., 2015; Hammervoll et al., 2012). Research has suggested that sustainable capabilities can be enabled via various internal and external mechanisms.

Among other, authors have mentioned the critical role of organizational culture, collaborations, and innovativeness in facilitating organizational sustainable capabilities (Sehnem et al., 2012; Hammervoll et al., 2012; Rashid et al., 2015). The literature also indicates that one way toward increasing organizational sustainable capabilities is using advanced technologies (Benitez-Amado et al., 2010; Hofmann et al., 2021) and harnessing the synergies between digital transformation and sustainability (Ranjan & Jha, 2019).

** Advanced digital technologies for sustainable development**

A scant but growing body of literature has suggested mobilizing novel digital technology (e.g., cloud and mobile computing, IoT, and blockchain) as a strategy that organizations can pursue to develop more sustainable business practices. For instance, IoT-based technologies, the core of the “smart” revolution, are predicted to transform a variety of economic sectors, for example, agriculture, medicine, manufacturing, and engineering. Among other, they are crucial to new and more sustainable ways of managing waste and energy and various industrial processes (Nižetić et al., 2020; Kumar et al., 2019; Beier et al., 2018). Blockchain technology, while is predominantly associated with Bitcoin is also applied to promote environmental and social sustainability (Kewell et al., 2017). One example of this is the SolarCoin initiative, which incentivizes producers of solar energy by rewarding them with blockchain-based digital tokens for megawatt-hours of solar energy produced (SolarCoin website). Altogether, Höjer et al. (2018) outlined four ways of how digital technologies can assist in reaching environmental goals. These include: “inform”, which refers to large amounts of data generated by digital means that can illuminate environmental issues; “replace” that relates to analog artifacts being replaced by digital artifacts; “intensify”, which describes the increase in the use of existing things achieved via digital means; “streamline” that refers to the optimization of resource utilization by using digital technology.

Although several studies have presented digital innovation as instrumental to enacting sustainable development, a degree of doubt and controversy remains (Tomlinson et al., 2020). For instance, some scholars suggest that the environmental benefits facilitated by digital technologies might be overestimated (Fusch, 2008), or that the positive environmental impact might be tarnished by the environmental footprint of the production and consumption of the technologies (Schneider, 2019). Reaching sustainable development is indeed a complex subject, with no one-size fits all solution (Hargadon, 2015). Ultimately, further empirical research is required, which can offer a fine-grained understanding of the phenomena and elaborate on how exactly the positive synergies between digital innovation and sustainable development can be achieved (Nižetić et al., 2020; Liboni et al., 2017).

This chapter aims to fill this gap by focusing on one particularly promising digital innovation that has lately been gaining momentum, i.e. (big) data analytics and technology. DAT can be defined as a “holistic approach” of collecting, managing, and processing large datasets to create actionable ideas

(Boyd & Crawford, 2012). Studies have indicated that the positive outcomes of big data go beyond economic value (Günther et al., 2017; Mikalef et al., 2020; Acharya et al., 2018), also bringing benefits to the society and the environment (Loebbecke & Picot, 2015; Günther et al., 2017). For instance, DAT has been shown to increase the understanding of the dynamics of infectious diseases (Chen et al., 2017), in smart energy management (Zhou et al., 2016), and promote citizen inclusion (GSMA, 2019).

However, the literature has also indicated that solving the complex challenges of sustainability is not possible by using solely digital technology or relying on single individuals or organizations (Reficco et al., 2018; McCormick et al., 2016). These different types of actors, while being critical pieces to the puzzle, cannot be considered in isolation. Rather, examining interrelations and interactions between them and how they affect sustainability could be a promising way forward (Pappas et al., 2018), which so far has received only limited research attention. A particularly useful theoretical lens to address this research gap is the concept of digital business ecosystems (DBEs).

** Digital business ecosystems**

DBEs is an emerging interdisciplinary research field that requires further conceptualization and theorization (Senyo et al., 2019). Research has suggested various definitions for a DBE, with a shifting focus from the technology to organizational aspects (e.g., Lenkenhoff et al., 2018; Briscoe, 2010; Selander et al., 2013; Koch & Windsperger, 2017). Overall, DBE can be defined as a business environment of connected organizations, individuals, and digital technologies that aim to co-create value. Examples of DBEs are diverse and abundant: an interorganizational network of car manufacturers acquiring digital mapping services to build smart vehicles (Koch & Windsperger, 2017); cloth manufacturers' building a "customer to manufactory" platform to eliminate intermediaries and reach customers directly (Hu et al., 2016); and organizations and consumers co-creating branding on social network platforms (Kamboj et al. 2018). Potentially, the most prominent examples of DBE are recently emerged organizations based on multisided advanced platforms, such as Uber, Airbnb, and TripAdvisor (Sussan & Acs, 2017; Alaimo et al., 2020). These examples show that DBEs are heterogeneous in character and content, they cross geographic borders and dissolve industry boundaries (Koch & Windsperger, 2017). DBEs comprise diverse types of actors such as incumbent organizations, new ventures, and individuals. Moreover, following the metaphor of a natural ecosystem, a DBE's distinction is the "digital species" inhabiting ecosystems (e.g., software components or apps) (Nachira, 2002), which are as crucial to the ecosystem functioning as its "living" counterparts.

