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# From Smart Connected Products to Systems of Systems: Case Study and Archetypes<sup>1</sup>

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**Abstract.** As the digital transformation proceeds in great strides, industrial companies move forward on their evolutionary process from smart connected products to systems of systems. Empirically grounded in an 18-month innovation project at Sustainability Company – a globally leading supplier of piping systems – this manuscript strives to share in-depth insights on this journey deriving archetypes of such progressions: (1) Physical Takeover, (2) Physical Partnering, (3) Digital Intruding and (4) Digital Expansion. Considering restrictions by the single-case method, we can conclude that beside operational considerations increasingly strategic deliberations need to be taken into account. Industrial enterprises have to decide whether to lead, partner or participate when breaking the new grounds of smart connected products.

**Keywords:** Smart Connected Product, Smart Connected Product System, System of Systems, Platform, Ecosystem, Multi-sided Market, Case Study, Archetype, Industrial Sector, Piping System, Data Center.

## 1 Motivation

Leaders from both science and industry agree that smart connected products are a pivotal source of innovation in the industrial sector. Following the seminal papers by Porter and Heppelmann [1,2], smart connected products contain physical, smart and connectivity components. Empowered by these digital elements, the new capabilities monitoring, control, optimization and autonomy emerge [1,2], which in turn enable novel value propositions and business models [3,4].

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<sup>1</sup> Parts of this manuscript draw on content from the unpublished research proposal “Development of a Smart Connected Product System for the Industrial Piping Business” of the Swiss Innovation Agency. Furthermore, the project has been presented at the “5. F&E Konferenz zu Industrie 4.0” on 05.02.2020 in Zurich, Switzerland.

Nevertheless, industrial companies struggle in implementing the different evolution stages [1,5]. While the initial stages (stand-alone smart connected products) have been mastered, particularly the most promising stages “product system” (multiple interacting smart connected products) and “system of systems” (multiple interacting smart connected product systems) pose difficulties to the enterprises [1,5]. Based on lack in inter-organizational collaboration, technological compatibility and joint business, only scarce knowledge and few guidance on such systems is available today [1,6].

To address the gap, this manuscript reports from an 18-month innovation endeavor at SustainabilityCompany (SustCo) – a globally leading supplier of piping systems – in the setting of a Swiss Innovation Agency project. Specifically, we strive to share in-depth insights on this journey [7,8] deriving archetypes of such progressions [9,10]. This merges in the following research question: *[RQ] Which design options for the development of a smart connected system of systems are possible?*

We proceed in the following manner: Paragraph 2 communicates the academic and industrial state-of-knowledge in terms of smart connected products. Paragraph 3 introduces methods & materials referring to the applied methodology and empirical context. Paragraph 4 describes the case study focusing on the development process and its outcome. Paragraph 5 shares a discussion at both operative and strategic level. Lastly, paragraph 6 terminates with a conclusion.

## 2 State-of-Knowledge

*Academic state.* Various fields such as mechatronic engineering, information systems research, innovation management, computer science and management research engage in the design and exploitation of smart connected products [11]. To deepen our understanding of the current body of knowledge, we reviewed sources following established guidelines [12].

In a wider sense, smart connected products can be counted to digital platforms promoting an ambient ecosystem [13,14]. Constantinides et al. [13:1] conceptualize such platforms as “a set of digital resources [...] that enable value-creating interactions between external producers and consumers”. In a narrower sense, upon the diverse nomenclature contributions can be found under terms such as digitized, intelligent or smart products [11]. From a technical perspective, a novel technology stack is needed, comprising the product hardware and software, connectivity and a product cloud with integrations to external data, business systems and finally security/identity management [1,2]. From an economic point of view, several business models (e.g., Digital Add-on or Physical Freemium) and tailored approaches [3,4] have been proposed in this context. Nevertheless, works in domains such as healthcare [15], manufacturing [16] or logistics [17] predominantly address the stand-alone version and neglect higher manifestations. Especially for traditional incumbents it is more profound to change the way of doing business and build up new capabilities [18].

