



Fashion platform operations in the sharing economy with digital technologies: recent development and real case studies

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Abstract

With the emergence of digital technologies, we have witnessed a rapid growth of the sharing economy in recent years. In fashion industry, sharing economy concept is also widely applied. Instances can be found all over the world, like Rent the Runway, Golden Tote, Stitch Fix, and Le Tote in the US, Air Closet in Japan, Y Closet, Ms Paris, and Dora's Dream in China, etc. In this paper, motivated by the industrial practices of fashion sharing platforms, we first conduct a literature review on business operations of sharing platforms, including the sharing platform operations, digital and information technologies employed in sharing economy, business models, and sustainability and circularity in business operations. Afterwards, we analyze the challenges faced by fashion sharing platforms by exploring the two leading fashion sharing platforms in the US and in China, respectively. At last, we propose future research directions on fashion sharing platform operations and conclude the paper.

Keywords Digital technologies · Blockchain · Information transparency · Sharing economy · Fashion industry · Sustainability · Case studies

1 Introduction

Sharing economy was first proposed in Weitzman (1986), considered that the essence of the sharing economy was a wage system, and the marginal costs were less than the average labor cost. The sharing economy, where peers can offer and purchase vast kinds of products and services, such as property, resources, time and skills (Woskow, 2014) from each other through an online platform, is continuously observed in industries. At present, it has increasingly gained attentions from both industry and academic. In this paper, motivated by the industrial practices of fashion sharing platforms, we analyze the challenges faced by fashion sharing platforms and propose future research directions.

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1.1 Industrial motivation cases

With the emergence of digital technologies, we have witnessed a rapid growth of the sharing economy in recent years. Accompanied by the rapid growth of the sharing economy recently in practice, the concept of sharing has been introduced into plenty of industries. As indicated in Woskow (2014), industries focus on three sectors where the sharing economy is increasingly well-established, i.e., personal and commercial space, transportation of car clubs and ride sharing, time and skills. Vehicle industry is the most popular and developed industry in sharing economy, such as the car sharing platform like Uber, Didi, Caocao and Togo. There are also quite a lot of bike-sharing platforms, such as Mobike, Bluegogo, Hellobike and BeeFly. The first one is the leading company in the bike-sharing platform in China, and the last two companies provide electrical bicycle sharing services. Significant growth potentials have been detected in fashion, food, and personal item industries. Other industries relate to daily life product, such as portable battery, umbrella, camera, even office and accommodation platforms like Airbnb, etc.

In fashion industry, sharing economy is quite popular. Many sharing platforms can be found throughout the world, like Rent the Runway, Golden Tote, Stitch Fix and Le Tote in the US, Myonbelle in Germany, ByRotation in UK, Air Closet in Japan, Style Theory in Singapore, Y Closet, Ms Paris and Dora's Dream in China, etc. As consumers become more environmentally and rationally nowadays, fashion industry employs sharing services to fulfill the requirements of consumers. Sharing economy in fashion industry can provide services like swapping, renting, and resale instead of purchasing new ones. According to the 2019 Future of Fashion & Retail Consumer Survey of CGS (Computer Generated Solutions, Inc.), fashion is the most common rental service, and the survey indicates that more than 70% of consumers are willing to pay \$50 or more on fashion sharing services, especially for luxury products.¹ The trend of "rentable/sharing fashion" rapidly becomes a mainstream in the current fashion market. It is estimated that the revenue of the global fashion sharing market will grow steadily from 2021 to 2025, and the global revenue of the market is expected to exceed around seven billion U.S. dollars by 2025.²

Although the competition in sharing economy is fierce, some of the companies still have gained large amount of revenue and market share. For example, Rent the Runway, has 8 million community members now and gains \$100 million revenue annually³. The platform is entering into the fast-growing period, and trying to go public. By contrast, some platforms, which emerge in the very recent years, are still struggling or even step back from the market, such as Dora's Dream. Set up in 2015, the Dora's Dream App cannot be accessed after two-year operations, which indicates a failure story. Y-Closet, which grew fast in the past five years, suddenly closed in the middle of August in 2021. Many successful cases of sharing economy are experiencing explosive growth (such as Airbnb and Uber in the US), which have catalyzed a vibrant sharing economy discourse, participated in by the media, ICT industries, venture capitalists, entrepreneurs and grassroots activists (Martin, 2016).

¹ <https://www.cgsinc.com/blog/sharing-economy-and-its-impact-fashion-and-apparel> (Accessed on 26 Aug 2021).

² <https://www.statista.com/statistics/1195613/rental-apparel-market-revenue-worldwide/> (Accessed on 26 Aug 2021).

³ <https://fortune.com/2021/07/21/rent-the-runway-ipo-filing-luxury-spending-parties-events-post-covid/> (Accessed on 26 Aug 2021).

At the beginning, people think positively for sharing economy, however, many problems have emerged recently. As been observed from the news, tonnes of sharing bicycles from different companies are stacked up together, including the usable products and those in need of repairs.⁴ Therefore, the government should show help to find the best solutions and regulations for the sharing platform (Cannon & Summers, 2014), by fully understanding existing obstacles. Schor (2016) declares that sharing economy has led to regulatory and political battles. Similarly, Woskow (2014) suggests the government should update its procurement frameworks, so that sharing economy platforms are still one choice for customers when travelling, alongside the more traditional services. Observing the successful cases like Rent the Runway and other unfortunate cases like Y-Closet, it is necessary and important to analyze the obstacle and challenges that the sharing platforms face, and derive the possible strategies for better operations.