The majority of DBEs, disregarding their composition, nature, and goal of collaboration, are characterized by mutually beneficial relationships leading to the creation of value greater than what can be achieved by any single organization (Senyo et al., 2019; Adner, 2006). Previous research on DBEs has predominantly focused on exploring co-creation of value in the context of business-oriented goals and objectives such as how to increase innovation capabilities, build a brand, or achieve a competitive

advantage (e.g., Adner, 2006; Selander et al., 2013; Kamboj et al., 2018). What seems to receive a limited attention is how DBE's participants can increase their sustainable capabilities to reduce the environmental burden associated with achieving economic performance (York et al., 2003).

There are indications that the ecosystem perspective might generate valuable insights into the development of sustainable capabilities of ecosystems and involved actors. Romanelli (2018), for instance, discussed the critical role of ICT and interactions among individuals, governmental agencies, and businesses in increasing the sustainability of cities and communities. Ma et al. (2018) empirically investigated the sharing mobility industry and discussed the crucial links and recursive processes among the actors of the evolving business ecosystem and the government in realizing digital innovation, which addresses a city's sustainability agenda. Taken together, this limited body of work indicates that achieving sustainable development requires the involvement and cooperation of various types of actors, and this frequently occurs around digital technologies.

In this chapter, I attempt to advance this line of thought by exploring how interactions among participants of a digital business ecosystem contribute to the development of sustainable business practices. Moreover, I explicitly focus on novel digital technology as a central participant of such ecosystems.

<a> METHODOLOGY

** Last-mile logistics: Digital business ecosystem of online food delivery**

The empirical setting for this study is the logistics firms providing last-mile delivery. Specifically, I focus on online food delivery. Online food delivery relies on the ecosystem of participants and is based on collaboration between incumbent firm partners (e.g., restaurants and groceries) and digital entrepreneurs — the delivery firms. Other critical participants of the ecosystem are customers who place orders and couriers who deliver the orders. These various types of stakeholders are united by a digital platform on which each has a dedicated digital space (i.e., a website or an app).

The increasing demand for delivered food is the impetus of the accompanying growth in the online food delivery industry. Some examples of organizations include delivery companies like “Deliveroo” (UK) and “Postmates” (USA). While many organizations started up by primarily targeting the food delivery market, some eventually diversified their portfolio with a range of applications. The food delivery application, however, potentially represents the most prominent case and illustrates well the value co-creation benefits within a digital business ecosystem. Here, delivery companies collaborate with restaurants, coffee shops, and other eating places whose menus they aggregate on a digital platform to offer end-customers a variety of dishes and cuisines. Customers select menu items and place orders via an app or a website. Couriers (frequently independent contractors making deliveries) pick up orders

from restaurants and deliver them to customers. Thus, customers can eat restaurant food at home, restaurants can outsource delivery and increase their digital presence and capabilities, and couriers can earn living on deliveries. The delivery firm makes money by charging restaurants and customers a fee (flat or per order). Despite being nascent, this rapidly growing market has attracted a substantial amount of investment and is expected to be worth at least \$200 billion by 2025 (Singh, 2019).

At the same time, sustainability practices of the digital business ecosystem of food delivery are controversial. Its members are experiencing three major sustainability challenges. One challenge is the carbon emissions generated. The last-mile delivery segment is considered not only as the most expensive part of logistics, but also as the most polluting one (Brown & Guiffrida, 2014). Another challenge is food wastage. Striking one third of food produced globally is lost or wasted, which threatens food security and the environment (Chalak et al., 2018; Papargyropoulou et al., 2019). Finally, the third challenge is the amount of disposable plastic and packaging waste generated by the ecosystem. For instance, a typical delivery might include multiple types of materials (e.g., cardboard, plastic, paper, aluminum foil, and styrofoam) (Chueamuangphan et al., 2020), with only a fraction of it being recovered (Aarnio & Hamalainen, 2008). According to the World Economic Forum, in the next 10 years, the demand for deliveries to the door will increase by 78%, which under today's conditions would exacerbate the sustainability problems (Whiting, 2020). Resolving them is becoming even more urgent in the light of the COVID-19 pandemic, which more than doubled the demand for online deliveries (Unnikrishnan & Figliozzi, 2020; Marketwatch, 2020)

Furthermore, many of the delivery firms are nascent and frequently built with data analytics at their core. DAT is widely used in the industry in many ways and across various organizational functions (Jeske et al., 2013): from powering machine learning models responsible for order – courier allocation and predicting customer demand to informing customer relationship management practices, with some organizations reporting reliance on data in 90% of decisions made (Wong, 2018).

Taken together, the case of the online food delivery industry represents a fruitful ground to explore the big data phenomena and to achieve the goals of this study.

** Research design, data collection, and analysis**

Due to the limited understanding of the role of data analytics in the development of sustainable business practices, this chapter adopts a qualitative exploratory research design. The main goal of this study was to advance the understanding of this phenomenon on the basis of comprehensive empirical insights, which required the collection and analysis of data from multiple sources (Miles et al., 2014).