*Industrial state.* From a practical perspective, innovative firms have undertaken efforts to create these evolved stages, for example, in the domain of farming: In a previous evolution stage, John Deere and AGCO presented a “farm equipment system”

integrating smart connected tractors with adjacent products (such as planters or tillers) for optimized operations [1]. Meanwhile, in a further evolution step, this farm equipment system has been complemented with additional systems (e.g., seed optimization system) to generate a “farm management system” [1]. Other industries have recognized this innovation potential and are following the trajectory to build up own systems like the Smart Connected Waste Management System by Anta Swiss [19] or the Smart Connected Mining System by Joy Global [1].

*Research gap.* In sum, characterizing the gap according to Müller-Bloch and Kranz [20], a knowledge void is present – especially referring to the design, governance and management of such smart connected product platforms for established industrial incumbents [1,5,21]. To these points, this manuscript aims to make a contribution in research and practice.

### **3 Methods & Materials**

*Applied methodology.* Our goal is to share insights on the development towards a smart connected system of systems and derive archetypes of such progressions. Thus, a case study as an “empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” [7:13] serves as eligible methodical setting. During the period from 10/2019 to 03/2021, we had the opportunity to accompany SustCo in its innovation endeavor. Drawing on Yin`s framework [7], this represents a (1) single case study [SustCo] and a (2) single unit of analysis [project]. This intense involvement in the project offered us a sound empirical base. In terms of data collection, we could triangulate by observations (e.g., customer interviews, development meetings), documentations (e.g., management presentations, technical documents), archival records (e.g., annual reports, product presentations) and physical evidence (e.g., minimal viable products) as suggested by established guidance [7,8]. With regard to data analysis, we decided for a longitudinal qualitative analysis [22,23].

*Empirical context.* SustCo is a globally leading supplier of piping systems headquartered in the DACH region. With a three-digit number of years heritage in materials and product engineering, it nowadays represents a multinational with several thousand employees and sales in the billion EUR range. SustCo focuses on both individual components and complete solutions for the transport of fluids as well as related industrial services. Piping systems are complex technical systems, being composed of different in-line components such as valves. The supplier has successfully digitized its valves adding sensors and actuators, and connectivity to sense and control the transmitted fluid (e.g., pressure, flow rate and temperature). However, these solutions are currently sold as stand-alone products, further components are not included or have their own platforms. Hence, the next critical step is to integrate additional components such as pumps and heat exchangers. Besides, SustCo also aims at exploiting new business fields, so the application context is the emerging data center market. In addition to the thermal system, data centers furthermore comprise power, IT and other (e.g., fire suppression) [24].

## 4 Case Study

### 4.1 Project Overview

To create a useful solution for its customers, SustCo followed a classic product development approach while integrating feedback loops to increase agility. Figure 1 demonstrates the overarching project course using the nomenclature by Peffers et al. [25], which directly relates to the “understanding – design – evaluation” paradigm. In the first phase, objectives for a solution were defined. In the second phase, the actual solution was developed. Finally, in the third phase, the solution was evaluated.