1.2 Research questions and contribution statements

Motivated by the practices in fashion sharing industry and literature review, in this paper, we aim to address the following important research questions regarding to sharing economy:

- (1) In the digital age, what are the present main research domains in the literature of sharing economy, and what are the related research findings?
- (2) What are the challenges in practice for the fashion sharing platforms, e.g., with respect to the use of information?
- (3) What are the important operational strategies in the fashion sharing platforms?
- (4) Is the (fashion) sharing platform sustainable to the environment? What are the optimal strategies?

To the best of our knowledge, this is the first paper in the literature that focuses on fashion sharing economy and real cases. A case study is established to further introduce the two famous platforms' operations strategies and examine challenges faced by platforms with comparison. The challenges faced by the current fashion sharing platforms are analyzed, and potential solutions to handle with the challenges are derived in this paper. The findings in this paper can fill the research gap both in literature and in real world practices in fashion sharing economy.

The rest of the paper is as follows. We conduct the comprehensive literature review in Sect. 2 including platform operations, digital and information technologies, business models, sustainability and circular economy. Section 3 is a case study of two fashion sharing platforms, i.e., Rent the Runway in the US and Y Closet in China. The operational strategies in both of the platforms are studied. In Sect. 4, we proceed to discuss the features, challenges and potential solutions in fashion sharing platforms, and propose future research directions accordingly. Finally, we conclude this paper in Sect. 5.

2 Review of related studies

In the literature of sharing economy, tremendous works arise during the last decade. We conduct a literature review on business operations of sharing platforms. To be specific, we search papers published in English in Google Scholar and ScienceDirect, and exclude edito-

⁴http://www.xinhuanet.com/2019-05/20/c_1210138736.htm (Accessed on 2 Feb, 2021).

rial materials, early access and proceeding papers. We searched for the works in recent five years with the key words of sharing economy and sharing platform for literature review. Cheng (2016) reviews the works in sharing economy and reveals that there are three main research foci with sharing economy in general, i.e., the business model and its impacts, the nature of sharing economy, and the sustainability development in sharing economy. In this section, research works related to sharing platform operations, digital and information technologies, business model, as well as sustainability and circularity will be reviewed one after another.

2.1 Platform operations

Sharing economy is well known in business-to-business (B2B) domains (such as the sharing of machinery in agriculture and forestry), business-to-consumer (B2C) domains (e.g., self-service laundries, ski/video and car rental, public libraries and pools), and consumer-to-consumer (C2C) (Puschmann & Alt, 2016). In the literature, we can find numerous works related to sharing economy in different industries. Bianchessi et al. (2014) study a highly configurable and heterogeneous electric vehicle sharing platform, which is eco-friendly. Teubner & Flath (2015) explore the multi-hop ride-sharing platform and illustrate how information systems can leverage its potential through the empirical ride sharing data. Zurek (2016) studies the food sharing in Europe, by mapping and analyzing the risks and regulatory challenges posed by the variety of emerging sharing economy practices in the food sector. Serrano et al. (2017) study the scheduling problem in a cross-dock platform. Zervas et al. (2017) conduct a case study of Airbnb to investigate the economic influence of sharing economy on incumbent firms. Choi et al. (2019) study the food leftover sharing platform in a two echelon supply chain, which contains a single supplier and multi-retailer. They explore the value of the platform in both the decentralized and the centralized supply chains.

Besides the exploration in different sharing industry, a number of works concentrate on the operational management issue. For instance, ter Huurne et al. (2017) propose that a key factor in sharing economy is overcoming uncertainty and mitigating risk, and show various antecedents of trust in the sharing economy (e.g., reputation, trust in the platform, and interaction experience) relate to multiple entities (i.e., seller, buyer, platform, interpersonal, and transaction). Other analytical works include but not limit the following. Banerjee et al. (2016) explore the optimal pricing decisions in the platform for ride-sharing services. Bimpikis et al. (2019) examine the spatial pricing in ride-sharing networks, in which the riders are heterogeneous in terms of their destination preferences and their willingness to pay for receiving service. In the market, some consumers may rent out their own product in the sharing platform (such as Xianyu in China), when the product value for them is low. And so, Tian & Jiang (2018) explore the effects of consumer-to-consumer product sharing on distribution channel analytically. Results reveal that there exists a threshold for the capacity cost coefficient. For a high capacity cost coefficient, product sharing will increase the manufacturer's optimal capacity, while a low cost will decrease the optimal capacity. Abhishek et al. (2018) suggest potential opportunities to enhance the economic and operational performance of on-demand platforms by eliciting customer preferences and adjusting prices and service levels accordingly. The results are in line with industrial practice. For

example, Uber and Didi have provided differentiated services that implicitly account for heterogeneity in time preferences.

Among different kinds of sharing platforms, the fashion sector has been sharing as well. In early stage, people may rent, swap and resell their clothes before sharing economy emerged. Nowadays, fashion sharing platforms provide people a huge number of products that they might want to buy, but consumers only pay the rental instead of paying the selling price. For example, Bag Borrow Or Steal in the US, provides rental services on its platform for fashion handbags, on which the customers can take away the bags for a limited period by paying a rental fee for that (Choi & He, 2019). Having witnessed the rapid expansion of the fashion sharing industry, Cohen & Kietzmann (2014) state that the public perception of shared goods has changed substantially in the past few years, as well as in the fashion industry. Choi & He (2019) investigate the optimal pricing decision for peer-to-peer luxury platform service. The findings show that the revenue sharing scheme outperforms the fixed service-charging scheme in a luxury sharing platform. Yuan & Shen (2019) investigate illegal renting behavior's impacts on a rental fashion supply chain. They find that when the customer has higher valuation, he is more likely to change the behavior from renting the product to illegally renting. Shen et al. (2020a) examine the value of demand learning in luxury industry for two modes ("see now buy later" mode and "see now buy now" mode),