The initial step in data collection was mapping out important players with head offices in Europe (mostly in Scandinavia, the United Kingdom, and Germany) and the United States, focusing on organizations that positioned themselves as firms at the intersection of food delivery and digital

technology. Most of these firms focus specifically on delivering food and related products in collaboration with restaurants and other food suppliers, but some of them position themselves as “generalists”. This initial step was crucial to building an understanding of the food delivery industry and each of the involved parties constituting the digital business ecosystem, as well as various use cases and applications of data analytics. Besides two informal conversations with the industry insiders, key activities in this initial step included collecting information on organizations from their websites as well as articles and publications on dominant players and the industry more generally, focusing on pieces especially relevant to this study’s research context. One of the informants pointed to developers’ blogs (e.g., <https://doordash.engineering/>) as a valuable source of information, which was added to the growing corpus of relevant data. Already in this initial stage, it became evident that data analytics play an essential, albeit often indirect, role in the development of sustainable capabilities. This preliminary investigation also uncovered notable and unexpected findings such as “nonhuman” participants of the digital business ecosystem. It shifted the research focus to explore in more detail not only “human” participants and how they use data but also nonhuman participants, namely, the decision-making algorithms and their role in developing sustainable capabilities within a digital business ecosystem. Such shifts in research focus are innate to studies characterized by exploratory research design (Saunders & Lewis. 2012).

The next step involved contacting relevant industry informants to discuss and further enrich the emerging insights. These industry informants included organizational members working with data analytics (e.g., data and business analysts and business intelligence specialists), business development, and various industry experts (e.g., researchers within the field and journalists specializing on the industry). Table 1 provides an overview of the dataset, which was mainly collected in 2020.

Data sources and details	Key issues and concerns
10 in-depth semistructured interviews with the delivery industry experts and representatives of delivery organizations working with data analytics or business development.	• Industry state of the art; • Involved participants and their roles and relations; • Use cases of data analytics across organizational functions; • Data analytics for sustainability; • Involved in the ecosystem tools, technologies, nonhuman actors.
98 items of magazine articles, online publications, organizational blogs, and developers’ blogs.	
App screenshots and “how to” sections (e.g., Deliveroo, DoorDash, Uber Eats).	• “Digital spaces” for stakeholder groups, functionality, and options.

Table 1. Data collection

Data collection and analysis were concurrent, as recommended by the literature on qualitative research (Miles et al., 2014). Data were coded and analyzed by using the strategy, which can be described as thematic analysis (Maguire & Delahunt, 2017). However, rather than exclusively applying open coding, a hybrid approach was used; thus, some themes were identified in advance, and others emerged during

the coding process (Fereday & Muir-Cochrane, 2006). For instance, some predesigned themes, which motivated the study or emerged during the preliminary data collection and analysis, included “digital business ecosystem of food delivery”, “data sources”, “sustainability challenges of food delivery”, and “applications and use cases of data analytics within food delivery organizations”. Some core themes, which subsequently emerged, included “challenges related to DAT implementation”, “nonhuman decision makers as critical participants of DBE”, and those related to “circular participation”. Figure 1 illustrates the analytical reasoning behind the development of “circular participation”, a core concept of this chapter.

Insert figure 1 about here

Figure 1. Illustration of data analysis process.

This approach to data collection and analysis enabled me to build a comprehensive account of the role of DAT in the development of sustainable capabilities within a digital business ecosystem of online food delivery.

<a> OPTIMIZATION AND DAT-ENABLED SUSTAINABLE CAPABILITIES

The analysis of collected data indicates that DAT primarily enables sustainable capabilities within a digital business ecosystem through the process of *optimization*, which refers to how DAT assists DBE participants to optimize their various systems, processes, and resource utilization. Ultimately, optimization contributes to reducing CO₂ emissions and food waste, encouraging environmentally friendly behavior and a more efficient use of resources overall. It is predominantly achieved by using two specific mechanisms: *enabling* and *supporting*. Enabling describes the crucial role that DAT plays in enabling nonhuman actors’ decision-making. Supporting relates to DAT’s supportive role of human actors’ decision-making. Figure 2 presents these findings in more detail.

Insert figure 2 about here

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Figure 2. Role of data analytics and related technologies in increasing and co-creating sustainable business practices within a digital business ecosystem of online food delivery.

Overall, DAT relies on a variety of data, sourced automatically via various online platforms and applications (e.g., the delivery platform and social media platforms) and provided directly by various stakeholder groups (e.g., data from suppliers and partners, couriers, and customers). Digital and nondigital actors and some core processes of various business functions rely on the collected data and

derived from it insights. At the same time, DAT enables the sustainable capabilities of the digital business ecosystem and contributes to reaching sustainability goals.

The following two sections explain Figure 2 and the findings of this chapter in detail. Specifically, I explicate the role of DAT in enabling decision-making in nonhuman actors and supporting human actors decision-making and its implications for the development of sustainable capabilities within a digital business ecosystem of online food delivery.

