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Managing Emerging (Mis)Alignments in Data-Driven Servitization

Unresolved tensions between the technical development of complex data-driven servitization products and the business logic required to commercialize them can derail a servitization effort.

Peter Altmann and Marcus Linder

OVERVIEW: Manufacturers moving to service-based business models are generally advised to provide total-care solutions to their customers in order to boost profits and strengthen customer relationships. To reduce the risks associated with such services, service providers often rely on remote monitoring technologies to access data on their products' health and usage. Our study reveals a tension between the technical development of complex products capable of remote monitoring and the business logic required to commercialize this potential. Specifically, we show that the collaborative value co-creation context within which these products are typically developed requires managers to seek alignment in technical specifications and value co-creation logics simultaneously. However, technical alignment is contingent on factors that can lead to business logic misalignments.

KEYWORDS: Servitization, Data-driven servitization, Remote monitoring technologies

Manufacturing firms increasingly complement product offerings with services ranging from simple add-ons like phone support and training to advanced total-care solutions (Parida et al. 2014). Through these services, firms enhance customer relationships, increase product profits, and enable more stable revenue streams (Baines et al. 2009; Cusumano, Kahl, and Suarez 2015). One way to offer complementary services is by equipping products with remote monitoring technologies that generate data on how products are used in the field (Grubic et al. 2011; Grubic 2014). For example, Boeing collects data from various aircraft subsystems and components and analyzes these data to support its offering of detection, diagnosis, prognosis, and mitigation services (Reveley et al. 2010).

As simpler add-on services such as phone support are becoming commoditized (Opresnik and Taisch 2015; Parida et al. 2014), firms are increasingly exploring more complex total-care solutions to build competitive differentiation and boost profits (LaValle et al. 2011; Opresnik and Taisch 2015; Ostrom et al. 2015; Schüritz, Seebacher, and Dorner 2017). These more complex servitization attempts are both risky and difficult (Suarez, Cusumano, and Kahl 2013), especially attempts at data-driven servitization supported by remote monitoring (Schüritz, Seebacher, and Dorner 2017; Schüritz et al. 2017). Following complex servitization programs, firms often report a decline in financial performance (Gebauer, Fleisch, and Friedli 2005; Parida et al. 2014); some find their existence threatened (Benedettini, Neely, and Swink 2015).

Insights into attempts at data-based servitization could help managers understand its potential challenges (Grubic 2014; Westergren 2007; 2011). This paper describes a servitization attempt that involved equipping bus and truck tires with sensors for remote health and usage monitoring. The findings show that participants can codevelop solutions with the potential to generate value. However, the conditions required for the discovery of potential value can also create misalignments in beliefs about how it should be realized. These misalignments may be hard to predict, as they stem from context-specific interpretations of value; understanding where they may emerge can help managers anticipate and proactively address potential sticking points.

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TABLE 1. Unique challenges in data-driven servitization

Challenge	Details	Sources
Technological	Lack of standards related to remote monitoring technologies and the data they generate	Grubic 2014; Schüritz et al. 2017
	Hard to access data and to use data in meaningful ways	Schüritz et al. 2017
Value Logic	Manufacturers struggle with understanding and articulating the benefits of data-driven services	Brax and Jonsson 2009; Gremyr, Löfberg, and Witell 2010
	Hard to capture the value that is created through data-driven services (e.g., customers do not recognize the added value from these services)	Grubic et al. 2011; Westergren 2011; Schüritz, Seebacher, and Dorner 2017; Schüritz et al. 2017
	Need for a data-driven business logic	Schüritz et al. 2017
Sociotechnical	Users are skeptical of otherwise accurate sensor data, or rely on data to the point where it negatively affects product usage	Jonsson and Holmström 2005; Westergren 2011
	Users derive context-specific meaning from sensor data	Westergren 2011
Ecosystem	Realizing the potential of data requires ecosystem participants to engage in co-creation efforts	Westergren 2011
	Collaboration and coordination needs are high as data may not be generated within an organization's sphere of control	Schüritz et al. 2017

Remote Monitoring Technologies and Challenges in Data-Driven Servitization

Remote monitoring technologies comprise "a combination of software and hardware technologies that enable remote collection of data about the performance and usage of a product in the field" (Grubic 2014, p. 107). Firms can use these technologies to collect health and usage data that then can be analyzed to support product improvements and tailored service offerings (Grubic 2014; Jonsson and Holmström 2005; Westergren 2011). For instance, firms can monitor component health data to support a pricing model based on total uptime (Brax and Jonsson 2009) or analyze usage data to provide targeted advice about usage and handling (Laine, Paranko, and Suomala 2010).