Table 2.1 Summary of the important literature on platform operations

Papers	Research Direction	Applied Industry	Key Insights and Findings
Banerjee et al. (2016)	The operational management issue	Ride-sharing platform	The optimal pricing decisions in the platform for ride-sharing services is derived
Teubner & Flath (2015)	The exploration in different sharing industry	Multi-hop ride sharing platform	Information systems can leverage its potential through the empirical ride sharing data
Zurek (2016)	The exploration in different sharing industry	Food sharing platform	Map and analyze the risks and regulatory challenges posed by the sharing economy practices
Bimpikis et al. (2019)	The operational management issue	Ride-sharing platform	The spatial pricing in ride-sharing networks is derived
Choi et al. (2019)	The exploration in different sharing industry	Leftover food sharing platform	The values of the platform in the decentralized and the centralized supply chains are explored
Choi & He (2019)	The operational management issue	Luxury fashion sharing platform	The revenue sharing scheme outperforms the fixed service charging scheme in a luxury sharing platform
Cai et al. (2021)	The operational management issue	Leftover product platform	The ethical problems can be lessened by employing digital technologies such as blockchain
Choi et al. (2020)	The operational management issue	Demand service platform	Blockchain technology can help to mediate the price strategy in the platform operations
Shen et al. (2020c)	The operational management issue	Online pre-book platform	Pre-ordering in luxury fashion helps the retailer charge a higher price by stimulating more scarcity but it leads to a higher wholesale price and is less beneficial for the retailer
Ruch et al. (2020)	The operational management issue	Ride-sharing platform	The impact of ride sharing on efficiency and service level is assessed for several benchmark operational policies
Yan et al. (2021)	The operational management issue	Ride-sharing platform	The resulting ride-sharing solution is not only stable and system-wide optimal, but also makes the system profitable

when the brands webcast fashion shows, and analyze market feedback from social media information exposure. The findings show that the feedback information accuracy and holding cost have more positive impacts on the brands performances of “see now buy now” mode than “see now buy later” mode.

Some recent works focus on studying platform operations from different perspectives. Shen et al. (2020c) explore the online pre-book platform operations, and propose a two-echelon luxury fashion supply chain with conspicuous consumers. The results show that pre-ordering in luxury fashion has two critical effects. On one hand, it helps the retailer charge a higher price by stimulating more scarcity. On the other hand, it leads to a higher wholesale price and is less beneficial for the retailer. Cai et al. (2021) focus on the ethical problems in leftover product platform operations. The authors analytically find that the ethical problems can be lessened by employing digital technologies such as blockchain. Choi et al. (2020) explore the risk attitudes of customers and how they influence the on-demand service platform operations. They uncover the crucial role of the consumer’s risk attitude, and suggest that blockchain technology can help to mediate the price strategy in the platform operations. Ruch et al. (2020) explore the trade-offs between the efficiency gains and the reduction in quality of service in ride sharing platform. Yan et al. (2021) study matching and pricing in dynamic ride-sharing problem, and find that ride-sharing solution is not only stable and system-wide optimal, but also makes the system profitable. Table 2.1 summarizes the important literature regarding platform operations.

2.2 Digital and information technologies

Information technology is applied in the process of information in order to store, process, transmit, protect, and display information, and the focal point is to enhance the activity efficiency (Ibatova et al., 2018). Technology, which makes the economic activities much easier and cheaper, is the main drive of the sharing economy (Demary, 2015). Actually, the most convenient way to facilitate sharing among individuals and/or companies is to employ technology-based platforms (Tian & Jiang, 2018). Moreover, technology also facilitates interactions between firms and consumers, as well as consumers and consumers that were impossible in the past. Innovative business ideas, which are often disruptive, are usually inspired by the new technology. Constantiou et al. (2016) find that a number of digital start-ups focusing on different forms of sharing have been established during the last decade, which serves as means of connecting different parties (business or customer) who have incentives to share or exchange information, products or services. Zhang et al. (2011) propose an agent-based smart gateway for RFID-enabled real-time wireless manufacturing. Wang (2008) proposes an integration of promising information technologies of RFID technology, mobile devices and web portals, and ensures that RFID can help enhance the effectiveness and flexibility of information flow in material test management. In application, technologies like Internet of Things (IoT), Radio Frequency Identification (RFID) and recently blockchain technology, are the most used facilitators to increase the speed of system reaction, reliability and information transparency. In the following, we review blockchain technology and information transparency one after another.

2.2.1 Blockchain technology

Information asymmetry can be seen as a condition wherein one party has more or better information than another (Bergh et al., 2018). A blockchain is a chain of blocks, in which each block consists of data and links with other blocks. Blockchain can be used to process data in terms of storing and sharing, with the distributed, transparent and tamper resistant manner (Bodkhe et al., 2020). The benefit of blockchain has been confirmed related to information transparency in the supply chain, as well as the lower signaling costs, and other advantages of blockchain mainly relate to strong security, disintermediation, record integrity, and automation (Chod & Lyandres, 2021).