** Enabling decision-making in “nonhuman actors”**

<c> *Real time operational monitoring*

DAT is used in courier – order allocation and dynamic route optimization systems. Food delivery routing is a dynamic vehicle routing problem and a major challenge in the last-mile logistics (Reyes et al., 2018), which has been extensively discussed in the existing literature (e.g., Greco, 2008; Reinelt & Rinaldi, 1995). This is the case due to the on-demand nature of the industry, the scale of operation (thousands of orders simultaneously), high standards and expectations (e.g., delivery of piping hot meals within minutes), and unpredictability (e.g., fluctuating demand, traffic congestion). DAT is crucial in building a responsive, flexible business ecosystem that can solve the dynamic routing problem. This used to be performed manually, but today, delivery firms rely on artificial intelligence.

Such nonhuman actors are commonly employed in the industry and are especially important in facilitating key ongoing operations. One example is Deliveroo, whose engineers built a “super smart” dispatch engine they call “Frank”, named after Danny DeVito’s character from the television show “It’s Always Sunny in Philadelphia”. Frank succeeded another dispatch engine called “Louie”. Among other, Frank has a capability to “change its mind” and reassign orders on the basis of real time data. Moreover, engineers at Deliveroo created a visualization tool called “Frank’s Brain” to observe the inner workings of Frank’s decision-making (Pudwell, 2017). Deliveroo’s Frank is not alone on the mission. In fact, the digital business ecosystem of online delivery is bubbling with “cyberlife”. DoorDash, for instance, has created a dispatch engine called “Sibyl”, named after the Greek oracle known to utter predictions in “an ecstatic frenzy” (Zeng, 2020). Similarly, the delivery giant UPS employs “Oreon” to optimize routes and reduce delivery miles by 100 million (Marr, 2019).

These nonhuman actors distribute orders among the couriers in the most optimal way in real time. Given unpredictable conditions of “living, breathing cities”, they must consider multiple data points such as courier and restaurant locations, possible travel routes, food preparation time, the number of couriers on the road, and weather conditions — data that enable them to select a courier and to calculate the most optimal delivery route. Such advanced digital technology becomes even more critical in facilitating “order stacking” - situations when a courier is assigned multiple orders per trip.

Using DAT to address such operational objectives ultimately benefits all ecosystem participants. Customers receive their food as quickly as possible and can track their orders. Couriers, due to not losing time waiting at restaurants' doorsteps, can secure more deliveries and increase their earnings. For the delivery organization, DAT makes delivery more efficient and reliable. For instance, Frank enabled Deliveroo to decrease the delivery time by 20% (Shead, 2017). In a business in which customers value quick delivery and hot food, the speed of delivery becomes a competitive advantage.

Regarding organizational sustainable capabilities, optimization of key organizational systems and processes leads to **finding optimal delivery solutions**. This seems to positively contribute to crucial environmental goals, for example, reducing greenhouse gas emissions. In this particular case, this positive effect is achieved because of the possibility of using one courier trip for multiple orders and by calculating optimal routes to destinations, eliminating unnecessary mileage. As one of the interviewed experts shared with me, *"...the beauty of it is that these algorithms are self-learning, they keep refining itself. It significantly improves efficiency of food delivery... Optimizing vehicle routing and cutting time that couriers spend on the road positively contributes to cutting carbon emissions. You know, this huge global problem has to be addressed at all levels... So absolutely, advanced digital tech, AI particularly, can have an impact on the environment."*

Advanced algorithms also contribute to increasing sustainable capabilities by **enabling innovative business models**. For instance, New York's food tech startup "Gebni" applies what they call a *"Stock market for food"* business model. The firm's vision is to decrease food waste, a goal mainly achieved by enabling users to place orders weeks in advance and by adjusting prices in real time. Specifically, Gebni's business model relies on an advanced algorithm that analyzes the demand for menu items in real time to optimize an item's prices by increasing or decreasing them accordingly. According to Gebni's CEO, *"What makes our algorithm unique and effective in fighting food waste is that we do not update prices of menu items as a whole but rather dynamically price major ingredients making up the item itself"* (Food Tank, 2017).

** Supporting "human actors" decision-making**

DAT supports decision-making across different organizational functions and levels. In the food delivery industry, organizations draw from multiple data sources to generate business insights that support marketing, customer relationship management, product management, strategic decision-making, and operational capacity planning. For instance, on the question "What are you using data analytics for?", one of the interviewed senior data analysts replied, *"It is easier to say what we are not using it for. Data is the foundation of our organization, it was built around data"*. Notably, this case is ubiquitous in the food delivery industry. For example, according to senior staff at Deliveroo, data runs through the veins of everything they do, and every single employee probably uses analytics at least once a day (Looker,

2018). Among other, interviewees mentioned that DAT assists with making data-driven decisions, increasing understanding of customers' tastes and behavior, adjusting to market shifts, tracking marketing efforts, and market segmentation.