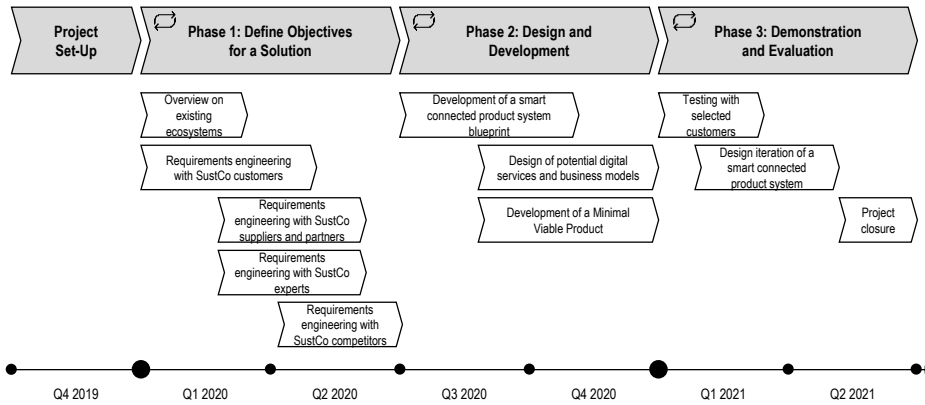
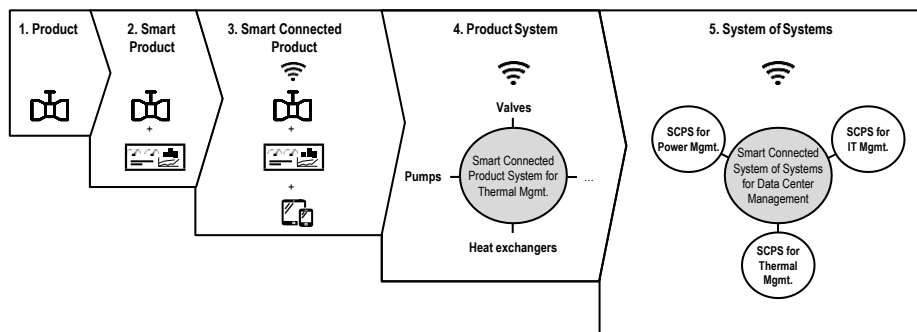


Fig. 1. Overarching project course using the nomenclature by Peffers et al. [25].

### 4.2 Phase 1: Define Objectives

After an analysis of existing platforms and ecosystems to learn from their design, requirements engineering specifically for the data center domain adopting different stakeholder perspectives stood in the center. During interviews and workshops with SustCo’s customers (i.e. data center owners/operators, but also data center general contractors), needs such as (1) guaranteed availability, (2) increasing sustainability and (3) reduced human involvement were identified. Beyond the highest requirements regarding trustworthiness, this segment emphasized the holistic coverage of infrastructure and elimination of siloes. This shaped the project towards the system of systems direction and extended the initial goal of a product system. Furthermore, adopting similar techniques, SustCo’s potential suppliers and partners (i.e. pump, heat exchanger and valve manufactures) were surveyed regarding their point of view on such an ecosystem. The evolution towards the system level is consistently recognized as value adding, but at the same time the companies were aware of their own limitations arising from the market position and firm-internal capabilities and resources. So, instead of building own platforms, the parties were interested in contributing smart components and smart services (e.g., a heat exchanger and a fouling prediction service),

either as pure provider or as co-owner. Additionally, in internal exchanges SustCo's sales and marketing department highlighted the sensitivity of the data center business which impacted intelligence level decisions (i.e. rather monitoring with recommendations than active management). Lastly, competitor analyses with established and emerging players (data center infrastructure management tools in the narrower sense, Internet of Things platforms in a wider sense) helped to untangle white spots, such as component compatibility and service offerings. To summarize, Figure 2 illustrates SustCo's targeted evolution from smart connected products to systems of systems adopted from Porter and Heppelmann [1].