The challenges associated with servitization in general are well explored in the literature (see Alghisi and Saccani 2015; Baines et al. 2009; Zhang and Banerji 2017). Firms that attempt to offer services based on data collection via remote monitoring face additional challenges related to both the remote monitoring technology (Grubic 2014) and the data itself. These challenges include issues related to the technology, its interdependencies, and its potential, as well as the value logic required to realize this potential. Sociotechnical issues inherent in users' interaction with these systems may also give rise to challenges, as may the firm's business ecosystem (Table 1).

The value logics in the business ecosystem add a layer of complexity to the approach to dealing with technological interdependencies. Adner's (2013) account of Goodyear's run-flat tire innovation reveals how difficult ecosystem coordination can be when the success of an innovation requires adjustments from multiple participants in the value stream. Data-driven servitization presents a related yet distinct challenge: the value-capture logic is notoriously difficult to identify (Schüritz, Seebacher, and Dorner 2017; Schüritz et al. 2017). Firms may struggle to understand and articulate the benefits of remote monitoring technologies and the data they collect (Brax and Jonsson 2009; Gremyr, Löfberg, and Witell 2010) and often fail to charge appropriately for data-based services (Grubic et al. 2011; Schüritz, Seebacher, and Dorner 2017; Westergren 2011).

Data-driven servitization is hard also because it is difficult to predict how users will interact with sensor data. This is problematic because success requires knowing how the innovation will affect the daily activities of end users and others (Adner 2013). Yet research has shown that some users can be skeptical about the accuracy or significance of sensor data, while others rely on sensor data to the point that interaction with the product is negatively affected (Jonsson and Holmström 2005; Westergren 2011). When data are shared among multiple ecosystem participants, each participant may derive meaning from them in context-specific ways (Westergren 2011), adding another layer of complexity.

To overcome these challenges, researchers suggest using performance-based contracts that transfer the risks of operational downtime from customers to service providers. This contracting approach signals the firm's commitment and allows for the inclusion of data-driven services in pricing (Gremyr, Löfberg, and Witell 2010; Grubic 2014). Researchers also encourage firms to develop capabilities to effectively manage relationships with partners in order to access high-value services (Parida et al. 2014) and align the value logics of the firm with those of collaborators (Adner 2013; Chesbrough and Schwartz 2007). However, in cases where data drives value co-creation efforts, it is unclear how firms can identify such complementarities or determine how compatible their value logics will be in the end.

To overcome these challenges, data-driven servitization requires a value co-creation logic that enables standards, increases trust, and bridges the gap between value providers and customers (Grubic 2014). Work that details the process necessary to develop such a value logic is scant. One notable exception is Westergren's (2007, 2011) work, which shows how value is both co-created and co-discovered via participant relationships that are constantly changing. Within those relationships, Westergren argues, participants interpret (and continuously re-interpret) co-created value differently and must understand multiple context-specific interpretations—both their own and those of other participants—to succeed. In this context, identifying the ultimate impact of data-driven servitization across ecosystem participants is clearly difficult at best.

Our study sought to understand how these gaps can be bridged via a detailed case study of a value co-creation project involving equipping retreaded truck tires with remote monitoring technologies. Success required the participation of multiple ecosystem participants in both the development of the sensor-equipped tires and the attempts to deal with emerging incentive misalignments.

The Study

The co-development project that is the subject of this study involved six organizations: one public research institute and five private firms, each occupying a different part of the tire retread value network (Figure 1). Industry participants filled four roles:

- TireRetreader, a firm focused on retreading used tire casings;
- TruckCorp Trucks, a truck manufacturer;
- TruckCorp Services, a service provider that provides tires to haulers and offers fleet management services to fleet operators; and
- MatRecyclers, two companies focused on tire recycling.