<c> *Strategy and operational capacity planning*

One, especially relevant to sustainability example, is the role of DAT in operational capacity planning (Figure 2). The largely unpredictable nature of the industry does not prevent organizations from attempting to forecast demand in hope to **optimize utilization of resources** — a crucial factor for a profitable business in logistics (Jeske et al., 2013), and an essential sustainability consideration. As stated by an informant: “...our data forecasts food demand... We can see which city area is the busiest, which helps with resource allocation...Forecasting demand increases the margins and reduces waste”. Capacity planning is, therefore, a vital business function. Here, DAT's predominant roles are supporting organizational members in forecasting short- and long-term demand, locations, and the number of couriers required on duty and identifying trends important for investment decision-making. Improving predictive capabilities of advanced regressions and modeling techniques requires a range of input data such as geographic location, time of the day, day of the week, events, season, and weather conditions. By drawing on historical data, DAT supports decision-making by providing insights into important patterns and trends. This approach enables organizations to scale the capacity up or down depending on the forecast, which translates into increasing the efficiency of the use of resources in the long run and in day-to-day operations. Ultimately, it increases organizational sustainable capabilities.

<c> *Partner relationship management and DAT-enabled sustainable capabilities*

The findings of this chapter also demonstrate that DAT is crucial in enabling organizational partners (i.e., restaurants and other food suppliers) to achieve growth and increase their sustainable capabilities. As aforementioned, delivery firms collect data from a variety of various sources. Based on this data, analysts derive critical business insights related to general trends and patterns as well as insights specific to each single partner. The general trends illuminate order peak times, macro food trends, popular cuisines, as well as the relations among various factors such as gender, weather conditions, seasons, holidays, and orders. For example, women are more likely to order cupcakes, sushi, or salads, while men are more likely to go for meals containing bacon (Samuely, 2017). Insights specific to partners relate to ratings, delivered orders, preparation times, and outcomes of marketing efforts.

The findings of this chapter demonstrate that DAT is crucial to understanding and **managing surplus inventory**, namely, the excess food and ingredients that restaurants buy or produce. As stated by one of the experts, “There are many benefits of data analytics. I think everyone learned to appreciate it... Forecasting demand is a powerful tool, it helps to make better decisions... It [forecasting] helps to increase the net profit by reducing waste... So, yes, it has this environmental effect”. Reports and dashboards highlight the underperforming menu items, leading to menu optimizations. Infrequently

ordered items are removed, replaced, or adjusted. DAT also assists partners in decreasing food waste by providing insights into ingredients that have not been used or sold and by assisting in their utilization. Some initiatives involve partnerships with third-party food recovery organizations (e.g., Copia), which redistribute unsold restaurant food to nonprofit organizations. Over time, combined data insights, namely, those provided by Copia and the delivery firm to their partner restaurants, enable restaurants to understand overbuying and overproduction. DAT helps organizational partners **optimize their resource utilization** and consumption by pointing out, for example, infrequently ordered menu items, ingredients, and demand spikes, reducing overbuying and overproduction (cutting food waste). For instance, using such data insights, VIOS, a virtual spinoff brand of a Greek restaurant, decreased food waste by up to 15% (Wong, 2018). Ultimately, improving the understanding of consumer preferences and what ingredients are frequently left in stock helps partners avoid surplus inventory and increases organizational sustainable capabilities.

<c> Product management and the creation of new sustainable product features

Building new and managing existing products is a complex organizational endeavor (Pershina & Soppe, 2017). Here, DAT frequently plays an essential role. Among other, it supports the product design and development efforts of product teams and is instrumental for experimentation. Experimentation enables teams to identify product features and initiatives that work best. DAT assists teams with evaluating the effects of product change overall and across customer segments or geographic markets. Moreover, DAT is used to identify areas for product improvement. This is predominantly performed through the analysis of customer feedback and data projects dedicated to increasing the organizational understanding of how consumers use product features.

The findings of this chapter demonstrate that DAT often plays an important part in enabling more sustainable product options and features. For instance, as stated by one data analyst, the data insights his team produced showed that the majority of their customers order food to their homes, and if given the choice, would opt out of receiving disposable plastic cutlery. Many customers would also like food in eco-friendly packaging. After implementing some of the changes to the product (e.g., opt-in to cutlery function), DAT also helped to test and evaluate customer reaction to the change. Analyzing in-app user activities represents a more objective way to build an accurate picture of consumer's genuine behavior and sentiment. Ultimately, DAT is a useful tool for **the development of more environmentally friendly product options**.

* Circular participation*

DAT can contribute to environmental sustainability of the digital business ecosystem. My findings, however, point to a crucial condition necessary for enabling such positive outcomes: *circular participation*, a novel concept that this chapter introduces. Circular participation is a concept that describes the circular nature of data exchange and participation required for enabling positive

sustainability outcomes. It relates to the willingness of DBE participants to share required data with the focal organization and then act on derived sustainability-oriented insights and product options (Figure 3).

Insert figure 3 about here

Figure 3. Circular participation.

First, DBE participants must share relevant data with the delivery firm. For instance, partners would share information on products, ingredients (e.g., local origins, being “eco”, and CO₂ emitted during its production), and dishes’ completion time; customers - survey answers and feedback; couriers - their location, choice of transportation, and availability. Second, DBE participants would have to choose to act in a sustainable manner on data insights or product features provided by the delivery firm and enabled by DAT. One illustration is a courier’s choice of transportation. While data insights show that cycling is sometimes the fastest way to reach customers, couriers (riders) need to choose to use bicycles. Similarly, restaurants need to choose to donate food surplus or optimize their menus to reduce food waste. Customers need to choose to “opt-out” from cutlery and condiments, use the “shared delivery time” option, buy “discounted meals” or preorder meals days in advance. Therefore, sustainable capabilities within a digital business ecosystem require sharing various data with the delivery firm and acting on the insights derived from it.