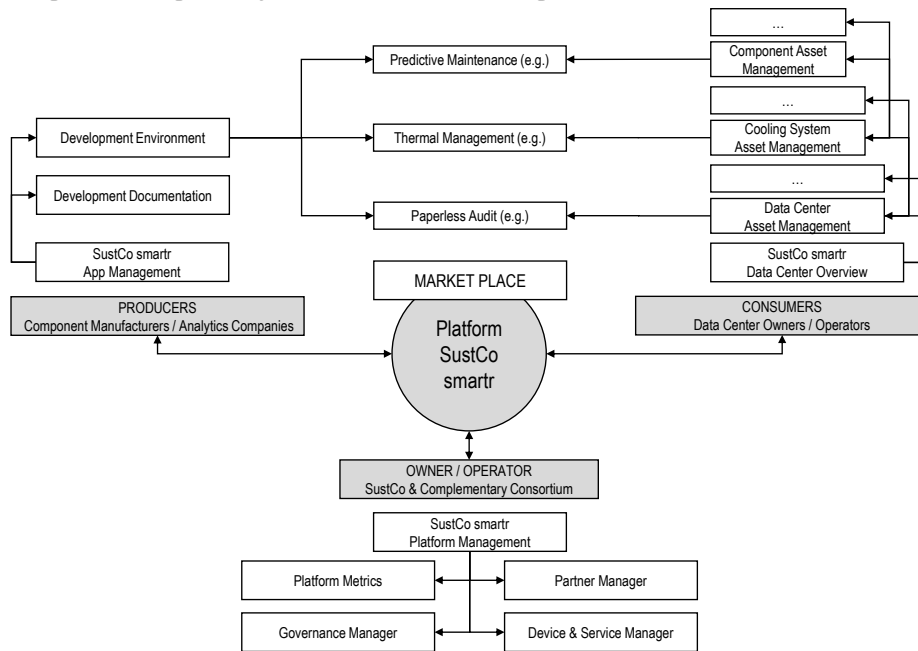


**Fig. 2.** SustCo's targeted evolution from smart connected products to systems of systems adopted from Porter and Heppelmann [1].

### 4.3 Phase 2: Design & Development

Drawing upon evidence from the previous phase, the design of a blueprint and corresponding digital services and business models, followed by the technical implementation into a Minimal Viable Product dominated. Starting with the blueprint, the team decided to realize the system as a multi-sided market to go beyond conventional solutions. Figure 3 sketches the logic of the multi-sided platform “SustCo smartr” and corresponding platform modules. Organizationally, the solution comprises the platform owner/operator (SustCo & complementary consortium), service producers (component manufacturers/ analytics companies) and service consumers (data center owners/ operators). From a consumer view, the data center operators connect their devices to the platform. Based on these IoT data, digital services (apps) help to manage the data center at different levels. For example, at the level “Data Center” a Paperless Audit, at the level “Cooling System” a Thermal Management or at the level “Component” a Predictive Maintenance service supports the operations. From a producer point, these apps are not only provided by the platform owner, but also by third-parties. These parties may be on the one hand component manufacturers (e.g., a valve manufacturer offers a corresponding valve monitoring service) and on the other hand analytics companies without associated hardware (e.g., a certification body offers a paperless audit service). To bring these apps to the market place, a development documentation and development environment is included. From an owner perspective,

the platform itself is owned and operated by SustCo and a complementary consortium, to benefit from further competences and foster acceptance in the market. To control the platform and the surrounding ecosystem, the solution includes modules for managing partners, governance and devices & services by the aid of essential platform metrics. The owner is supported by an IT partner that develops and maintains the platform (not visualized). Considering the secrecy, SustCo decided for a tightly regulated platform which is open to all consumers, but only selected producers have access. With regard to the IoT strategy, the team aims at supporting as many standards as possible to ensure component compatibility and increase the market pervasion.



**Fig. 3.** Logic of the multi-sided platform “SustCo smartr” and corresponding platform modules.

In total, the platform offers a win-win situation: The consumers can turn their data into value. The producers can profit from additional app sales. Targeting to steadily attract more consumers and producers over time (network effects), SustCo and the consortial partners benefit with every transaction made. In terms of monetization, a combination of “Subscription” and “Add-On” was selected. The consumer is periodically charged for basis functionalities (Subscription) and can use further services on demand (Add-On), whereby SustCo receives a broking commission by the producer.

