A Digital Platform Architecture to Support Multi-Dimensional Surplus Capacity Sharing

Henrique Diogo Silva[1], António Lucas Soares[1,2], Andrea Bettoni[3], Andrea Barni Francesco[3] and Serena Albertario[4]

[1] INESC TEC, Porto, Portugal
{henrique.d.silva, asoares}@inesctec.pt
[2] University of Porto, Porto, Portugal
[3] SUPSI, Manno, Switzerland
{andrea.bettoni,andrea.barni}@supsi.ch
[4] Holonix Srl, Meda, Italy
serena.albertario@holonix.it

Abstract. The highly disruptive transformation that digital platforms are imposing on entire sectors of the economy, along with the broad digitalization of industrial business processes, is having an impact on supply chains around the world. To take advantage of this new aggregated market paradigm new business models with a heavy focus on servitization are changing the value proposition of businesses. In this paper, we describe a reference architectural framework designed to support a digital platform fostering the optimization of supply chains by the pairing of unused industrial capacity with production demand. This framework aims at harmonizing stakeholder requirements with specifications of different levels in order to set up a coherent reference blueprint that serves as a starting point for development activities. A four-layer approach is used to articulate between technical components, with the data and tools layers, and the ecosystem, with the business and interfaces layers. The overall architecture and component description is presented as extensions of the initial set of affordances.

Keywords: Digital platforms, Digital platform architecture, Manufacturing as a service.

1 Introduction

One of the more prevalent effects of the platform paradigm in the economy is the separation of physical assets from the value they create, the separation of function from the form [22]. In the industrial sector, this switch is evidenced by the widespread shift of income generation from the sale of physical products to the charging of customers for the availability of functionalities of a product [31]. From the perspective of companies that chose to invest on hefty fixed assets like top-of-the-line laser cutting machines or a 5-axis CNC machine this selling of capacity allows for better resource distribution while for other businesses it provides facilitated access to costly equipment that can help in alleviating initial costs of business or even the ability to meet seasonal peak demands. The growing willingness of companies to both buy and sell manufacturing capacity has precipitated the development of the Manufacturing as a Service (MaaS) paradigm [4] that both boosts and leverages the platform economy.

The explosion of the platform business has had a profound impact on businesses structures. The traditional pipeline perspective where processes were arranged step-by-step with producers at one end and consumers at the other has given way to new platform mediated structures [22]. In this new paradigm, the linearity of the value chain is twisted and tangled to the point where the boundaries of user and producer are regularly crossed or in some cases inexistent.

Having this landscape as the starting point, and taking digital platforms as stimulants for the transition of industry businesses towards service-oriented approaches [7, 12, 19, 32] it becomes clear that a platform centered ecosystem is needed in order to further advance the MaaS business model. In [4] authors lay out their vision for a digital platform in the MaaS realm that leverages this disruption of the value chain and fluidity of user roles. By adopting a holistic perspective of the value network, and going beyond the simple matchmaking of manufacturing resources, the sharing potential is extended to the whole manufacturing ecosystem network. The fulfillment of this vision, in turn, requires a platform that can establish the bridge between the expected affordances of digital platforms and the cross-sectoral environment, in an ecosystem able to generate added value to its users. By bringing together tools and ecosystem, we are promoting a better and more sustainable use of resources, the reintegration in the loop of unused manufacturing capacity, leading to the creation of local, more efficient value networks, and the seamless involvement of different actors along the value network for cross-fertilization of product-service solutions and underlying technologies.

Leveraging the ensued entanglement of the value chain, this paper aims at describing the design approach and resulting core components that will constitute the backbone architecture of a MaaS platform. The paper is divided into a first section that puts into perspective the manufacturing domain that will represent the platform's ecosystem, as well as the features the platform is expected to support, followed by the core section where the components that make up each one of the four layers are described in detail.

2 The Manufacturing Digital Platform Landscape

2.1 Digital Platform Affordances

The development of the sharing economy is a clear example of how digital platforms have played a fundamental role in the development of the market [29]. Scholars point to six crucial affordances that stride the balance between the rigidity of the technological and the human components of platform ecosystems [23]: (1) generation of flexibility; (2) matchmaking; (3) scale and reach extension; (4) transaction management; (5) trust building; and (6) community creation support.