<a> DISCUSSION

This chapter’s main goal was to explore how organizations use DAT and its implications for sustainability. Here, it is important to acknowledge that many of the DAT-enabled environmental gains described in this study primarily stem from organizations’ desire to optimize their processes and resource utilization to decrease the associated operational costs. However, it also seems that the growing environmental awareness and the understanding of DAT’s potential and its proliferation across various organizational functions increasingly influences organizations to also *intentionally* search for synergies between digitalization and sustainability. This search, among other, sometimes leads to the deliberate creation of novel sustainable business models and product functions and features that encourage improved environmental behavior. Overall, this study illuminates how DAT assists DBE participants in decreasing food waste, carbon emissions, and overexploitation of a DBE’s resources. In the remaining paragraphs, I elaborate on the contributions of this work to the literature.

Most studies on DBEs have explored their value creation capabilities in the context of commercial goals and objectives (Kazan et al., 2015; Selander et al., 2013). This chapter shifts this focus towards co-creation of sustainable values through participation and data exchange in a digital business ecosystem. Particularly, this study highlights the crucial role of interactions among involved actors, reaffirming

that positive sustainability outcomes frequently require joint efforts of multiple stakeholder groups (Reficco et al., 2018; McCormick et al., 2016). The findings of this work also indicate and elaborate on specific roles these different stakeholders play in enabling such positive outcomes.

Moreover, this chapter focuses on the use of cutting-edge digital technologies and related interactions among DBE participants. Specifically, the findings indicate that DAT plays a crucial role in enabling the sustainable capabilities of DBE via two specific mechanisms: *enabling nonhuman decision makers* and *supporting human decision makers*. These mechanisms ultimately lead to finding optimal delivery solutions; enabling novel, more sustainable business models; managing surplus; and developing more sustainable product options and features. Researchers have proposed that digital technology may assist with “streamlining” and “intensifying” resource utilization, thus positively contributing to sustainability (Höjer et al., 2018). My study empirically contributes to this line of work by explicating concrete mechanisms and conditions required to enact such positive outcomes using DAT.

Importantly, the findings of this chapter illuminate the profound significance of nonhuman participants of the ecosystem (e.g., “Frank” and “Sybil”), who, together with human actors (e.g., employees, customers, and partners), collectively contribute to the development of DBE’s sustainable capabilities. Thus, while most researchers have focused on the creation of value together with customers and partners (Kamboj et al., 2018; Ceccagnoli et al., 2012; Prahalad & Ramaswamy, 2004), this work underscores the importance of digital entities. With that, my chapter answers recent calls for more research on emerging technologies and their integration within DBEs (Senyo et al., 2019).

Overall, this research contributes to the emerging body of literature examining the effects of digital technologies on sustainability (Singh & El-Kassar, 2019; Höjer et al., 2018; Seele & Lock, 2017). Specifically, the findings of this chapter demonstrate that although digital technology can be applied “for good” (Kewell et al., 2017), in many cases, such positive outcomes seem possible only through *circular participation*. This insight indicates that sustainable capabilities within a digital business ecosystem require not only sharing data (Singh & El-Kassar, 2019) but also embracing its outputs and acting on the insights.

More generally, the findings of this work contribute to increasing our understanding of how positive sustainability effects can be achieved through collaborations between digital entrepreneurs (delivery firms) and analog “pre-digital” incumbents (restaurants and food suppliers). With that, while a majority of existing research adopts a macro perspective that frequently illuminates competition and incompatibilities between pre-digital incumbent regimes and emerging digital entrants, this study emphasizes the cooperative dynamics between them and the sustainability potential of such settings (Markard et al., 2012).

<a> CONCLUSION

Digital technologies transform existing and trigger the creation of novel business landscapes, resulting in cost reduction, efficiency, and overall commercial gains for its various actors. Such positive outcomes of digital technologies however might offer more than mere economic benefits. This chapter illustrates the potential of digital technologies in opening up more environmentally friendly routes for organizations and their partners and customers. However, although digital technologies harbor such potential, realizing it requires involvement, close collaboration, and purposeful actions of multiple stakeholder groups. Digital technologies are powerful but ultimately just tools. In the end, it is up to organizations and individuals to decide whether to realize the sustainability potential within them and catalyze the change toward a more sustainable future.

In conclusion, although this chapter offers essential empirical insights into the synergies between digitalization and sustainability, the net environmental impact of DAT is difficult to determine and beyond the scope of this chapter. E-waste, increasing electricity demands, exploitation of rare earth metals are some of the concerns that surround digital technologies production and use. With that, some central questions remain largely unanswered: Are digital technologies ultimately good or bad for the environment? How can digital innovation be responsibly built and used for the benefit of the environment and humanity?