#### 4.4 Phase 3: Demonstration & Evaluation

To assess the hypotheses during the development, the concept was tested in a qualitative and quantitative manner with selected customers. In terms of qualitative evaluation, testing interviews and workshops with European data center owners/ operators and



general contractors unveiled strengths on both sides. For instance, consumers appreciated the holistic approach covering all sub-systems and the openness in terms of hardware and software, whereas the producers highlighted the additional revenue potential and the consortium approach. Nevertheless, also open points and improvement possibilities emerged. For example, consumers discussed the sensitive data sharing to third-parties, while producers focused more on topics such as IP ownership and platform competition. With regard to the quantitative evaluation, the average approval rating on value proposition, economic and technical feasibility was 0.77 on the consumer side and 0.75 on the producer side, leveraging a scale from -2 (strongly disagree) to +2 (strongly agree). In a subsequent design iteration, actions were taken to incorporate this feedback into the solution (e.g., consumer: dashboard for advanced rights management, producer: legal framework on IP). Final outcome of the project is a Minimum Viable Product for SustCo's smart connected system of systems. Figure 4 visualizes the exemplary user interface "Data Center Overview" of "SustCo smartr" (anonymized). After a presentation to the board of management in spring 2021, SustCo currently reflects how to bring the concept to life, especially leveraging synergies with other customer segments.

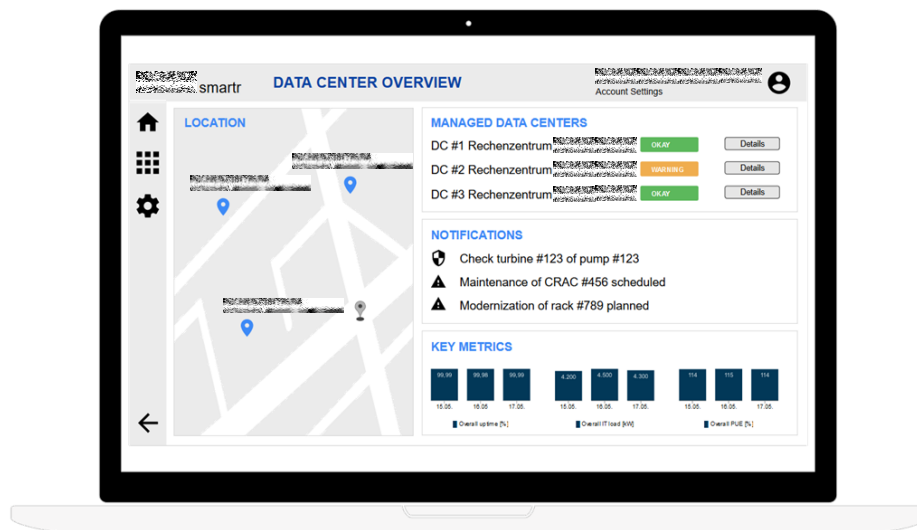


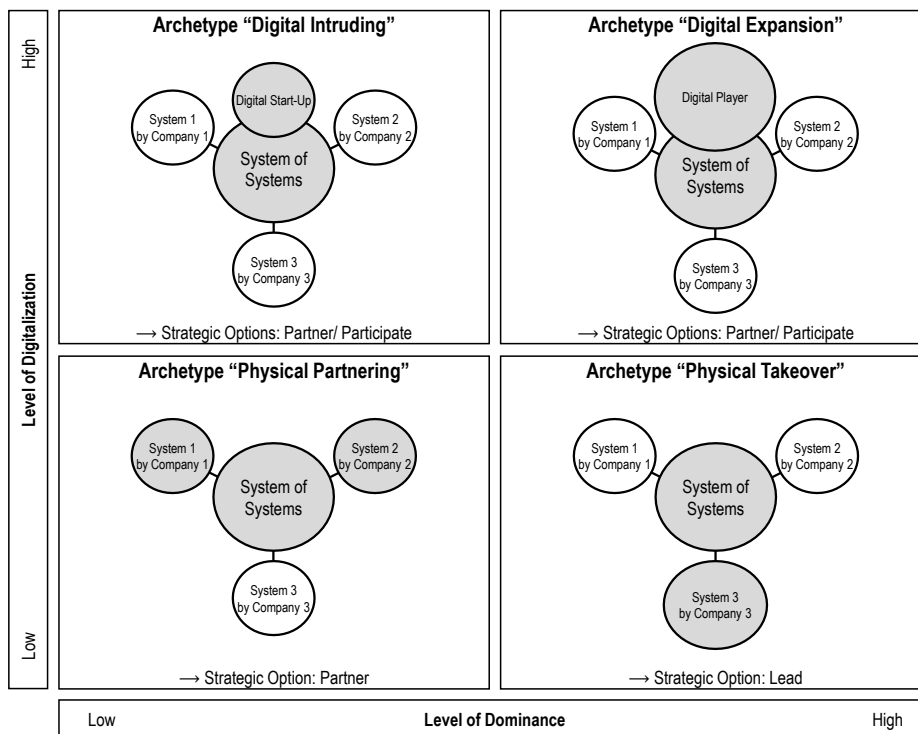
Fig. 4. Exemplary user interface "Data Center Overview" of "SustCo smartr" (anonymized).