Digital platforms have the capacity to generate flexibility, not only in how and when users can interact with the platforms [15]. The fluidity between user roles within the platform has also shown a measurable impact in the interactions and consumption habits. Authors such as [8] and [24] point to ability to regularly access sharing economy platforms as an essential component of its success as a business model, while [2] show how the ability to easily change roles within the platform between client and producer has the beneficial effect of incentivizing the engagement on different levels.

The matching of users, along with pulling them to the platform and facilitating their actions and interactions, are some of the main functions of a digital platforms [22]. The ability to perform matchmaking based on a set of attributes then becomes a fundamental function of digital platforms [3, 25]. Different mechanisms for matchmaking currently exist based on algorithmic assignment and powerful searching and sorting tools [29]. This automation of processes then becoming the entire value proposition of many platforms. For industry-focused platforms, perspectives like the one presented by [4] are starting to rethink this process beyond the matching of manufacturing resources to the whole manufacturing ecosystem value network.

The scale and reach brought about by the facilitated access to an extensive network of organizations, consumers, and resources that compose a platform's ecosystem is also one of its main competitive advantages [9]. By striking the balance between the benefits of network externalities and the automation capabilities, made possible by its technological constructs, platforms are able to create a scaling loop that, after crossing the initial hurdle of the point of critical mass, have the potential to grow indefinitely [5, 10, 14];

The management of the transactions involved in the transmission and securing of goods, information or labor is another widespread functionality of sharing economy platforms [30]□. In this sense, platforms double up as marketplace and bookkeeper by bringing both parties together while also keeping records of all transactions, ensuring the validity of all the exchanges [6, 33];

Trust and trustworthiness are a contested point in the digital realm. Where anonymity has always been an obstacle in the conduction of transactions through this medium [16], and in-person meetings made for the more trustworthy method, in the last decades the advent of several trust-based mechanisms has started to invert this trend. The popularization of features like user profiles as extensions of resumes [20, 27], the utilization of subjective and non-subjective user reviews system [13] along with the implementation of more strict governance directives for the management of platform's communities [18, 26] have tipped the scales in favor of the digital. When thinking about the impact of trust in digital platforms it's also essential to distinguish between trust between users of the ecosystem and the trust users deposit in the platform itself, as both play an essential role when it comes to the adoption of these systems.

The human component of digital platforms is what truly elevates them to the status of sociotechnical constructs [1, 28]. Community building structures that serve as venues for community interactions and participation play an import role in onboarding new users and the facilitation of new relationships between them [21]. This is a crucial aspect to keep in mind at the platform design stage as previous studies suggest that, for sharing economy platforms, not only economic profit but also community involvement play a critical role as motivators in platform adoption [6, 11], even in platforms with minimal community interaction capabilities.

3 A MaaS Platform Supporting Sharing of Unused Resources

3.1 The MANU-SQUARE Platform

Building on the MaaS concept, the MANU-SQUARE project [4] aims at establishing a European ecosystem of organizations and other relevant stakeholders that, in a marketplace environment, can act as both supplier and client. Through this approach, the platform moves available capacity closer to production demand, further disrupting the traditional linear value network, allowing for the rapid and efficient creation of local value networks for innovative providers of products and services and the optimization and reintroduction in the loop of unused capacity that would otherwise be lost.

The MANU-SQUARE platform goes far beyond the partner search and matching, and supply-chain/virtual enterprises formation proposed in the last 20 years of virtual enterprise literature in three crucial points: (1) extending the sharing potential to the whole manufacturing ecosystem value network; (2) by focusing on surplus capacity; while (3) adopting a multi-dimensional and cross-sectoral vision of capacity.

Current approaches to the sharing of manufacturing capacity have narrowed down their scope to both specific sectors of the industrial ecosystem, and the sharing of unused production resources. This limited view of surplus capacity leaves out, however, much of the wealth that the European industry has been building through the years. Our perspective scopes this vision back up to not only include all the actors that make up the European manufacturing value chain, such as manufacturing organizations, knowledge providers, innovation facilitators, etc. but also to enlarge the concept of capacity beyond production to surplus know-how, technology, and by-products.

