



# Considerations on Investment and Business Models

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**Abstract.** Business models are evolving from selling products towards delivering outcome that may be measured as system performance, capacity, and availability. Novel business models may also include elements of sharing value. Machinery manufacturers and suppliers face a rapidly changing business environment and look for major growth in digital solutions, automation and services. The implementation of advanced technologies and business models call also for novel models of sharing risks and benefits. The literature review on advantages and disadvantages of various business models underlines the investment risk. Modelling of the cash flows of different business models provide examples for leveraging initial investments in assets when applying emerging technologies. The business partners also have to consider how their risk landscape changes and what are the preventable, strategy and external risks of the planned business model. The chosen business model poses requirements to the risk management process and highlights the importance of the collaboration and transparency. This paper focuses in the automation options in the transport sector and uses major port terminal as a case example, but the developed methods are applicable also in other capital intensive industries.

**Keywords:** Investment · Business models · Input-based · Outcome-based · Value sharing · Cash flow · Risk · Port terminal

## 1 Introduction

Automation and digitalization have changed the work processes, activities, tasks and employee's duties in many industries. In this transformation, transport sector is no exception. In the future logistics systems, machines will be self-steering, and the humans' duties will change from driving the vehicles to monitoring the processes. Frost & Sullivan [1] forecasts that autonomous logistics could extend beyond warehouses to outside logistics and several functions in the transport chain like cross docking and transshipment, could become fully automated and intelligent. However, an automatized fleet requires bigger investment compared to investment in a traditional, manually driven fleet. For instance, Muricy Souza Silveira [2] estimate that the initial investment in an automated port terminal is about 57% higher than initial investment in a manned port terminal with the same capacity Even though the price of automated equipment

is high, the improvements in safety, reduced unplanned downtime, increased production and improved workforce effectiveness should be taken into consideration when making investment decisions [3]. In a longer term the investments in automation and digitalization may still pay out.

The main criterion in the investment decision making is still often the acquisition price - and not the life cycle cost [4]. The savings incurring over the asset life time - that may extend to several decades - are highly uncertain and difficult to assess in a credible way. Solutions based on digital technologies may have a positive impact on the company's operations but the monetary benefits across the asset life are often hard to define [5, 6]. Application of a value assessment approach and models improve the ability to communicate the value of digital solutions to the other partners in the business ecosystem. In addition, demonstration and communication of cost savings and benefits can serve as a bridge-builder between technology suppliers, customers and other stakeholders [7].

This paper discusses on the risks and advantages of different business models in capital-intensive industries with the focus in port operations, and introduces an investment model that could help in sharing risks between supplier and customer in a fair way. The paper aims to answer two research questions: (1) *How to leverage the economic barriers that emerge from higher cost of automated solutions?* and (2) *How to share benefits and risks in complex ecosystems?*

## 2 Study Context and Methodology

The study is a part of the ongoing Finnish national research project 'Operational excellence and novel business concepts for autonomous logistic systems in ports (AUTO-PORT)' [8]. The project is a co-innovation project that aims to path the way towards automated operations in ports by developing model-based design, operational excellence, and models for sharing incurring costs and benefits. AUTOPORT project is conducted in close co-operation with the research organizations and the company network that consists of machinery and ICT solution providers and engineering companies.

In our research, we use literature review and content analysis to create knowledge of the risks, disadvantages, benefits and advantages of the different business models to the business partners. We have also developed a simple model and a MS Excel tool that allows us to test and illustrate the impacts of different business models. The modelling aims to highlight the differences in cash flows between discussed business models.

The input data needed for the empirical work is derived from the work of Muricy Souza Silveira [2] that considers the automation options of the Port of Santos in Brazil. In this case, the port assets include 20 Ship-to-Shore Cranes (STS), 5 container spreaders (STS - Spreader), 20 Rubber Tyred Gantry cranes (RTG), 5 RTG spreaders, 10 terminal tractors and 7 trailers, and Terminal Operating System (TOS). In our study, the Port of Santos served as a case example that helps to provide a thorough understanding of the phenomenon in question [9].

### 3 Business Models for Acquiring New Technologies

Business models describe how organizations create, deliver and capture value [10]. According to Sjödin *et al.* [11] in collaborative business models, more understanding should be developed about how customers and suppliers agree to jointly create value and to share it fairly. Critical point of business models are not only designing the value creation and sharing processes, but ensuring they are adapted and aligned to each other. Appropriate governance mechanisms are needed to ensure that value creation is greater than the cost of realizing that value and that the value surplus is distributed fairly among the parties [12].