## 5 Discussion

*Operative perspective.* Juxtaposing this system development project with existing product development case studies (e.g., [15,16,17]) operatively, similarities but also differences are recognizable. As expected, we detect equal methods such as customer- and user-oriented techniques to identify needs, and similar IT tools like cloud-based prototyping software to build the platform [17]. Surprisingly, with regard to

organization and processes, however, over-proportional complexity, interdependency and uncertainty is striking. For instance, this manifests in the fact that SustCo is highly dependent on its partners in terms of hardware (e.g., communication protocols) and software (e.g., programming languages) specifications. This is even enforced by the realization as multi-sided market, where additional stakeholders participate. Further discussion points arise from the specificity of the data center environment [24]. A first aspect concerns the multi-disciplinarity (i.e. fluid, power, IT) [24]. This peculiarity forwarded the project directly to the system of systems stage, whereby the initial goal of a product system was skipped. A second aspect refers to the specific design decisions (e.g., tightly regulated market place) which imply heavy trade-offs for the generalizability of the solution (domain-specific vs. industry-overarching).

*Strategic perspective.* During the stepwise and final reflections [26], the strategic issue came up whether SustCo is the right one to own and operate such a platform and what would be alternatives. To address this question, we adopt an archetype approach [9,10] rooted in the strategic management domain. Based on informed conceptual research [27], Figure 5 formulates four archetypical progressions from smart connected products to systems of systems using the “Level of Dominance” and “Level of Digitalization” as critical dimensions. These archetypes are started in parallel, however in the long-term, the most successful approach will prevail.



**Fig. 5.** Four archetypical progressions from smart connected products to systems of systems.

*Physical Takeover:* This type (high level of dominance, low level of digitalization) describes a course, where an enterprise that already dominates the physical system also aims to own the digital platform. The smaller players are not interested or do not see a realistic chance to take over that leading position. As an industry example, process engineering can be named, where a large share of the infrastructure is provided by the market leader, complemented by special machinery. Translating this type to the management, the strategic option is “Lead” (high risk, high gains).

*Physical Partnering:* This archetype (low level of dominance, low level of digitalization) represents an approach in a market with rather decentralized power relations. As no dominating player exists and the smaller ones do not have enough resources to stem it alone, a complementary consortium takes over the platform ownership. Here, our case in the piping systems domain, where SustCo collaborates with partners, serves as an illustrative example. Applying this archetype to decision makers, the strategic option is “Partner” (lower risk, lower gains).

*Digital Intruding:* This type (low level of dominance, high level of digitalization) appears in an environment, where no current market participant fights for the role of the platform owner. Instead, a new entrant, usually a start-up, takes over this leading role. As recent case, micro-mobility can be declared, where intruders use data from smart connected scooters and – in coordination with the cities – take on the micro-mobility management. Transmitting this type to industrial leaders, the strategic options are “Partner” (share ownership; lower risk, lower gains) or “Participate” (offer apps while dropping ownership; low risk, low gains).