This broader scope carries with it the necessity of an architecture able to cope with an increasingly nuanced system. To answer these demands, tried and true standards, such as semantic infrastructures, need to be articulated with state-of-the-art technologies like distributed ledger systems, to produce new and better trust-based, platforms for negotiation, networking and community building.

In this sense, the value proposition of the platform becomes:(1) from a user’s perspective, be able to, among a European-wide pool, quickly find trustworthy suppliers according to a set of requirements. This matchmaking would help to manage fluctuating production demand or build/extend production capacity without owning production means relying on a structured RFQ and information sharing system and a transaction management system. (2) From a supplier's perspective, access to a broader cross-sectorial market becomes the main value proposition. This wider access gets complemented by the ability to sell unused capacity, access to up-to-date client information, structured and trustworthy processes for the dissemination of documentation such as RFQs, plus reputation management, and transaction management systems.

3.2 Stakeholders & Functionalities

The vast literature on stakeholder analysis has yet to catch up with the platform reality. Very much focused on stakeholders for small and medium enterprises (SMEs), [34] define five stakeholders roles: Innovation Commercialiser; Innovation Funder; Innovation Generator; End User; and Platform Operator. On a 2017 report, the World Economic Forum divides the roles in a platform ecosystem into four, non-mutually exclusive, categories: Orchestrator; Producer; Consumer; or Infrastructure provider.

From this theoretical underpinning, and supported by interviews and workshops with industry players, eight stakeholder typologies were identified. **Manufacturing** organizations, consisting of producers of products, components, and technology, are the leading stakeholder group. A second group of stakeholders consists of **Service and knowledge providers**, ranging from IT Laboratories, legal and consultancy organizations to research institutes and universities. By integrating joint research projects and offering their services through the platform, these stakeholders become critical in the development of new and improved value chains. In this same vein, **start-ups** and **innovation facilitators** also become essential users of the platform by bringing together innovation/technology hubs that facilitate and promote innovation.

In order to build self-sustaining, thriving communities of both customers and suppliers on the platform, achieving a critical mass of users is essential. This continuous task of community building is supported by two stakeholder roles: **multipliers** and **investors**. Clusters and sectorial network organizations, industry associations and investors that are looking for new business and investment ideas are essential elements in enabling access to larger a pool of ideas and business opportunities.

Also, in supporting roles of the central platform functionalities, **auditors and regulators**, plus **consumers** are relevant stakeholder groups. Regulatory compliance and audit authorities place complex sets of constraints on organizations. With these supervisory bodies as platform stakeholders, organizations can take advantage of the privileged contact in order to facilitate compliance, that can even lead to added value for customers in the case of certifications. On the other hand, the presence of consumers in the platform becomes relevant for the development or improvement of products and services.

Based on the defined stakeholders, a set of base 14 functionalities are described in Table 1. Table 2 maps the relationships of each functionality to the relevant affordance.

Table 1. Platform functionalities

Functionality	Description
Matching	
Production capacity matching	Matchmaking between suppliers of available manufacturing capacity and customers that aims to exploit that capacity. The platform recommends potential compliant suppliers, filtering them according to user selected parameters.

Know-how capability matching	Matchmaking among suppliers of available knowledge and customers that require support in the related field of expertise.
By-product matching	Matchmaking between companies whose manufacturing processes generate one or more by-products, and customers that can exploit these by-products as an input resource.
Optimization	
Sustainability assessment	The platform supports the optimization of matchings according to an environmental sustainability assessment.
Ecosystem optimization	The platform supports the ecosystem optimization, ranking suppliers and suggesting the most sustainable matchings.
Management	
User profile management	The platform supports each user in the development of its profile.
Reputation management	The platform allows for both user subjective and quantitative, KPI based evaluations of involved parties in transactions, for establishing a reputation level of users.
Certifications management	The platform allows Auditors and Regulators to certify players through a verified and secure certifications management system.
Trust management	The functionality supports the management of information across the platform giving users the right to define the level of accessibility to provide to their information.
Communication support	The platform supports communication among platform users, streamlining connections and mediating the interactions among parties.
Innovation management	Starting from a user introduced idea, different users can provide tracked and structured contributions. The platform administrates the flow of contributions.
RFQ management	The platform provides the infrastructure to enable the definition and management of quotations, managing the level of visibility of the quotations and partners exchanging requests and transactions.
Transactions management	The platform supports the creation of traceable transactions across the platform value network.
Platform expansion	The platform supports the expansibility of its core functionalities through a complete expansion SKD.