In sharing economy, blockchain is found to be helpful in terms of security, convenience, traceability and efficiency. Huckle et al. (2016) find that auto pay is one of the benefits that IoT and blockchain technology can help in sharing economy applications. Sun et al. (2016) discuss how the features of blockchain technology may contribute to sharing economy, in the development of smart city. It concludes that security is comprised of confidentiality, integrity, and availability, and requires the concurrent existence of the availability for authorized actions, confidentiality, and integrity. Noticed from the real world, nearly all of the today's internet giants (such as Google, Facebook, Twitter, Uber, or Airbnb) rely on the users' contributions as a means to generate value within their own platforms. De Filippi (2017) also indicates that blockchain facilitates the exchange of value in a secure and decentralized manner, without searching for intermedia. Blockchain can ensure secure information sharing over wide area networks. Agrawal et al. (2018) explore the potential application in implementing a blockchain-based traceability system for textile and fashion supply chain and list the advantages of blockchain technology for implementing traceability. In the sharing economy, trust between peers plays a crucial and complex role. Hawlitschek et al. (2018) explore the potential of blockchain technology for dissolving the issue of trust in the sharing economy, and results show that blockchain technology is able to replace trust in platform providers to some degree. Kaiser et al. (2018) discuss the privacy-preserving way of vehicle data exploitation by considering blockchain technology, because it is associated with privacy-friendly concepts including transparency, trust, and decentralization. Kouhizadeh et al. (2019) indicate that blockchain is an emergent and critical technology, and can support the information systems to improve circular economy performance at multiple levels. Saberi et al. (2019) study blockchain technology and its relationships in a sustainable supply chain. Comparing the scenarios with and without blockchain adoption, Fan et al. (2020) find that it is conditional for the supply chain to adopt the blockchain technology, which relates to the traceability awareness of consumers, the costs of production and adoption of blockchain. In fashion supply chains, Choi (2020) studies supply chain financing based on newsvendor problem, taking risk issues into consideration, and finds that the operational risk is a bit lower for blockchain-supported supply chain, with respect to the traditional supply chain. Zheng et al. (2020) propose the application scenarios of blockchain-based intelligent contract technology in the supply chain factoring business. The results show that equilibrium solution can be reached and the intelligent contract under blockchain has optimization effects. Zhang et al. (2021a, b) explore the price strategy in supply chain with an initial retailer and an entrant retailer, and both of the competitive retailers can determine blockchain adoption strategy. They find that consumer privacy concerns may reduce the prices and profits of both retailers in the presence of blockchain adoption.

2.2.2 Information transparency

Information transparency is defined as the degree of information visibility and accessibility (Zhou & Zhu, 2010). In order to build trust between consumers and complementors, many platforms are transparent regarding the performance information of the complementors, rating information and past sales information to consumers. Some works analytically explore the information transparency problems in supply chain management. For instance, Huang & Yang (2016) study a two-layer supply chain, considering different information transparency degrees. The results show that under some scenarios the supplier is beneficial from information transparency. Classifying consumers into two groups, i.e., the leader group and follower group, Shen et al. (2017) explore the luxury supply chain with consideration of social influences between the two groups. When social influences are increasing, the supply chain tends to provide better services to the leader group. Shen et al. (2019) discuss how contracting and the consideration of information in terms of information updating and information asymmetry influence each other in the supply chain. Shen & Chen (2020) qualitatively study the quality management in outsourced global fashion supply chains, and address the importance of quality information visibility. Li et al. (2020) study the quick response technology effects on the sustainable supply chain in China, and find that market and export pressures affect the performance of the supply chain significantly, and quick response technology can repress the influences of internal improvement practice and economic performance. Ponte et al. (2020) study the information transparency of bullwhip effect in a circular supply chain, and indicate that the information transparency degree affects the influences of return rates and lead times on supply chain performance. Jiang et al. (2020) examine the information transparency in a gray market and dual-channel supply chain, and uncover that information explosion has both positive and negative effects on retailer's performance. Chernonog

Table 2.2 Summary of the important literature on digital and information technologies

Papers	Name of technology	Functions
Wang (2008)	Radio Frequency Identification technology	Enhance the effectiveness and flexibility of information flow in material test management
Zhang et al. (2011)	Smart Gateway technology	Capture real-time production data from various manufacturing resources
Huang & Yang (2016)	Information transparency	Under some scenarios the supplier is beneficial from information transparency
Huckle et al. (2016)	Blockchain technology	Create secure shared economy distributed application
Sun et al. (2016)	Blockchain technology	Contribute to sharing economy, with the development of smart city
De Filippi (2017)	Blockchain technology	Facilitate the exchange of value in a secure and decentralized manner, without the need for an intermedia
Agrawal et al. (2018)	Blockchain technology	Implement traceability
Hawlitcshek et al. (2018)	Blockchain technology	Dissolve the issue of trust in the sharing economy
Kouhizadeh et al. (2019)	Blockchain technology	Support the information systems to improve circular economy performance at multiple levels
Li et al. (2020)	Quick response technology	Repress the influences of internal improvement practice and economic performance
Ponte et al. (2020)	Information transparency	Affect the influences of return rates and lead times on supply chain performance

(2020) studies a two-layer supply chain in which the retailer is less informed than the manufacturer of product costs, and find the conditions when information sharing is optimal or not. Many platforms are information transparent to the complementors to enhance the consumers' trust, like ratings and sales information. Li & Zhu (2021) study the competition in platform operations, which is caused by multi-homing. The analysis emphasizes the influence of information transparency on consumers, rival firms, and the industry empirically, and indicates that limiting information transparency helps reducing multi-homing. Zhang et al. (2021a, b) focus on information transparency for pre-ordering strategy in new products launching, and examine the profitability of omni-channel. The results show that advance selling is not always profitable for the retailer, but is circumstantial on the hassle costs. Table 2.2 summarizes the important literature regarding digital and information technologies.