Each firm operates within the Scandinavian heavy truck and bus tire value network, but the firms had not previously collaborated in this way. The organizations entered a collaborative partnership to explore remote monitoring technologies and data-driven servitization. The public research institute that initiated the project, which was funded by the Swedish government agency for research and development, coordinated the research project and aided with sensor development, tests, and data analytics.

The participants had two primary reasons to examine whether tire casings could be equipped with remote monitoring technologies to collect health and usage data. First, TruckCorp Services sometimes sent faulty tire casings to TireRetreader; health and usage data could help detect faulty casings earlier in the process. Second, because inspecting tire casings is difficult, TireRetreader normally retreads casings only once. Health and usage data could help identify casings suitable for multiple retreads, providing both financial and environmental benefits. Critically, equipping tires with sensors did not require any major adjustment for any participant, thus limiting integration risks like those described by Adner (2013).

Within those relationships, participants interpret co-created value differently.

Data were collected from late 2016 to early 2019. We collected and analyzed data on both technical feasibility and business implications, including workshop notes, meeting minutes, lab tests, and business reports. Technical data were readily available and feasibility tests revealed sensor capabilities and limitations.

Despite the availability of technical data, it was difficult for participants to agree on technological specifications, because their data needs were contextually determined and contextually interpreted. We conducted interviews to determine how these context-specific needs shaped the conversation around technical characteristics. We also mapped the existing technical data flows through the value network.

It was during the interview stage that we learned how differently industry participants framed the potential benefits of the remote monitoring data and that we noticed emerging misalignments. For instance, during a project workshop in April 2018, one industry participant expressed enthusiasm about remote monitoring capabilities and the potential for using health data to improve haulers' opinions of retreaded tires. Another industry participant argued against such a use, since it could undermine that organization's commercial efforts.

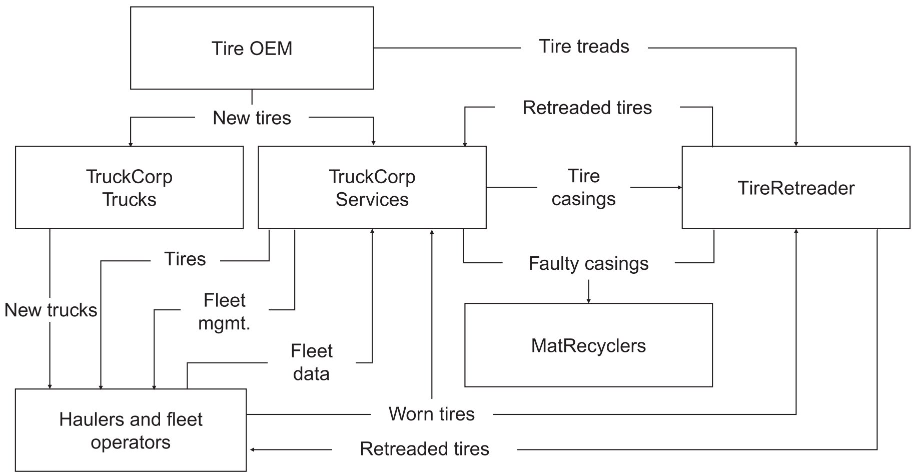

FIGURE 1. The tire retread value network

Upon observing this misalignment, we reanalyzed all the data to gather additional insights about the emerging misalignments. This analysis focused more specifically on the commercial, as opposed to the technical, aspects of the data flows; in mapping these desired commercial flows, we labeled the ways the firms wanted to use data. Several of the proposed firm-specific use cases were non-rivalrous; for instance, one tire recycler wanted to use application area data as input to its pyrolysis process, and the tire retreader planned to use these same data to identify customers for retreaded tires.

Firm-specific use cases generated tension because they conflicted with each other—one firm's efforts would undermine the efforts of another.