Table 2. Mapping of functionalities and relevant affordances.

	Generation of flexibility	Matchmaking	Scale and reach extension	Transaction management	Trust building	Community creation support
Production capacity matching		•	•			
Know-how capability matching		•	•			
By-product matching		•				
Sustainability assessment		•	•			
Ecosystem optimization			•			
User profile management					•	
Reputation management					•	•
Certifications management					•	
Trust management					•	•
Communication support			•			•
Innovation management			•			•
RFQ management	•			•		
Transactions management	•			•		
Platform expansion	•					

3.3 Platform Architecture

Given the socio-technical nature of digital platforms, the architecture design process needs to take into account not only all the technological underpinnings that serve as a platform infrastructure but also all the social and business elements that eventually will develop into the ecosystem. In many ways we may akin the process of platform design to city planning: infrastructure is an intrinsic and essential component of the project, but if focused to the detriment of other components, it may give way to problematic cities. Expansion, of both population and industry/services, equal distribution of services and natural resources and the development of functional transportation networks, are some of the challenges that can be exacerbated by this lack of human perspective.

The adopted four-layer architecture, shown in **Fig. 1**, can further be divided into two groups. A first group, consisting of the Data and Tools layers, corresponds the technological, infrastructure backbone of the platform, while a second group, corresponding of the Business and Web Portal players, are responsible for the ecosystem management, the human and business component of the platform. Each of these four layers houses components that, through their interplay, allow for all the functionalities of the platform.

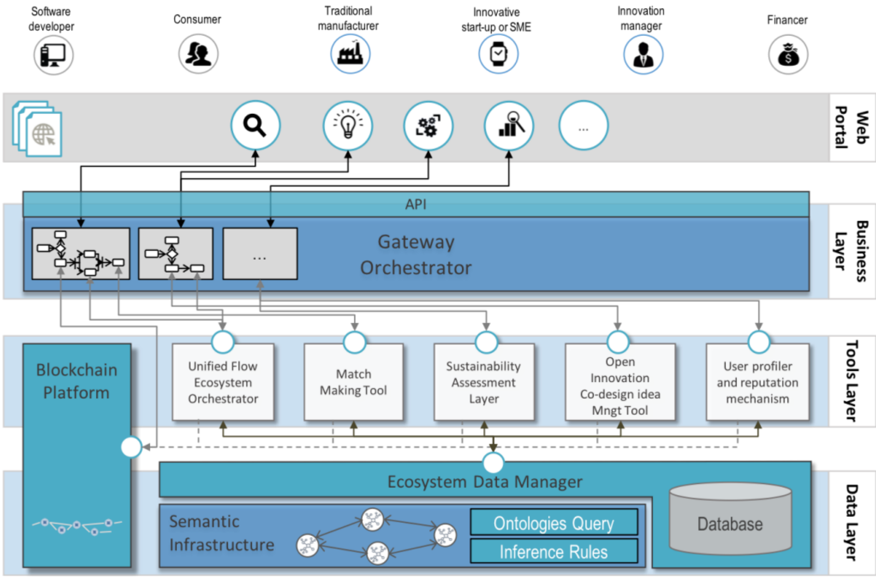

Fig. 1. Low-level platform architecture

The Data layer sits at the heart of any information system. Where more traditional paradigms of data storage/management were static abstractions where value was derived from the read/write logic, with the development of technologies like the semantic-WEB and distributed ledger systems, in between reads and writes we can gather context, inferences, and accountability. Through this layer, we leverage a semantically described ecosystem of actors, interactions and resources flow to feed an inference reasoning engine capable of uncovering non-trivial and previously unknown opportunities. The developed MANU-SQUARE core ontology, presented by [17], acts as the first step in the description of a MaaS ecosystem and along with standard services and interface options such as an RDF data store and a SPARQL endpoint, it will feed other platform tools with rich data for other functionalities.