*Digital Expansion:* This archetype (high level of dominance, high level of digitalization) describes a progress where an established digital player seeks to enter certain physical branches. As an industry example, hyper-scale data center operators can be quoted that aim to scale their self-developed software to external data centers or structurally similar segments. Translating this type to the board of management, the strategic options are “Partner” (share ownership; lower risk, lower gains) or “Participate” (offer apps while dropping ownership; low risk, low gains).

## 6 Conclusion

Reverting to our introduced *[RQ] Which design options for the development of a smart connected system of systems are possible?* we shared the “SustCo smartr” case study and conceptualized four archetypical design options [(1) Physical Takeover, (2) Physical Partnering, (3) Digital Intruding and (4) Digital Expansion], which leads to the conclusion that beside operational considerations increasingly strategic deliberations need to be taken into account. A key implication is that industrial enterprises have to decide whether to lead, partner or participate when breaking the new grounds of smart connected products. Thereof, the design options go way beyond the actual digital product augmentation and even impact organizational forms (e.g., joint-ventures or strategic alliances).

Targeting the field of smart product lifecycle management [28,29], our contributions to science are for one unique insights in usually hidden research & development

activities and for another the carved out archetypes reflecting a theory for analysis/description [30]. These deliverables are also valuable to practice, as executives that have mastered the initial stages can benefit from insights and guidance.

Against the backdrop of the single-case method, a first restriction is the involvement of the researchers (consortium approach [31]) which could have impacted the project. A second limitation is the accomplishment during COVID-19 which might have influenced SustCo and its stakeholders. A third shortcoming refers to the simplified analysis upon the large, heterogeneous data from the multi-year project.

Thinking a step forward, our case offers first, promising evidence, but the insights need to be validated through additional enhanced case studies in further application areas. Future works should naturally study the “right” evolution stage for enterprises. Also, open questions regarding the interoperability of such platforms and ecosystems may be lighted more intensely. Beyond the design, the lifecycle management still deserves more attention.

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## References

1. Porter, M. E., Heppelmann, J. E.: How Smart, Connected Products Are Transforming Competition. *Harvard Business Review* 92(11), 64–86 (2014).
2. Porter, M. E., Heppelmann, J. E.: How Smart, Connected Products Are Transforming Companies. *Harvard Business Review* 93(10), 96–114 (2015).
3. Fleisch, E., Weinberger, M., Wortmann, F.: Business Models and the Internet of Things. Bosch IoT Lab White Paper, St.Gallen, Switzerland (2014).
4. Bilgeri, D., Brandt, V., Lang, M., Tesch, J., Weinberger, M.: The IoT Business Model Builder. Bosch IoT Lab White Paper, St.Gallen, Switzerland (2015).
5. Zheng, M., Ming, X., Wang, L., Yin, D., Zhang, X.: Status Review and Future Perspectives on the Framework of Smart Product Service Ecosystem. *Procedia CIRP* 64, 181–186 (2017).
6. Bilgeri, D., Wortmann, F.: Barriers to IoT Business Model Innovation. In: *Proceedings of the 13. Internationale Tagung Wirtschaftsinformatik*, St.Gallen, Switzerland (2017).
7. Yin, R. K.: *Case Study Research – Design and Methods*. Sage Publications, London, United Kingdom (2003).
8. Yin, R. K.: Validity and Generalization in Future Case Study Evaluations. *Evaluation* 19(3), 321–332 (2013).
9. Miller, D., Friesen, P. H.: Archetypes of Strategy Formulation. *Management Science* 24(9), 921–933 (1978).
10. Greenwood, R., Hinings, C.: Understanding Strategic Change: The Contribution of Archetypes. *Academy of Management Journal* 36(5), 1052–1081 (1993).
11. Raff, S., Wentzel, D., Obwegeser, N.: Smart Products: Conceptual Review, Synthesis and Research Directions. *Journal of Product Innovation Management* 37(5), 379–404 (2020).
12. Webster, J., Watson, R.: Analyzing the Past to Prepare the Future: Writing a Literature Review. *MIS Quarterly* 26(2), xiii–xxiii (2002).
13. Constantinides, P., Henfridsson, O., Parker, G. G.: Platforms and Infrastructures in the Digital Age. *Information Systems Research* 29(2), 1–20 (2018).