But other firm-specific use cases generated tension because they conflicted with each other—in these cases, one firm's commercialization efforts would undermine the commercialization efforts of another. We focused on these rivalrous uses, as the tensions they produced had the potential to obstruct the servitization process. Specifically, TruckCorp and TireRetreader provided the most salient examples of emerging incentive misalignments.

The Tire Retread Market—Aligning Goals and Data Needs

Retreaded tires can offer similar performance to premium OEM tires with a lower carbon footprint and at a lower cost. Premium tire manufacturers such as Michelin and Goodyear claim that, as a rule of thumb, a retread doubles a tire's lifespan at half the cost, using a third of the energy and a quarter of the raw materials of a new tire. With additional services, such as tread profile restoration, the total cost of ownership of a retreaded tire is 70 percent that of a new tire. Therefore, retreads are marketed as environmentally friendly, low-cost solutions.

However, the retread market is facing two major challenges. One is the growth in Chinese imports of truck and bus tires that are priced as low as one-third the cost of premium tires. These imports nearly tripled between 2007 and 2016, a period during which sales of retreads declined by more than 26 percent. While a provisional anti-dumping duty has provided some respite, industry incumbents are looking to technological advances and servitization for more long-term solutions. However, achieving further cost reductions will require that a tire casing be retreaded more than once; making multiple retreads safe and cost-effective will require health and usage data on tire casings, which service providers and retreaders currently lack.

The co-creation project at the heart of this study was initiated to address these challenges; the goal of the project, stated in the initial research plan, was to better understand how "different actors can increase resource productivity [using] integrated sensors." This goal was inspired by the growing use of tire pressure monitoring systems in bus and truck tires. Tire producers such as Continental, Goodyear, Bridgestone, and Michelin equip truck and bus tires with sensors that generate health and usage data and use these data to support fleet monitoring services. The research project aimed to investigate whether the benefits those companies were seeing could be extended to the retread market.

Reaching that goal required collaborative input to develop the remote monitoring technology and find ways to co-create value from it. The plan anticipated how that might happen. For TireRetreader, health and usage data could benefit operations by revealing tire casing health. For TruckCorp, the benefit was initially framed by the sustainability department as decreasing raw material usage. Members of MatRecyclers who worked with raw materials recycling were interested in accessing tire identity data (for instance, winter or summer tire) and application area data. These data would improve tire sorting operations and the materials recovery process, which could lead to lower operational costs and a reduced need for virgin raw materials. In addition to these benefits, the aim was to explore other services that could be developed using health and usage data.

The project's staffing reflected each organization's initial aims and goals. TireRetreader's CEO was interested in technologies that could help secure health and usage data. The initial three members from TruckCorp all worked with sustainability (lifecycle analysis or resource efficiency). One TruckCorp member was tasked with linking the project to other TruckCorp sensor projects and to prepare for future integration. This member was also charged to examine the value-creating potential of sensor-equipped retreads and explore how such tires would affect the daily work of maintenance staff at TruckCorp's service division. The members of MatRecyclers worked on securing the reverse flow of tire casings or in raw materials recycling. Several other MatRecycler members had extensive experiences within waste management, recycling, and chemical processes and their ultimate aim was to better control the feedstock into their industrial processes.

The initial alignment among the participating firms was high. Application area data and tire identity data facilitated the sorting of worn tire casings. MatRecyclers benefitted from these data through a better control of feedstock and TireRetreader through the identification of casings suitable for retreading and the matching of the retreaded tire to an application area. TruckCorp's sustainability aim related to increased raw material efficiency. These aims and intended uses were highly aligned, despite the organizations framing the benefits of the effort differently.

During the early technical development stage, therefore, the problems and data needs were clear. However, the technical solution was hard to pin down. Each of the participants faced unique problems and their existing remote monitoring capabilities ranged from extensive (TruckCorp) to minimal (TireRetreader). In addition, their data needs differed, as did the extent to which these unmet needs could be addressed using remote monitoring technologies (Table 2). The three interviewees at TireRetreader (the CEO, an operations manager, and a line worker) wanted to use data to estimate casing fatigue. Unmet data needs included both health data (tire pressure, tire temperature, sidewall impact, and road hazard impact) and usage data on application area and distance traveled. Data linked to the tire's history and owner was also considered useful. In comparison, the TruckCorp's sustainability group only needed to know a tire's history, more specifically the number of times it had been retreaded. The data needs for MatRecyclers were limited to application area and tire identity.