The Blockchain platform, although still part of the Data layer, spills into the tools layer, due to its very nature. At a high level, this component works to ensure provenance, immutability, and finality of data, by guaranteeing that only mutually agreed upon transactions become part of a consensual and cryptographically secure shared ledger. Features like these make blockchain, and distributed ledger technologies in general, an ideal fit for digital platforms where affordances as trust and trustworthiness are a must, even more, when considering how they can be articulated with other components. Acting as the single point of trust for the ecosystem, from simple operations such as logging user access or storing stakeholder's reputation data in a immutable manner, to automating complex transactional operations that involve the exchange of sensitive information, the integration of the blockchain platform will help to fill trust building, transaction management and flexibility generation functionalities.

Given the modular architecture of the platform and both the data persistence methods previously presented, an extra abstraction to facilitate the access to information independently of its location is needed. By abstracting all the underlying data structures, the ecosystem data manager becomes the data broker for the platform and, by exposing a structured API to other components, allows for ubiquitous access to data, regardless of storage infrastructure, while preserving all of the inherent benefits of each storage method. Because this makes the ecosystem data manager aware of all the data flows within the platform, it will work in conjunction with the blockchain platform as a control point for data access.

The tools layer houses the modular tools that will provide many of the core services of the MANU-SQUARE platform. In an on-demand perspective, these services will be in constant communication with both the data layer and the business layer to fulfill many of the functionalities proposed in Table 1 and cover affordances presented in 2.1. The five tools that make up this layer are: (1) The Unified Flow Ecosystem Orchestrator that provides functionalities to analyze the needs of the different companies to propose ecosystem (re-)configurations that better link availability of resources with their optimal environmental performance, working closely together with the matchmaking mechanism; (2) the Matchmaking Tool that provides the production, know-how and by-product capacity matching functionalities. Feeding off of all the stakeholder profiling information, this tool is responsible for the optimal pairing of user's needs with available resources in the ecosystem; (3) the Sustainability Assessment Layer that provides functionalities to support the evaluation of the environmental impact of new chains established through the platform; (4) the Open innovation & Co-design Idea Management Tool provides the Innovation Management functionality by leveraging the open innovation paradigm; and (5) the user profiler and reputation mechanism that provide the user profile management, reputation management, and certifications management functionalities. Because establishing trust and trustworthiness between organizations is a complex, time and resource intensive process, by integrating blockchain-controlled transactions to keep track of quantitative KPIs such as on-time delivery and quality of products, beside qualitative platform user feedback, based on the perceived quality of interactions with other actors of the ecosystem, we can strike the balance between the technological with the human components of trust.

The business layer, standing between the user-facing interfaces and the core services of the platform is responsible for the orchestration between tools and the complex set of functionalities. Composed by a combination of the gateway orchestrator and a set of outward facing APIs, this engine is responsible for the implementation of business processes relevant the platform's stakeholders through the use of the tools from the Tools Layer. From a modular architecture standpoint, this layer is essential in realizing the full potential of the ecosystem as it alights the flexibility provided by the decoupling of services with the flexibility in the reorganization of services to better fit different business process needs. At its heart, the gateway orchestrator is powered by decision automation software that can interpret business processes codified in standard business process modeling notation (BPMN) and, according to the services offered by the platform, provide users with the optimal experience.

The web portal directly provides the platform expansion functionality and empowers all the remaining by representing the primary interface through which users will interact with the platform. Leveraging the ubiquitous and flexibility of the WEB platform, this layer provides both general graphical interfaces in the form of web pages as well as platform expansion points for external tools. This layer, in direct contact with the gateway orchestrator, will be able to trigger different business processes and run users through the involved tasks.