2.3 Business models

Technological advances promote the appearance of novel business models based on online platforms. The platforms facilitate the previously unmatched connection of demand-side and supply-side by innovative models of value creation, delivery and capture (Taeuscher & Laudien, 2018; Cohen & Kietzmann, 2014) examine the existing shared mobility business models, in order to discover the optimal relationship between service providers and the local governments, to achieve the common objective of sustainable mobility, and results show that private or public models are fraught with conflicts. Kathan et al. (2016) examine the potential of sharing economy to produce a long-term transformation in consumption behavior, and then propose a new model that could respond to the changes brought by sharing economy. Habibi et al. (2017) propose a mix of transaction and sharing platform model in order to achieve a better operation performance. Benoit et al. (2017) discuss the roles and motivations of the players of the sharing platform, service provider and customer. Nowiński & Kozma (2017) explore the ways that blockchain technology may disrupt the existing business models, and propose three crucial ways that blockchain technology can affect and disrupt business models, i.e., by authenticating traded goods, via disintermediation and via lowering transaction costs. Lombardi & Schwabe (2017) take sharing economy as a new business model for energy storage systems, and then find that when operating a battery storage system, a sharing economy-based model may increase the profitability compared to the single use of business model. Motivated by the industrial practice that major OEMs such as Daimler and BMW have implemented car sharing in their business models, Bellos et al. (2017) study the interaction between choice of business models, design of product line, and environmental regulation to find out the trade-off between driving performance and fuel efficiency. Kumar et al. (2018) construct a conceptual framework which could help the service providers and customers be benefitted from the sharing platform. Zhang et al. (2019) qualitatively conduct research to identify a customer value proposition in successful sharing economic, including social, emotional and technical, and the findings indicate that social and emotional values play equal roles in motivating customers to revisit sharing economy businesses.

Within the works of business model in sharing economy, game theory application in this niche can be widely observed. For instance, reputation is not a necessary condition for trust, and sometimes people even trust strangers with no reputation information. Ert et al.

(2016) structure a trust game model to examine the role of personal photos appearance in sharing platforms like Airbnb. Wei & Yang (2018) explore the development trend of sharing economy in big data era based on duplication dynamic evolution game theory. We summarize the important literature regarding business models in Table 2.3.

2.4 Sustainability and circular economy

Circular economy often turns goods into resources for others at the end of their service life (Stahel, 2016). It forms a closing loop in industrial ecosystems and minimizes the waste. For example, shifting to a circular economy would reduce each nation's greenhouse-gas emissions up to 70% and grow its workforce by about 4%. The work also divides circular-economy business models into two groups. One is to reuse and extend service life through repairing, remanufacturing, upgrading and retrofitting. The other is to turn old or used goods into as-new resources by recycling the materials. Martin (2016) shows that sharing economy is an economic opportunity and a more sustainable form of consumption. Benjaafar et al. (2018) characterize equilibrium outcomes including ownership and usage levels, consumer surplus, and social welfare in the sharing economy. The results indicate that consumers always benefit from collaborative consumption, and the difference in social welfare between the profit-maximizing and social-welfare-maximizing platforms is relatively modest. Anna & Legg (2018) focus on fare sharing, urban food sharing, and sustainability in food sharing economy. De Sousa Jabbour et al. (2018) make a case for the integration of the increasingly popular and largely separate topics of Industry 4.0 and the circular economy. In the work, a pioneering roadmap is proposed to enhance the application of circular principles in organizations by means of Industry 4.0. Circular economy, which is a concept to rethink and redesign the economy works, recognizes effective and efficient economic functioning at multiple scales (i.e., governments and individuals, globally and locally, large and small businesses) (Kouhizadeh et al., 2019; Geissinger et al., 2019) describe and classify the sustainability connotation of sharing economy platforms, suggesting that the sustainability connotation closely connects to specific sectors such as fashion, on-demand services and logistics. In the

Table 2.3 Summary of the important literature on business models

Papers	Research Methodology	Applied Industry	Key Insights and Findings
Cohen & Kietzmann (2014)	Qualitative cases	Car sharing	Private or public models are fraught with conflicts
Ert et al. (2016)	Quantitative empirical methods	Accommodation	Examine the role of personal photos appearance in sharing platforms like Airbnb
Kathan et al. (2016)	Qualitative cases	General	A new model that could respond to the changes brought by sharing economy is proposed
Bellos et al. (2017)	Analytical modelling	Car sharing	Find out the trade-off between driving performance and fuel efficiency
Lombardi & Schwabe (2017)	Analytical modelling	Battery sharing	A sharing economy-based model may increase the profitability compared to the single use of case business model when operating a battery storage system
Kumar et al. (2018)	Qualitative cases	General	Construct a conceptual framework which helps the service providers and customers to be beneficial from the sharing platform

secondhand online platform, Shen et al. (2020b) emphasize the importance of blockchain technology for secondhand product, and show that when adopting blockchain, horizontal integration is more effective to improve total profit of the supply chain. Guo et al. (2020) examine the green product development in fashion supply chain considering competition, and find that green competition may reduce the optimal greenness level of fashion products.

People deem that sharing would reduce the waste and save energy for the whole society; therefore, a number of research works considered this social issue in sharing economy. Some sharing platforms have expanded the functions to social media, which could increase customer viscosity as expected. Given that sharing business model is new, regulators or government may not be aware of how existing regulation may unfairly bias one business model over another, particularly when comparing traditional and sharing economy businesses (Cannon & Summers, 2014). For example, rules in Washington D.C. prevent passengers using taxi services from specifying their destination so as to avoid discrimination, but this would likely favor Uber and Lyft over Sidecar. Thus, regulations and policy should be an important issue that the sharing platform should consider. We summarize the important literature regarding sustainability and circular economy in Table 2.4.