As the project developed, it became clear that a sensor-based solution would only work if the monitoring technologies could be integrated with the vehicle's existing ICT system. As a result, developing the final specifications required the involvement of additional stakeholders within TruckCorp. As these new stakeholders entered the project, the existing alignments were both improved and challenged. For instance, involving the uptime services and the uptime and quality functional areas at TruckCorp improved the technical alignment by removing redundant functionality and improving the fit with existing ICT systems. But it also introduced tensions in how these data should be commercialized due to the conflicting value logics between direct sales (which transfer risks to the haulers) and performance-based service contracts (which allocate the risk to the service provider).

Not all new stakeholders introduced disturbances. For instance, input from TruckCorp's tire department aligned well with both TireRetreader's and TruckCorp's sustainability interests. Similarly, the input from raw material recyclers at MatRecyclers did not cause misalignments. Also, some disturbances caused only temporary misalignments that were easily resolved. Others, however, triggered major misalignments that thwarted co-creation efforts. Our analysis focuses on these major misalignments.

Emerging Misalignments

The degree of alignment among participants in a co-creation project can change as co-creation efforts unfold (Westergren 2007, 2011). These changes are hard to predict because new stakeholders join when technical problem solving requires input from additional functional areas. For instance, when TireRetreader informed the research institute's sensor and data analytics experts about the determinants of casing health, a solution emerged that used remote monitoring technology—impact sensors on tire casings—and data analytics to detect road hazard impacts. Neither participant could have imagined the solution without the other participant's input. However, while the solution was technically feasible, it was never implemented because discussions between the researchers and TruckCorp revealed that accelerometers, already mounted on drive axles, could generate data that proved able to detect road hazard impacts. Thus, the technical alignment improved following the input from new stakeholders within TruckCorp, but it also introduced a new set of participants with different sets of interests, which tested existing alignments.

> **The degree of alignment among participants can change as co-creation efforts unfold.**

With each new stakeholder, the specifications for the technological solution improved. These improvements included both direct efficiencies created by reducing redundancies and better alignment with the sensor system already in place. Once the solution became clear, stakeholders began interpreting its potential within their own contexts:

1. **Tires.** The tires context included TireRetreader's entire business and those working within the tires functional area at TruckCorp. In this context, health and usage data could have efficiency benefits; it would reduce the labor costs associated with sorting and inspecting tire casings and make it easier to identify casings suitable for multiple retreadings. Consequently, remote monitoring technologies would lower the cost of goods sold by allowing more casings to be reused. In addition, TireRetreader hoped to boost retread volumes and increase customers' willingness to pay by using sensor data to show that high-quality retreads performed similarly to premium OEM tires, information that is valuable when the risks are transferred to the customer through direct sales.
2. **Sustainability.** The sustainability context included actors from resource-efficient manufacturing, sustainability analysis, and environment and innovation functions within

TABLE 2. Participants' unmet tire data needs

		Casing fatigue										*Tire scrub*			*Comfort/safety*			
Participant	**Functional Area**	**TP**	**TE**	**LC**	**AA**	**AG**	**DT**	**SI**	**PR**	**ID**	**HI**	**AL**	**TA**	**TD**	**VI**	**RS**	**RH**	**NL**
TireRetreader	Operations	•	•		•		•	•	•	•	•						•	
TruckCorp	Tires	•				•	•				•							
TruckCorp	Sustainability									•								
TruckCorp	Customer support	•	•															
TruckCorp	Uptime services	•	•	•			•								•	•		
TruckCorp	Marketing	•	•	•		•	•				•				•	•		
TruckCorp	Uptime & quality											•	•					
TruckCorp	Services & sales	•	•					•				•		•			•	•
MatRecyclers	Reverse flow									•								
MatRecyclers	Material recycling				•					•								