4 Conclusions & Next Steps

In this paper, a description of the underlying, layered architecture that serves as the backbone of a MaaS platform has been presented. An initial six affordances, drawn from the gig/sharing economy paradigm, were transposed to the industrial sector and served as guiding principles for the definition of a core set of functionalities required for the introduction of digital platforms as added value tools for the MaaS paradigm. With the actualized architecture, composed by four different layers and eighth individual tools, this framework retains the flexibility of its modular design for the application in different manufacturing sectors, business processes or use cases, all the while maintaining its reliability through the use of state-of-the-art trust-based information technologies in conjunction with tried and true standards.

Next steps will consider the development and integration of the software tools, followed by an iterative approach to the demonstration pilots made possible by the development of the architecture alongside the MANU-SQUARE project.

Acknowledgments

The work presented here was part of the project "MANU-SQUARE - MANUfacturing ecoSystem of QUAlified Resources Exchange" and received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements No 761145.

References

1. Barnes, S.J., Mattsson, J.: Building tribal communities in the collaborative economy: an innovation framework. Prometheus. 34, 2, 95–113 (2016). https://doi.org/10.1080/08109028.2017.1279875.
2. Bauer, R.M., Gegenhuber, T.: Crowdsourcing: Global search and the twisted roles of consumers and producers. Organization. 22, 5, 661–681 (2015). https://doi.org/10.1177/1350508415585030.
3. Benoit, S. et al.: A triadic framework for collaborative consumption (CC): Motives, activities and resources & capabilities of actors. J. Bus. Res. 79, 219–227 (2017). https://doi.org/https://doi.org/10.1016/j.jbusres.2017.05.004.
4. Bettoni, A. et al.: Multi-Sided Digital Manufacturing Platform Supporting Exchange of Unused Company Potential. (2018). https://doi.org/10.1109/ICE.2018.8436294.
5. Botsman, R., Rogers, R.: What's Mine Is Yours - How Collaborative Consumption is Changing the Way we live. (2010). https://doi.org/10.1016/S0168-9525(00)00086-X.

6. Carroll, J.M., Bellotti, V.: Creating Value Together: The Emerging Design Space of Peer-to-Peer Currency and Exchange. In: Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing. pp. 1500–1510 ACM, New York, NY, USA (2015). https://doi.org/10.1145/2675133.2675270.
7. Cenamor, J. et al.: Adopting a platform approach in servitization: Leveraging the value of digitalization. Int. J. Prod. Econ. 192, 54–65 (2017). https://doi.org/https://doi.org/10.1016/j.ijpe.2016.12.033.
8. Cheng, M.: Sharing economy: A review and agenda for future research. Int. J. Hosp. Manag. 57, 60–70 (2016). https://doi.org/https://doi.org/10.1016/j.ijhm.2016.06.003.
9. Cohen, B., Kietzmann, J.: Ride On! Mobility Business Models for the Sharing Economy. Organ. Environ. 27, 3, 279–296 (2014). https://doi.org/10.1177/1086026614546199.
10. Cusumano, M.A.: How Traditional Firms Must Compete in the Sharing Economy. Commun. ACM. 58, 1, 32–34 (2014). https://doi.org/10.1145/2688487.
11. Hamari, J. et al.: The sharing economy: Why people participate in collaborative consumption. J. Assoc. Inf. Sci. Technol. 67, 9, 2047–2059 (2016). https://doi.org/10.1002/asi.23552.
12. Ian Barrett, M. et al.: Service Innovation in the Digital Age: Key Contributions and Future Directions. (2015). https://doi.org/10.25300/MISQ/2015/39:1.03.
13. Ikkala, T., Lampinen, A.: Monetizing Network Hospitality. In: Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW ’15. pp. 1033–1044 ACM Press, New York, New York, USA (2015). https://doi.org/10.1145/2675133.2675274.
14. Irani, L.: The cultural work of microwork. New Media Soc. 17, 5, 720–739 (2013). https://doi.org/10.1177/1461444813511926.
15. Ke, Q.: Service Providers of the Sharing Economy: Who Joins and Who Benefits? Proc. ACM Hum.-Comput. Interact. 1, CSCW, 57:1--57:17 (2017). https://doi.org/10.1145/3134692.
16. Kim, J. et al.: Why People Participate in the Sharing Economy: A Social Exchange Perspective. In: PACIS. p. 76 (2015).
17. Landolfi, G. et al.: An ontology based semantic data model supporting a MaaS digital platform. In: 9th international Conference on Intelligent Systems 2018. (2018).
18. Lee, K. et al.: Characterizing and automatically detecting crowdturfing in Fiverr and Twitter. Soc. Netw. Anal. Min. 5, 1, 2 (2015). https://doi.org/10.1007/s13278-014-0241-1.
19. Lenka, S. et al.: Digitalization Capabilities as Enablers of Value Co-Creation in Servitizing Firms. Psychol. Mark. 34, 1, 92–100 (2017). https://doi.org/10.1002/mar.20975.
20. Ma, X. et al.: Self-Disclosure and Perceived Trustworthiness of Airbnb Host Profiles. In: Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing - CSCW ’17. pp. 2397–2409 ACM Press, New York, New York, USA (2017). https://doi.org/10.1145/2998181.2998269.
21. Moser, C. et al.: Community Commerce: Facilitating Trust in Mom-to-Mom Sale Groups on Facebook. In: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. pp. 4344–4357 ACM, New York, NY, USA (2017).