In this section, we concentrate on two different business models namely on the input-based model and on the outcome-based model. In a traditional input-based model [13], machine supplier is paid for the product, and perhaps also for the services they deliver to their customer during the product life time. The ownership of the product is transferred to the customer that is also responsible of the operation and on the upkeep of the product [15]. In the outcome-based model [14], customer no longer buys the product but pays for the output that is delivered by the product [15]. The supplier is then in charge for the performance outcome of the product (and service), and is financially responsible for any shortcomings, such as equipment breakdowns. As the paper of Ng *et al.* [16] states, an outcome-based model focuses on the outcome of a system rather than the resources involved in its provision. In such a model, the supplier extends the focus from the delivery and commissioning of a product into the use-phase of the system and takes over the responsibility of the operation and maintenance of the product on their customer's behalf [17]. A number of contract packages could be build (i.e. pay per unit, pay per performance, fixed operations and maintenance fee, etc.) in outcome based business model. A decision as to which business model to use can have a significant impact on the cost and the risk of owning and operating a fleet [18].

For the supplier, both models entail advantages and disadvantages as summarized in Table 1 and 2.

**Table 1.** Advantages to the supplier.

Business model	Advantages for the supplier	Sources
Input-based model	<ul style="list-style-type: none"> <li>- Financial risk is shifted to the customer</li> <li>- Responsibilities in operations and maintenance are shifted to the customer</li> </ul>	[15]
Outcome-based model	<ul style="list-style-type: none"> <li>- Barriers to attract new customers are low due to low initial investment by the customer</li> <li>- Possibility to capture larger portion of the value stream and gain more profits</li> <li>- Resilient cash flow and revenue streams</li> <li>- Possibility to develop long-term business relationships that lock out competitors</li> <li>- Possibility to gather data from operations</li> </ul>	[15, 17, 19, 20]

**Table 2.** Disadvantages to the supplier.

Business model	Disadvantages for the supplier	Sources
Input-based model	- Less potential for innovation due to limited access to monitor and gather the data	[15]
Outcome-based model	- Financial risk due to retaining ownership of the system - Financial responsibility of any shortcomings such as equipment breakdowns - Responsibility of the product life cycle - Challenging to estimate suitable price-level for the service	[11, 15, 21]

The business model has also impacts to the customer. An input-based business model is a familiar way of realizing an investment. However, it is bound with major financial risks that may become an obstacle when considering novel technologies. The advantages and disadvantages of an input-based and an outcome-based business model from the customer point of view are summarized in Table 3 and 4.

**Table 3.** Advantages to the customer.

Business model	Advantages for the customer	Source
Input-based model	- Ownership of the property rights - Simple and familiar business model	[15]
Outcome-based model	- Various costs and activities are shifted to the supplier - Reduction of risks and barriers of acquiring new technologies - Supplier has incentives to improve system performance and reduce overall expense	[15, 19, 20]

**Table 4.** Disadvantages to the customer.

Business model	Disadvantages	Source
Input-based model	- A major capital investment causes a financial risk - Unknown expenses may occur (maintenance, repair, etc.)	[15, 19]
Outcome-based model	- Limited control of the operations management - Dependency of the suppliers performance - Increased complexity of the business environment	[15, 19, 20, 22]

## 4 Business Models and Risk Sharing

New business models that are based on complicated inter-organisational systems for innovation, development, common offering and performance metrics entail considerable uncertainties [22]. Understanding prevailing and novel risks, and designing the mechanisms and actions for governing and controlling risks are crucial for any successful business. The success of a business model innovation depends on the company's ability to recognize that the planned activities are more uncertain, complex, and therefore also riskier than current operations, and on the company's ability to cope with these process characteristics [22].

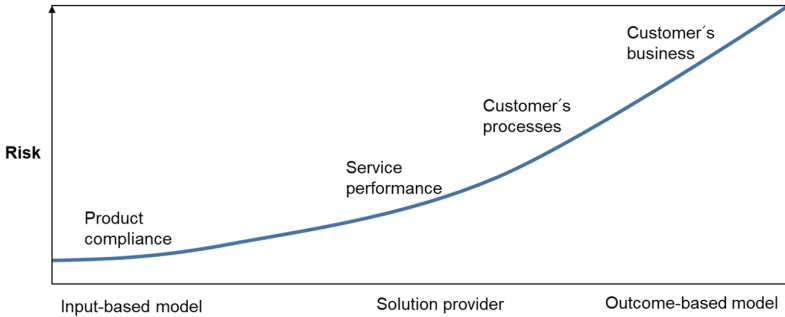
The ISO/IEC Risk management standard series (e.g. [23] and [24]) define risk as the effect of uncertainty on objectives. Risk is often expressed in terms of a combination of the likelihood and consequences of an event. Enterprise Risk Management (ERM, e.g. [25]) emphasise the need to embed risk management systems within business processes. ERM focuses traditionally in a single company and existing assets, but the framework helps also to identify and manage multiple inter-organisational risks, segmented mostly to four core risk groups: strategic, operational & cultural, financial and hazard risks [26]. For a company investing in assets, the investment assessment usually deals with considerable uncertainties as highlighted also in the Table 2 and 4.