TP *Tire pressure* ***AG*** *Age of tire* ***ID*** *Tire ID No.* ***TD*** *Thread depth* ***NL*** *Noise levels*
TE *Temperature* ***DT*** *Distance traveled* ***HI*** *Hauler identity* ***VI*** *Vibrations*
LC *Load carried* ***SI*** *Sidewall impact* ***AL*** *Axle alignment* ***RS*** *Road surface friction*
AA *Application area* ***PR*** *Past repairs* ***TA*** *Thrust angle* ***RH*** *Road hazard impact*

TruckCorp, as well as members from MatRecyclers, which aimed to reduce fossil exploitation by recovering useful raw materials from scrap tires. In this context, data on tire identity and application area enabled better control of the feedstock quality, sorting process, and estimations of environmental impact. Value was envisioned as stemming from increasing the number of retreads and reducing reliance on virgin raw materials, which would reduce TruckCorp's raw materials usage and increase its economic output per raw material input and boost MatRecyclers' businesses.

3. **Uptime.** The uptime context included the customer support, uptime services, and marketing functional areas of TruckCorp. Actors in this context were interested in health and usage data for two main reasons. First, 30 percent of unplanned stops are tire related, and an estimated 80 percent of those stops could be avoided with remote monitoring. Second, TruckCorp's existing customer base guaranteed a reverse flow of tire casings, which could result in a service offering that one manager described as "easy to include in our uptime services." Using sensor data to accurately compare quality retreads to premium OEM tires would provide valuable input to the pricing of performances in cases where risks are transferred to TruckCorp via performance-based contracts. Such performance-based contracts would be insensitive to the poor market reputation of retreads and thus would benefit from lower retread prices.
4. **Driving.** The driving context included actors from the uptime and quality and services and sales areas of TruckCorp. In this context, the value proposition revolved around reducing fuel costs and tread wear. As such, data on tire pressure was important because it affects fuel consumption. Similarly, data on axle alignment and thrust angle could be used to reduce both tread wear and fuel consumption.

As these context-specific interpretations of value became clear, misalignments between functional areas emerged. The largest misalignment we observed was between the tires context and the uptime context. Once it became clear that remote monitoring could enable more accurate quality estimations of retreaded tires through health and usage data, TireRetreader wanted to use sensor data to improve the market reputation for retreads, which would increase retread prices and improve margins from direct sales. This approach makes sense if the customer assumes the risk of the product. Members from TruckCorp's customer support and uptime services areas, on the other hand, wanted to use sensor data on casing quality to better estimate and price operational risks. This approach makes sense if the service provider assumes operational risks and wishes to signal a credible quality commitment to potential customers.

This misalignment affected participants' perception of the value of the project.

Efforts to increase market willingness to pay for retreads increases direct sales margins where customers (haulers) assume operational risks, but those efforts lower the rent-generating capacity of performance-based contracts in which the service provider assumes the operational risks and benefits of low retread prices. These contrasting usages of sensor-enabled data thus created a misalignment between TireRetreader and TruckCorp (Figure 2). This misalignment was a huge problem; it affected participants' perception of the value of the project and their willingness to share health and usage data. During a discussion around the conflict, one TruckCorp uptime services manager argued, "We should not have joined the project. We need to own the tire data and use it to minimize the risks associated with distance performance-based contracts."

There also emerged a smaller misalignment between the tires context and the driving context. Sensor data could be used to reduce tread wear, which would positively affect cost of operations but negatively impact the demand for tires, including retreads. One interviewee at TruckCorp's service center pointed out that increased health and usage data "is bad of course because [retreaders] get to sell fewer tires." This misalignment did not thwart servitization efforts, because the tire retreading value network is mainly limited by an access to tire casings. With better health and usage data, the number of suitable casings would increase.

Moving Toward Realignment

The goals and needs of the project's industry participants were initially aligned. As additional stakeholders joined the project, their contextual knowledge shaped both the technical solution and the avenues for commercialization of the solution. While some value logics aligned well—for instance, the drive to reduce raw material usage and the need to increase retread usage—others created tensions. The biggest tensions emerged when participants envisioned using the same data to pursue conflicting value-capture strategies. These misalignments were not apparent at the start of the joint development project, and they had to be addressed as they emerged.