14. De Reuver, M., Sørensen, C., Basole, R. C.: The Digital Platform: A Research Agenda. *Journal of Information Technology* 33(2), 124–135 (2018).
15. Chang, D., Gu, Z., Li, F., Jiang, R.: A User-Centric Smart Product-Service System Development Approach: A Case Study on Medication Management for the Elderly. *Advanced Engineering Informatics* 42, 100979 (2019).
16. Rymaszewska, A., Helo, P., Gunasekaran, A.: IoT Powered Servitization of Manufacturing – An Exploratory Case Study. *International Journal of Production Economics* 192, 92–105 (2017).
17. Holler, M., Herterich, M., Dremel, C., Uebernickel, F., Brenner, W.: Towards a Method Compendium for the Development of Digitised Products - Findings from a Case Study. *International Journal of Product Lifecycle Management* 11(2), 131–153 (2018).
18. Yoo, Y., Henfridsson, O., Lyytinen, K.: The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research. *Information Systems Research* 21(4), 724–735 (2010).
19. Innosuisse: Development of the Waste Management Ecosystem based on a Smart Connected Product-Service-System (PSS), [www.aramis.admin.ch/Grunddaten/?ProjectID=47044](http://www.aramis.admin.ch/Grunddaten/?ProjectID=47044), last accessed 2021/02/15.
20. Müller-Bloch, C., Kranz, J.: A Framework for Rigorously Identifying Research Gaps in Qualitative Literature Reviews. In: *Proceedings of the 36th International Conference on Information Systems*, Fort Worth, United States (2015).
21. Schreieck, M., Hakes, C., Wiesche, M., Krcmar, H.: Governing Platforms in the Internet of Things. *Lecture Notes in Business Information Processing* 304, 32–46 (2017).
22. Silverman, D.: *Doing Qualitative Research*. Sage Publications, London, United Kingdom (2009).
23. Myers, M. D.: *Qualitative Research in Business and Management*. Sage Publications, Thousand Oaks, United States (2013).
24. Levy, M., Hallstrom, J. O.: A Reliable, Non-Invasive Approach to Data Center Monitoring and Management. *Advances in Science, Technology and Engineering Systems Journal* 2(3), 1577–1584 (2017).
25. Peffers, K., Tuunanen, T., Rothenberger, M. A., Chatterjee, S.: A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems* 24(3), 45–77 (2007).
26. Baaz, A., Holmberg, L., Nilsson, A., Olsson, H., Sandberg, A.: Appreciating Lessons Learned. *IEEE Software* 27(4), 72–79 (2010).
27. Hirschheim, R.: Some Guidelines for the Critical Reviewing of Conceptual Papers. *Journal of the Association for Information Systems* 98(8), 432–441 (2008).
28. Terzi, S., Bouras, A., Dutta, D., Garetti, M., Kiritsis, D.: Product Lifecycle Management – From its History to its New Role. *International Journal of Product Lifecycle Management* 4(4), 360–389 (2010).
29. Rivest, L., Braesch, C., Nyffenegger, F., Danjou, C., Maranzana, N., Segonds, F.: Identifying PLM Themes and Clusters from a Decade of Research Literature. *International Journal of Product Lifecycle Management* 12(2), 81–106 (2019).
30. Gregor, S.: The Nature of Theory in Information Systems. *MIS Quarterly* 30(3), 611–642 (2006).
31. Österle, H., Otto, B.: A Method for Researcher-Practitioner Collaboration in Design-Oriented IS Research. *Business & Information Systems Engineering* 2(5), 283–293 (2010).