Risks can be categorized as preventable, strategy or external [27]. The management and control of preventable risks require standard operating procedures that help to avoid or eliminate the occurrence of negative events in a cost-effective way. Strategy risks are voluntarily accepted risk in order to generate superior returns from the strategy, and the control models include interactive discussions inside the organisation and stakeholders about the strategic objectives and necessary trade-offs. External risks arise from events outside the organization and are beyond its influence and control. The risk mitigation then concentrates in reducing the impacts should a risk event occur. Building up scenarios help to prepare for external risks.

As companies are increasingly relying on different collaborative arrangements in their business models, they become also more dependent on other companies capabilities and resources. This makes their situation more unpredictable regarding possible changes in the business environment. Inter-organizational networks increase interdependencies and this fact creates further challenges for managing risks [28]. The threat of increased responsibility and loss of control are mentioned also in Table 2 and 4. The networks also lead to second and third-order effects that are absent from a company to company relationship [29]. This requires companies to view their profits and risks not in terms of what they control internally, but in terms of their relational capabilities to the networks in which they are embedded [29] and emphasises the importance of analysing external risk factors affecting the business environment [30].

Figure 1 (next page) illustrates the supplier's increasing risk as a function of the business model. In an input-based business model the supplier carries the risk on the function and compliance of the delivered good at least over the warranty period, but the product liability may be longer. As the supplier takes more responsibility and delivers solutions instead of mere product, it faces increasing risk on the performance of the product in the customer's process and business environment. In an outcome-based model, this responsibility and risk extends beyond the product and its performance towards

carrying customer’s business risks or at least, towards sharing risks that are external to the supplier company. From the risk management point of view, the importance of thorough understanding the strategy risks and building up scenarios that help to prepare for external risks are of prime importance.



**Fig. 1.** A schematic presentation on the business model on the supplier’s risk.

In inter-organisational relationships, understanding of contractual risks is essential. The risks may be reduced by making visible the advantages from efficient collaboration of the network as well as value destroying effects of actions against the common objectives and principles of collaboration [31].

## 5 Modelling Cash Flows Generated by Different Business Models

In this chapter we illustrate the cash flows of input-based- and output-based business models, and the cash flows generated by a third option, namely a value sharing contract [32]. Our models represent simplified cash flows of an automated terminal port (Port of Santos), including all assets (spreaders, trailers, gates, etc.) and software, which are estimated to cost \$249.330.000 as an investment, and to generate \$230.000.000 profit in 10 years [2]. The revenue from a terminal port is generated by the delivery and the reception of containers, and from the associated tasks like inspections and weighing.

We have chosen a 10 year time frame for our study as the life time expectation of the major port equipment is 10 years or longer, and we have also made an assumption that no major renewals or upgrades are necessary during that time period. In addition, our models don’t take discounting, inflation or other factors which are usually considered in life cycle costing into account, as the models are generated only to demonstrate the risk and revenue sharing logics of different business models instead of estimating accurate values.

### 5.1 Input-Based and Outcome-Based Business Models

The cash flows generated by input- and outcome-based business models are presented in Fig. 2 and Fig. 3 The “building cost” includes all costs incurred during the early

stages of the product life cycle and those of building up the delivered system [13]. In our model, the building cost is estimated to be 70% of the acquisition price as the supplier is expected to charge a certain profit on the building cost. In addition, the annual revenues are assumed to be same every year in order to keep the models simple.