To resolve these tensions, the research project emphasized its focus on data. In a participant workshop in 2019, attendees agreed that a shift was needed away from the technical development of remote monitoring technologies and the physical product itself toward the use and commercialization of sensor-generated data. The researchers presented their mapping of data flows; a large telecommunications service provider was invited to present its data-sharing, analytics, and commercialization platform. This platform showcased a solution that aggregated data from multiple sources (for instance, weather data, traffic light data, air quality data) and analyzed them to provide information for traffic planners. Attention then turned to the heavy tire value chain; the participants discussed what data flows could look like in the future, what interfaces were necessary to support data aggregation, how sensor data could generate immediate value for project participants, and what potential existed to commercialize data outside of the existing value chain.

Shifting the focus to data helped further the discussion by emphasizing the benefits of data aggregation and data sharing

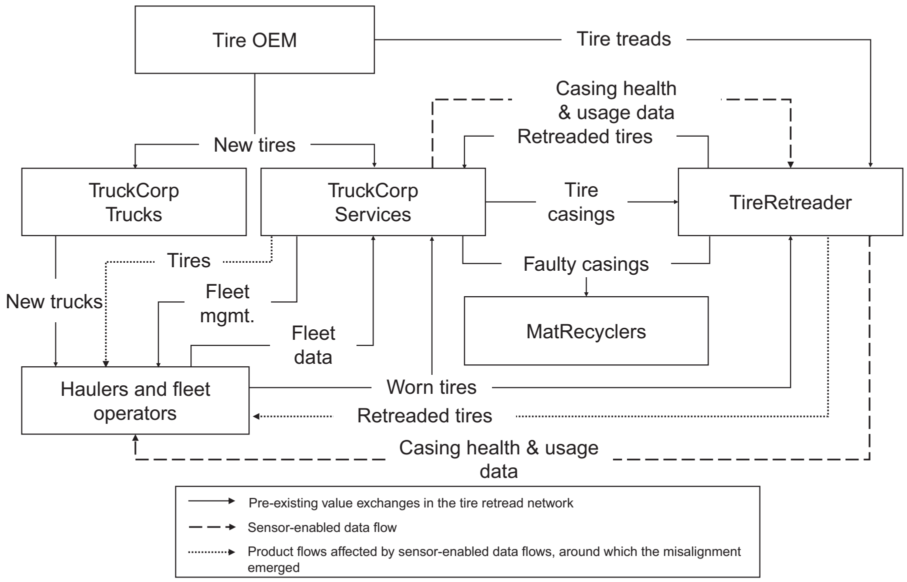

FIGURE 2. The sensor-equipped tire retread value network in which the misalignment emerged

in complex products. All participants agreed that tires are part of complex products and that aggregating data from multiple sources could unlock significant value for the ecosystem. A participant representing TruckCorp's uptime context argued that "it is difficult to build expertise around heavy truck tires and we often work with very high [and costly] safety margins. There is a lot of benefits to better understand the variables that impact tires." Participants representing the tire and sustainability contexts agreed that a better understanding of each tire's historical use and future intended use was desirable. For instance, using hauler and tire identity data would allow TireRetreader to customize the retreading process for particular customers. Similarly, health and usage data could enable cascading usage scenarios in which retreads were made with certain application areas in mind. However, these scenarios required data on multiple variables, which would only be possible in the context of a data-sharing model that enabled the data to show benefits related to material usage, uptime, and fuel consumption.

Participants also floated ideas around using data to supply information to actors outside the current ecosystem. For instance, road condition data (such as traction and grip, potholes, and pavement cracking) could be used to enhance driving safety and help road maintenance providers better assess maintenance needs. Similarly, additional sensors could provide traffic planners with real-time data on the entire road network. These ideas are currently being explored and plans for developing a data-sharing, analytics, and commercialization platform are underway. One key question that remains to be explored is how to price the data and how to turn the data into meaningful insights within and outside the existing ecosystems of the participants.