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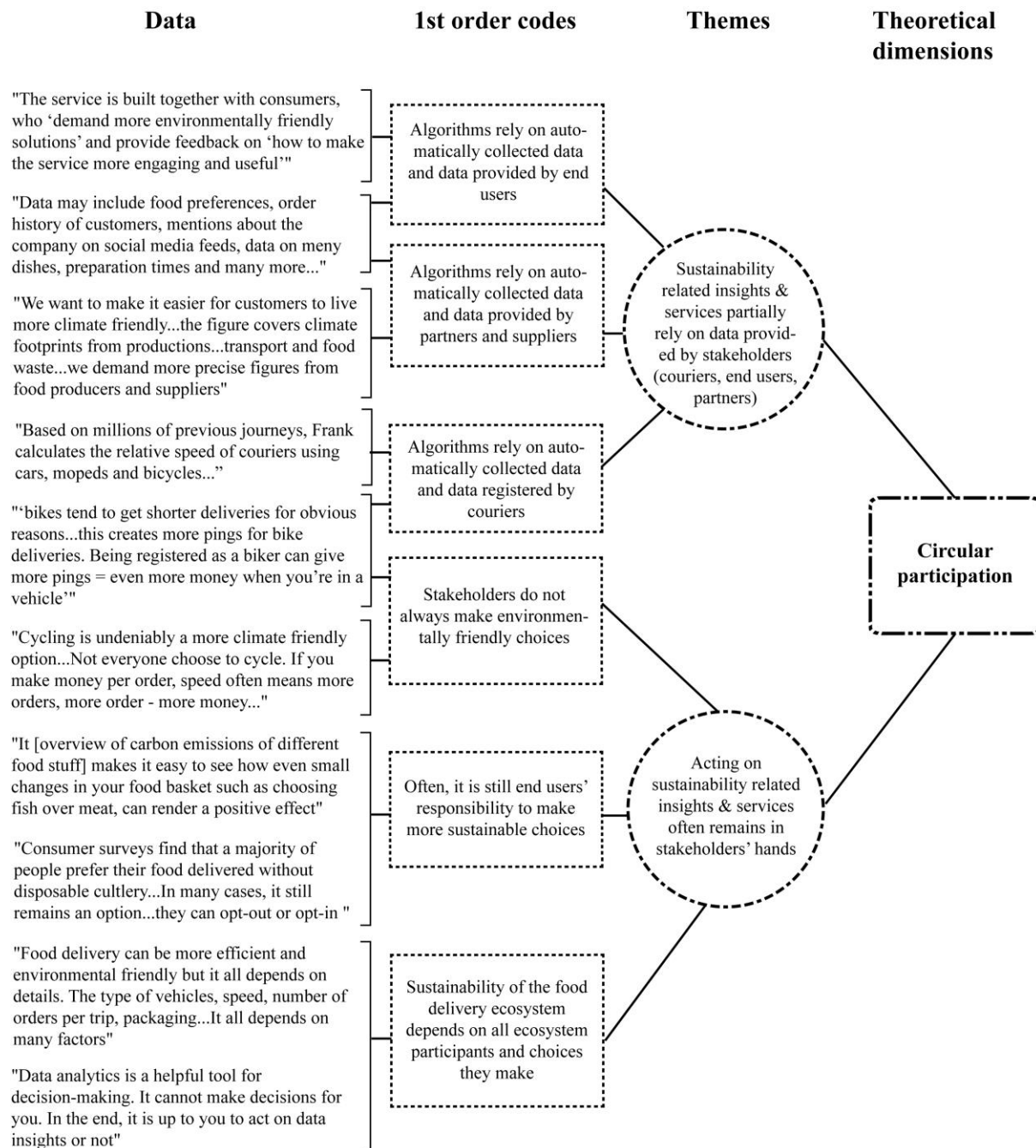


Figure 1.