3 Case studies of fashion sharing platforms

In this section, we conduct case study of two fashion sharing platforms, i.e., Rent the Runway and Y Closet. We choose the two fashion sharing platforms to study, because firstly, both of the two platforms are the famous and leading fashion sharing platforms in the US and China. The two platforms grow rapidly these years comparing to other fashion sharing platforms, some of which even went out of business. Secondly, both of the platforms are invested by Alibaba Group Holding Ltd in recent years, which possesses the leading E-retailing platform Taobao in China. The investment implies great potentials of these two fashion sharing platforms, which deserves to explore further. Thirdly, Y Closet has stopped in middle of 2021, whereas Rent the Runway is still alive. The reasons behind deserve more exploration, which could be helpful to other platforms.

Table 2.4 Summary of the important literature on sustainability and circular economy

Papers	Research Methodology	Key Insights and Findings
Martin (2016)	Quantitative empirical methods	Sharing economy is an economic opportunity and a more sustainable form of consumption
Benjaafar et al. (2018)	Analytical modelling	Consumers always benefit from collaborative consumption, the difference in social welfare between the profit-maximizing and social-welfare-maximizing platforms is relatively modest
Anna & Legg (2018)	Quantitative empirical methods	Provide the first macro-geographical analysis of urban food sharing mediated by ICT
De Sousa Jabbour et al. (2018)	Qualitative cases	Propose a pioneering roadmap to enhance the application of CE principles in organizations by means of Industry 4.0 approaches
Geissinger et al. (2019)	Quantitative empirical methods	The sustainability connotation closely connects to specific sectors such as fashion, on-demand services and logistics

3.1 Rent the runway

3.1.1 Background of rent the runway

Rent the Runway, the biggest fashion sharing platform in the US, was founded by Jennifer Hyman and Jenny Fleiss in Silicon Valley in November 2009. At the beginning, the main business is for the rental of dresses and apparel. Since 2016, it has begun to transform and increase daily apparel rental services. Rental models in the fashion sharing platform allow customers to borrow items for a period of time, typically at the cost of 10 to 20 percentages of an item's retail value.⁵

3.1.2 Operations in rent the runway

In the following, we explore the business operations in Rent the Runway in details. We will systematically discuss the details one by one under different domains, which range from product, brand, price, service, and logistics operation to operational strategies.

Product Products in Rent the Runway include various kinds of clothing for different occasions, like daily dress, wedding, cocktail party, night out, graduation, weekend, even maternity, etc. A customer can easily find what she wants to wear in a right way to attend the events. Moreover, Rent the Runway currently provides kids clothing for 2 to 12 years old children.

Brand Among the wide range of fashion brand in Rent the Runway, the platform also provides luxury brands for users. For instance, Vera Wang, Moschino, Y-3, and other high-end fashion brand can be found in the platform. Even kids can order luxury products from the platform, like Fendi Kids, Stella McCartney Kids, etc. Besides, the platform provides a lot of designer's brand for users. In total, the platform has a wide range of brand, including luxury brand, designer's brand, and middle-class brand.

Price The basic service is that, customer can choose four items at the same time, for which the product type is not limited (whatever it is clothes, bags, accessories, and jewelry). The rental fee is 69 USD for one month and 80 USD for two months with promotion recently. The original prices of these items in the market vary from 100 to thousands of dollars, which means more benefits to customers. Member-only discount is special for users to buy the favorite product with up to 80% discount.

Service Currently, the platform has brick and mortar stores in several developed cities, like New York, Las Vegas, and San Francisco. In order to help the users to better dress up, the platform provides VIP Concierge for customers. Now the special service is offered manually, however, as the technology develops, artificial intelligence technology will be used in the future. They also provide personalized recommendations to customers based on the data analysis.

⁵ <https://www.businessoffashion.com/articles/fashion-tech/will-the-sharing-economy-work-for-fashion-rent-the-runway-rental> (Accessed on 2 Feb, 2021).

Logistics operations Although most of the orders are from online customers, members of several big cities like New York can also directly return clothes to stores or pick up clothes in stores. Sometimes they return the product in different places during the trip. For example, the product can be sent directly to hotel and be sent back after use. Shipping is free for members, including dry cleaning and rental insurance. Rent the Runway has invested heavily in logistics, setting up the US's biggest dry cleaner that can dry-clean 2,000 dresses per hour. The cleaner guarantees that majority of returned fashion items can be dry cleaned and sent out for a new customer within one-day time.⁶

Operational strategies The platform sends the outfit inspiration and styling tips to users' inbox weekly to attract the users' reorder on the platform. In 2018, Rent the Runway first opened physical stores in Neiman Marcus, a luxury department store in the US. Accompanied with opening of these stores, the brand image of platform upgrades in some terms. Rent the Runway offers about 700 designer brands and a wide range of clothing sizes from 00 to 22 to cover nearly all of the figure types of customers.

Garments that are no longer suitable for renting service, will be sold as samples to customers or donated to selected organizations, such as Dress for Success, Operation Prom and Fab-Scrap. Whenever the products are rented or sold to customers, there is no information about how many times that the product has been rented and the current maintenance condition.

Technologies The platform uses RFID tags to get clarity on where inventory was within its system, making it easier to source items from the physical store, warehouse or showroom and get it out the door faster.⁷ Rent the Runway employs a Cloud based information warehouse running on a Cloud based infrastructure platform to support the large-scale fashionable products.⁸

3.2 Y closet

3.2.1 Background of Y closet

Y Closet was founded in December of 2015 in China, providing the clothing rent service for customers. Y Closet received 50 million USD⁹ in third round funding from venture capital in late 2018. The funding is used to upgrade algorithms system of clothing collocation recommendation, and build integrated operation center for washing and distribution warehouse in near future.¹⁰

⁶ <https://www.businessoffashion.com/articles/technology/will-the-sharing-economy-work-for-fashion-rent-the-runway-rental> (Accessed on 26 Aug 2021).