Opportunities and Challenges with Data-Driven Servitization

Our case study shows that data-driven servitization has the potential to generate value for participants in an ecosystem, but also highlights a key challenge in attempting to realize this potential. Service providers can rely on data to price risks and generate profits from transferring operational risks to themselves; manufacturers can use data to both improve cost-efficiencies and signal quality and thus increase value. Retreads are already marketed profitably across a range of industries; additional health and usage data could lower the total cost of goods sold and yield additional rents. Accurate risk pricing, also enabled by health and usage data, supports performance-based contracts that transfer risk to the service provider, who would benefit from lower retread prices. Thus, a data-driven servitization effort can support different value-capture logics across a business ecosystem.

Our case also shows that conflicting value logics may thwart servitization success in this context. As development unfolds and more actors get involved, additional context-specific knowledge is incorporated. Often that additional information is important for technical alignment, but it also risks causing misaligned value logics, as each actor interprets the value potential of the technology in its own context. Thus, while successfully developing these complex technological solutions requires multiple participants, collaboration efforts can make it difficult to find a pathway to commercialize the data generated by the solution.

It is hard to predict where and when misalignments will emerge. Data-driven servitization efforts may require a strong initial focus on the technical solutions that enable the necessary data. In such cases, actors may not be able to contextualize the value of the technology at the outset of the project. It is when this contextualization begins that misalignments may surface.

Thus, to succeed with data-driven servitization, managers must recognize that misaligned value-capture logics will be an integral part of the servitization effort. A number of approaches can reduce the risk that such misalignments will undermine the project:

- When the involvement of codevelopers is hard to predict, it may also be difficult to anticipate how these participants will want to commercialize data. When data can be used in rivalrous ways, and where it is difficult or impossible to limit such rivalrous uses, the technology development phase may need

One key question is how to turn the data into meaningful insights within and outside the existing ecosystems of the participants.

To succeed with data-drive servitization, managers must recognize that misaligned value-capture logics will be an integral part of the effort.

to be followed by a data-use alignment phase. Managers must plan for this additional alignment phase.

- Contractually separating the physical flow from the data flow will encourage managers to treat data as a resource that requires its own set of agreements to ensure its value potential can be realized. This is especially helpful in cases where a product capable of providing remote monitoring shifts ownership multiple times and where the data the product generates are useful in different ways in different contexts.
- Data are infinitely reusable, which means that each commercialization attempt has a low marginal cost. If data use is rivalrous in the ecosystem that supported technical alignment, managers can attempt to identify rent opportunities in contexts outside of the original ecosystem to avoid misalignments that thwart commercialization. This is especially effective if an increased understanding of the product and its interactions unlocks value beyond the rivalrous use case.

The limitations of our study approach make it difficult to estimate the extent to which these insights are generally applicable. Participants in other ecosystems may encounter a different set of challenges depending on factors such as technological know-how, prior experiences, and established relationships. Further studies could reveal patterns in the nature and timing of data-related conflicts. While firms' servitization processes, and the specific challenges they face in those processes, may differ, the fact that data are infinitely reusable and allow for simultaneous commercialization attempts is generally applicable.

Conclusion

The development of data-driven services presents manufacturing firms with a unique set of challenges. The participants in our study joined the collaborative research project with the initial aim to minimize the environmental impact of heavy truck and bus tires. When framed as a sustainability project, the participants' incentives were well aligned. However, to integrate the remote monitoring technology with existing ICT systems necessitated the involvement of additional participants representing other contexts. These additional contexts aided the technical alignment, but also introduced misalignments in the ways the participants sought to commercialize the sensor data. These misalignments, which were hard to predict, created tension that, in some cases, risked thwarting the servitization attempt.

Our study offers three key findings on how to resolve these tensions. First, managers must recognize and plan for a data use alignment phase following initial technology alignment. It is during this phase that participants can share why the sensor data are valuable to them and identify and manage potential misalignments. Second, to move toward realignment, it is important to recognize that data is a resource that can be reused multiple times independently of the physical product that generates the data. Third, it is important also to recognize that these data can provide value both within and outside the ecosystem that first developed the technology. Equipped with this knowledge, managers can resolve tensions related to specific use cases and start to explore the value potential inherent in the data their products generate, both on their own and combined with other data.

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