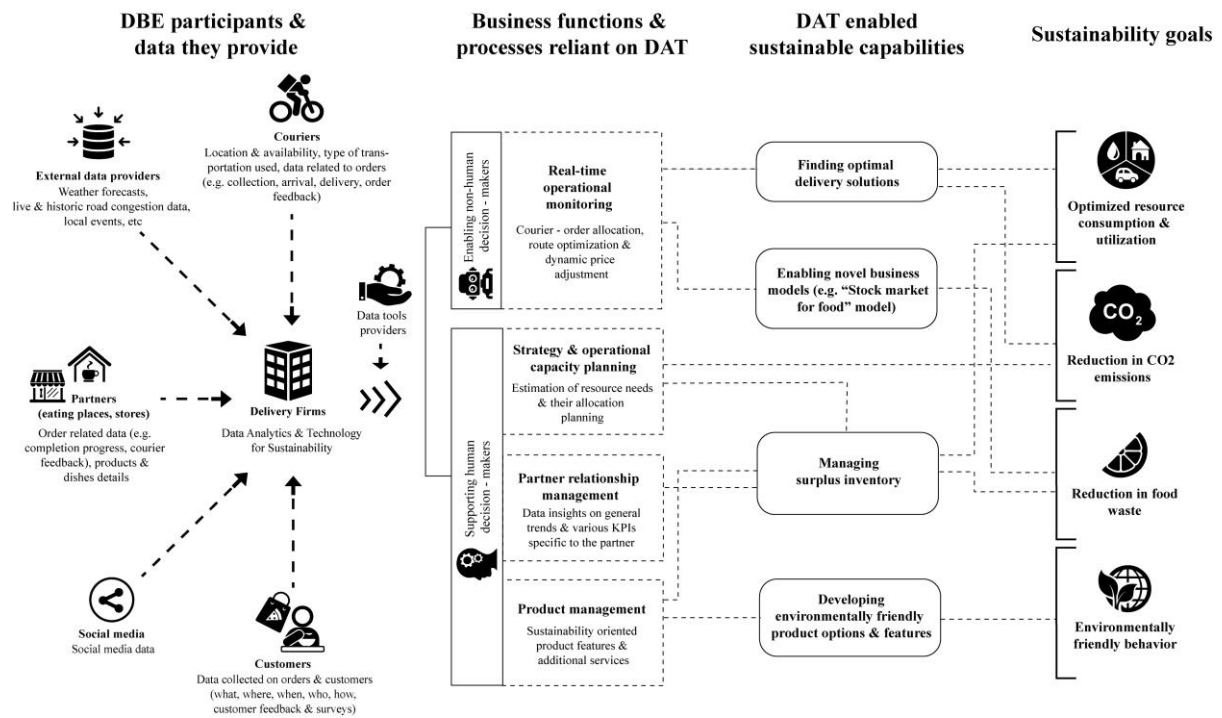


Figure 2.

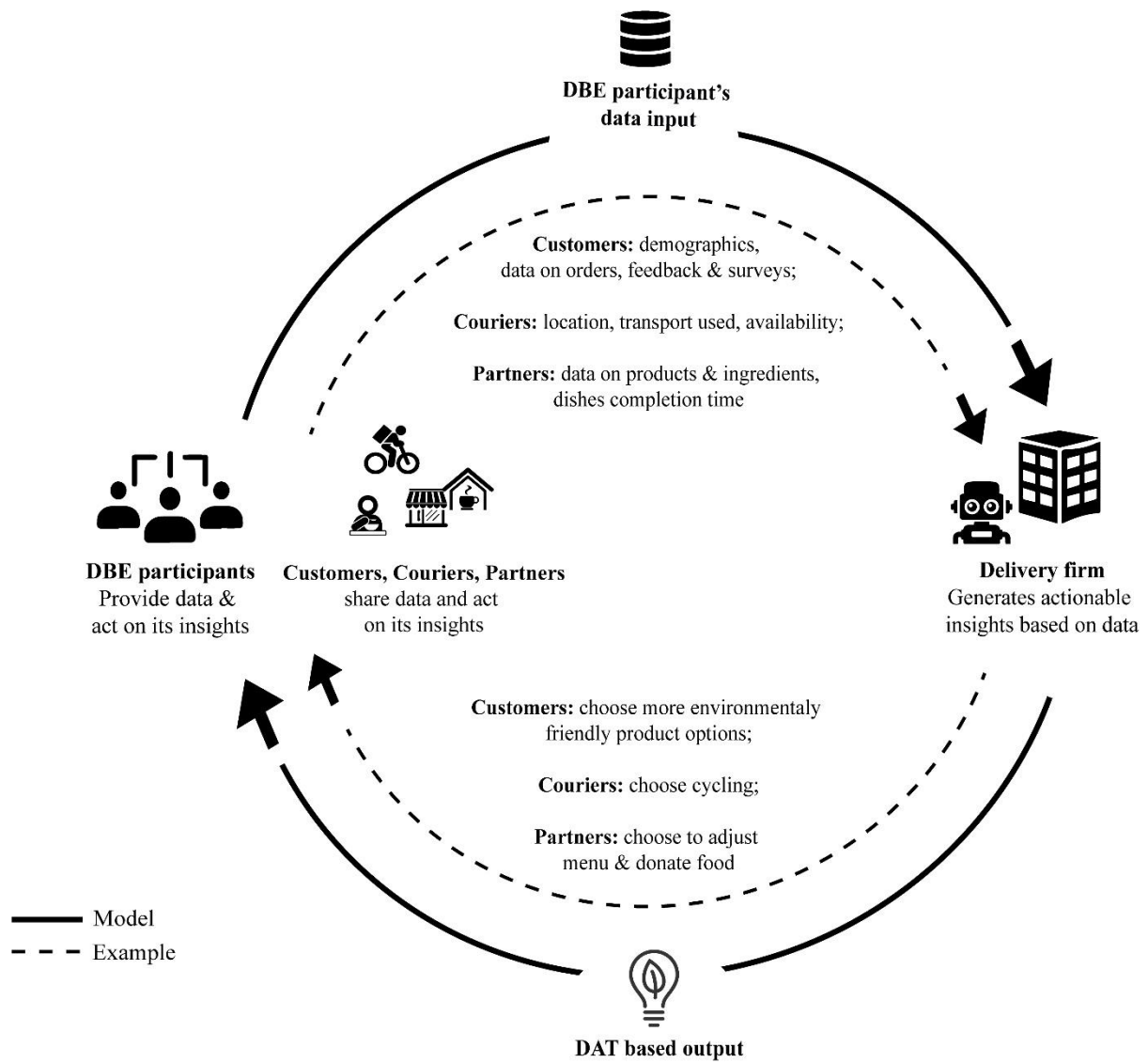


Figure 3.