https://doi.org/10.1145/3025453.3025550.
22. Parker, G. et al.: Platform Revolution. W. W. Norton & Company, Inc., New York, USA (2016).
23. Pee, L.G.: Affordances for sharing domain-specific and complex knowledge on enterprise social media. Int. J. Inf. Manage. 43, 25–37 (2018). https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2018.05.006.
24. Philip, H.E. et al.: Examining temporary disposition and acquisition in peer-to-peer renting. J. Mark. Manag. 31, 11–12, 1310–1332 (2015). https://doi.org/10.1080/0267257X.2015.1013490.
25. Puschmann, T., Alt, R.: Sharing Economy. Bus. Inf. Syst. Eng. 58, 1, 93–99 (2016). https://doi.org/10.1007/s12599-015-0420-2.
26. Rosenblat, A., Stark, L.: Algorithmic labor and information asymmetries: A case study of Uber's drivers. (2016).
27. Sarasua, C., Thimm, M.: Microtask Available, Send us your CV! In: 2013 International Conference on Cloud and Green Computing. pp. 521–524 (2013). https://doi.org/10.1109/CGC.2013.87.
28. Sutherland, W., Jarrahi, M.H.: The Gig Economy and Information Infrastructure. Proc. ACM Human-Computer Interact. 1, CSCW, 1–24 (2017). https://doi.org/10.1145/3134732.
29. Sutherland, W., Jarrahi, M.H.: The sharing economy and digital platforms: A review and research agenda. Int. J. Inf. Manage. 43, 328–341 (2018). https://doi.org/10.1016/j.ijinfomgt.2018.07.004.
30. Täuscher, K., Laudien, S.M.: Understanding platform business models: A mixed methods study of marketplaces. Eur. Manag. J. 36, 3, 319–329 (2018). https://doi.org/https://doi.org/10.1016/j.emj.2017.06.005.
31. Vargo, S.L. et al.: On value and value co-creation: A service systems and service logic perspective. Eur. Manag. J. 26, 3, 145–152 (2008). https://doi.org/https://doi.org/10.1016/j.emj.2008.04.003.
32. Vendrell-Herrero, F. et al.: Servitization, digitization and supply chain interdependency. Ind. Mark. Manag. 60, 69–81 (2017). https://doi.org/https://doi.org/10.1016/j.indmarman.2016.06.013.
33. Weber, T.A.: Intermediation in a Sharing Economy: Insurance, Moral Hazard, and Rent Extraction. J. Manag. Inf. Syst. 31, 3, 35–71 (2014). https://doi.org/10.1080/07421222.2014.995520.
34. Zibuschka, J. et al.: Stakeholder Analysis of a Platform and Ecosystem for Open Innovation in SMEs BT - Collaborative Networks for a Sustainable World. Presented at the (2010).