⁷ <https://digiday.com/marketing/rent-runway-pulling-off-deliveries-speed-amazon/> (Accessed on 2 Feb 2021).

⁸ <https://theferrari-group.com/the-lessons-of-rent-the-runway-span-beyond-a-warehouse-disruption/> (Accessed on 4 Feb 2021).

⁹ <https://www.scmp.com/business/china-business/article/2110128/china-clothes-sharing-start-ycloset-secures-us50m-new-> (Accessed on 2 Feb 2021).

¹⁰ <https://www.yi23.net/events/> (Accessed on 2 Feb 2021).

3.2.2 Operations in Y closet

Similar to the case in Rent the Runway in more details, we discuss Y Closet's operations one by one in the following, with the same classifications so that we can conduct a point-to-point comparison. Please note that in July 2021, Y Closet announced that the whole company would close on 15 Aug.¹¹ All of the information in this paper is collected before August of 2021.

Product Products in Y Closet contain various kinds of clothing for different occasions like daily dress, wedding, cocktail party, night out, etc. The platform does not only provide the clothing product, but also provides accessories for users. Y Closet does not provide kid clothing till now. However, it provides the Chinese traditional clothing for a niche customer.

Brand From the official website and App of Y Closet, Y Closet provides luxury brands like Prada, Kenzo, Armani Jeans, Michael Kors, etc. It also provides premium brands like Peace Bird, and designer's brand, such as Sleek, Finders, D-two, etc. Other kinds of brands include designer's brands (about 50% of the whole products), as well as fast fashion brands such as Zara and Topshop.

Price A customer should pay 77 USD for the rental fee per month and then she can order an unlimited number of items to wear during the period. In order to attract more clients, coupons are sent out for promotion. Up to now, 75% of platform revenue comes from members' rental fees, while the rest comes from the purchase orders, as users can buy the product at a discount price.

Service Currently, the platform does not have physical stores, customers can only order online. The platform recommends similar style clothing for the customers in its App. Y Closet has built the washing warehouse with Fonet China Ltd, which is the leading cleaning company in China, to provide washing and other maintenance services for clothing. Y Closet updates the inventory by season and by trends. For example, Y Closet has recently put online the autumn season new clothing line to meet the needs for women during the season-change days when their closets often lack suitable clothes.

Logistics operations Y Closet has built its national warehousing centers in Beijing, Nantong, Guangzhou and Chengdu, which integrates warehousing, washing and maintaining service to ensure timely turnover and distribution of products. Customers are more aware of delivery time and cleanness, which directly affects the user experience. To ensure the service quality and service level, the platform chooses to integrate the supply chain.

Operational strategies Some apparel brands send clothes products to Y Closet free. Y Closet provides revenue sharing to some of the brands, according to the users' rental and purchasing orders. The brands earn money from the cooperation, and can study the customers' behavior from the data collection. Y Closet also develops selected new brands jointly. Different from Rent the Runway, Y Closet develops the social media functions for users, so that they can upload their dress-up and discuss with other users on the platform. Meanwhile,

¹¹ https://www.sohu.com/a/481178649_100154767 (Accessed on 26 Aug 2021).

Y Closet also cooperates with some key opinion leaders to attract more customers and make promotion. Customers are encouraged to log in with their membership in Taobao.com, so as to get more information of the consumer shopping experience and information data.

Technologies At present, RFID technology is employed in Y Closet platform. By scanning the RFID tag, product information is received automatically, including the product type, washing method, and washing process, etc. The technology enhances the working efficiency and reduces the human cost.

3.3 Comparisons

Based on the findings above, we now proceed to report the comparisons between operations of the two fashion platforms. Table 3.1 shows the item-to-item comparison in details.

From Table 3.1, we can see that RR provides wide kinds of products including kids wear to users compared to YC, which does not have kids wear but provides Chinese traditional clothing. RR has more luxury brands to cooperate and YC has only a few. It is a bit weird that YC provide fast fashion brand, because most people rent clothing due to the high price of some brands. The two platforms provide different kinds of fashion products, like dresses, jumpsuits and rompers, tops, knits, bottoms, outerwear, shoes, bags, wedding dress, jewelry, etc. The categories are quite similar to the non-sharing fashion platforms or retailing platforms. The membership fees for both platforms are less than 100 USD. Compared to the retail price of the luxury brands and designer's brands, the membership fee is worthwhile for consumers. For example, a dress of brand Kntie May sold at a price of \$300 on the retail platform, can be taken home by a consumer with membership without paying. Currently, RR has several physical stores with great revenue, and the service is better since customers can go to the stores more conveniently. Opening stores in high-end department stores brings good image to customers. Both of the platforms have revenue sharing contract with brands,

Table 3.1 Comparisons between rent the runway and Y closet

	Rent the Runway (RR)	Y Closet (YC)
Information transparency	Product design, size, etc. No information about number of times being rented, rental history	Product design, size, etc. No information about number of times being rented, rental history
Product	Daily dress, wedding, cocktail party, night out, graduation, weekend, maternity, kids, etc.	Daily dress, wedding, cocktail party, night out, Chinese traditional clothing, etc. (No kids)
Brand	Luxury brand, designer's brand, and middle-class brand	Luxury, middle-class, designer's brand, and fast fashion
Price	69 USD for one month and 99 USD for two months with promotion, members-only discounts for retailing	77 USD per month, discounts for retailing
Service	Shipping free including dry cleaning and rental insurance, VIP Concierge	Shipping free including dry cleaning, recommend by system
Logistics operations	Return to physical stores, return to different places	Integrates warehousing, washing and maintaining
Operational strategies	Send outfit inspiration and styling tips, open stores in Neiman Marcus, community marketing	Revenue sharing with brands, community marketing
Technologies	RFID, web, mobile App	RFID, web, mobile App

which is wise enough to be a win-win strategy for platform and brands. Nowadays, social media plays a crucial role in marketing, especially in fashion and cosmetic industry. Both of the platforms offer consumers community to incent leader group sharing and marketing. The two platforms sell products after renting for several times, which shows the social responsibility in sustainability.

Looking into the information transparency in the selling process, there are many challenges. For example, customers cannot find any information about the rental times and other information (like whether been repaired, number of leases, cleaning chemicals that has been used) about the products, indicating that the information transparency to consumer is lower. For both of the platforms, the popularity of the product that shared is unknown, and whether the products are new or leftover in the last season is also unclear. However, this information is crucial for fashionable items. Consumers care about the difference between the retail price overseas and domestically, and this will affect the consumers' rental decision. However, pricing information of the product is not sufficient. RR focuses on the high-end brands, and collaborates with a large number of famous designers. Brands that RR offered for consumers are what they really want to wear with less money. The price strategy is competitive regarding to the high-end brands. In YC, the information of the designers is not clear. Most of the brands and designers are less famous and consumers may have few interests on them. The product information transparency is a bit lower. When consumers get the products, some of the review comments are negative. In the beginning, YC promised that it provides infinite rental service for members. However, the service of rental time has changed to be 4 times in a rental period in 2018. The above practices may lead to the recent failure of the fashion-sharing platform.

4 Challenges and future research agenda

Based on the literature review and real case studies, we analyze the challenges and under explored issues in fashion sharing platform. The business model of the rental platform is that users pay a certain amount of money monthly. After that, the users can rent clothes freely. Other platforms include Doraemon, Clothes, Magic Wardrobe, Rental Diary and so on. In general, the revenue of fashion sharing platform mainly depends on the membership fee, the price difference of clothes sold and rent. However, the platform has to pay the cost of clothes, logistics costs, cleaning and maintenance costs. At this stage, the profit of the platform cannot sustain operation cost of the platform, and if there is not enough financial support, some of the fashion sharing platforms will be difficult to survive in the future. Some of the fashion sharing platforms do not build their own washing equipment, but having cooperation with the existing washing companies instead. This means less investment in the early stage of the platform but high average washing cost per unit and uncontrollable washing service quality. Therefore, trying to find a way of stable revenue is necessary. Some of the platforms allow purchasing of products from the platform with a certain discount. However, for sake of profit optimization, how to determine the optimal price of the discount product and when product should be sold after rental is still unclear. These kinds of questions are valuable to be explored in the future.

The fashion sharing platforms have developed a lot in this decade. Although RFID is widely applied in the platforms, blockchain technology has not been widely used. As the

development of the technology, blockchain may be used in the future. Then, the effects that it brings to the fashion sharing industry deserve more research.

With the sharing platform, people usually think of sustainability. However, sustainability still needs more exploration. Although the users have paid the rental fee instead of payment, and the circulation rate of the product is much higher than the traditional fashion industry, higher circulation rate means more times of washing, and hence water wasting and environmental unfriendly. Considering the social welfare, how to determine the optimal decisions in operation in the fashion sharing platform?

Currently, some of the platforms allow customers to share their own products on the platform. From this model, platform could make revenue sharing contract with customers who provide the product to sell. The application of the business model in fashion sharing platform is still a question. Challenges and the way to implement need to be explored more.

We conduct future research agenda in the following area. First, artificial intelligence application and new technologies application like blockchain in fashion sharing platform and the related operations deserve examination. Second, sustainability and circularity of fashion sharing supply chain management with considerations of customer surplus and the social welfare can be explored further. The operations considering the recycled products after rental service can also be explored more. Third, research from the consumer's perspective, like consumer's behaviors research and C2C application in fashion sharing platforms, and revenue sharing, deserves more exploration in the operations. We summarize future research agenda in Table 4.1.

5 Conclusions

Motivated by the hot practice of sharing economy in fashion industry, we conduct both literature review and case study to examine the problem. We first conduct literature review in operations of sharing platform, including the sharing platform operations, technology in sharing economy business model, and sustainability and circularity. Platform operations in many industries have been explored, such as electric vehicle, food, accommodation, fashion, etc. Sharing economy can overcome uncertainty and mitigate risk. The significant influence of information has been confirmed in the sharing platform operations. In the fashion industry, consumers' values have changed substantially, like conspicuous consumption and ethical problems, which are investigated by some works and focus on the sharing platform operations. Blockchain and Internet of Things are adopted commonly in sharing platforms. Many works confirm the contribution of blockchain and indicate that blockchain facilitates

Table 4.1 Future research agenda

Perspectives	Future Research Agenda
Technology	Artificial intelligence application New technologies application like blockchain
Sustainability and circularity	Customer surplus Social welfare Recycled products after rental service
Operation	Consider consumer's behaviors Revenue sharing C2C application

the exchange of value, information transparency and consumers' trust in sharing platform operations. Supply chain members could be benefited from information transparency, and the information explosion has effects on performances of the members. Consumers can benefit from collaborative consumption, and sharing economy is economical and sustainable pattern of consumption.

Then, through the case study of two leading fashion sharing platforms of RR and YC, we analyze the features and challenges for fashion sharing platforms. In practice, not all of the fashion sharing platforms can make profits, and strategies that may enhance the profit are still under exploration. We analyze the operations in the two cases, and show the importance of information transparency in the practice. Future research directions of fashion sharing platform can be conducted in analytical ways to explore the optimal operational decisions with consideration of artificial intelligence application, sustainability and the social welfare, and consumer's behaviors.

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