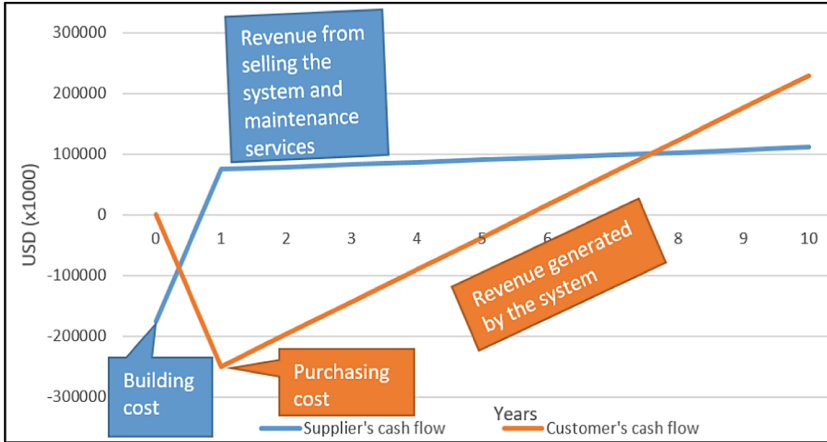
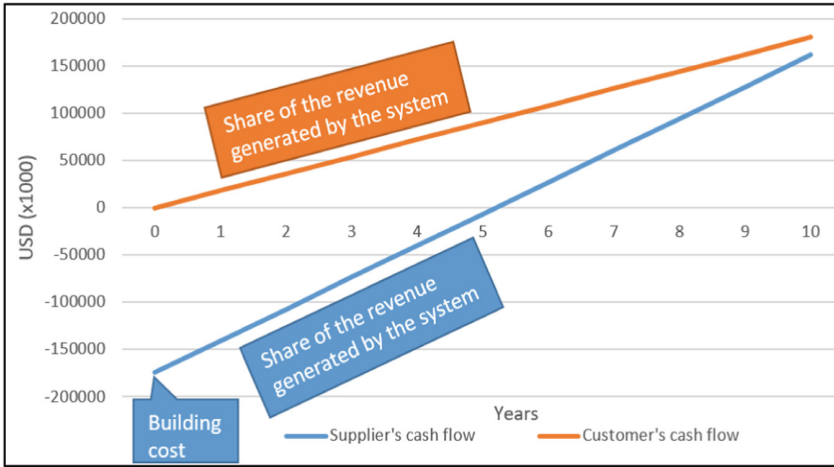


Fig. 2. Cash-flow of input-based model.

In the traditional input-based model, the customer orders an equipment, machine or system, and the supplier delivers it. The customer makes the initial investment and pays the acquisition price of the system in one payment or in several installments. The ownership of a product transfers from the supplier to the customer. In addition, supplier usually offers some kind of maintenance service and gets annual revenue from the customer [7]. In this example, the supplier gets instant profit, whereas customer has to wait about six year payback time before the investment turns profitable.

In outcome-based model, supplier builds the system on its own account and gets the revenue from its performance units instead of selling the product. The supplier who used to make money on the products, maintenance and spare parts, will now have to consider these items as costs, because the revenue depends entirely on the delivered outcome [11]. The customer starts paying to the supplier as soon as the supplier starts to provide the outcome as defined in the contract. In this example, the customer doesn't possess any investment risks, whereas the supplier's breakeven point is after five years. These examples above show why risk sharing business models are needed.

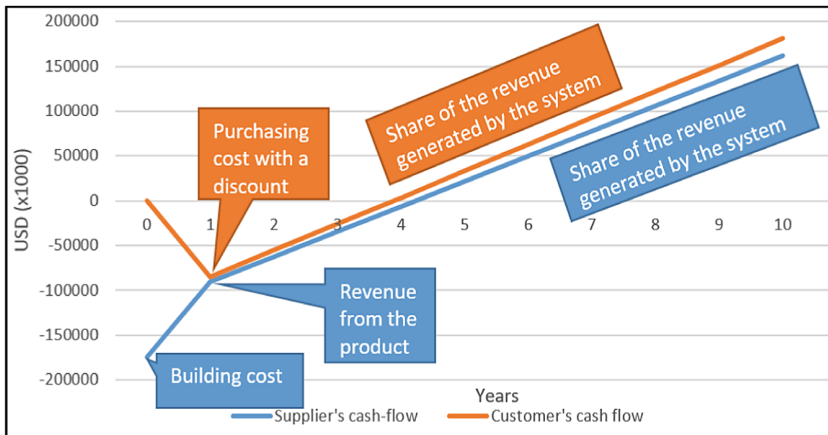
The challenge between the supplier and the customer is the investment risk. The supplier might prefer the input-based model to secure the revenue and to avoid disadvantages mentioned in the Table 1. On the other hand, the customer could prefer the outcome-based model in order to reduce or avoid the investment risk, and to gain other advantages summarized in the Table 2.



**Fig. 3.** Cash-flow of output-based model.

### 5.2 Solution for Risk Sharing

A solution that takes the interests of both parties into consideration is a value-sharing contract [32] that aims to share the investment risk between both parties. Such contract lowers the purchase price of a system in return for a proportion of the future value generated during its operational life. Cash-flow of the value-sharing contract is presented in the Fig. 4.



**Fig. 4.** Cash-flow in value-sharing contract.

In a value-sharing contract, supplier provides the system, and customer purchases it with a discount price but commits into value sharing. The future revenues generated by the system are shared between the supplier and the customer. This would share the



investment risk between both parties, and could leverage the economic barriers that emerge from higher cost of new technologies. In this case, both parties would make the investment profitable in about four years.

### 5.3 Risk Management Framework

For a supplier, the transition from input-based business to more complicated inter-organisational systems gives rise to a variety of new risks. The changing risk landscape must be carefully taken into consideration during the transition process and a risk management process covering the whole range of company internal and preventable risks, strategy risks and external risks is needed. In the steps of the transition process one must also consider the different risks that are connected for example to customer relationship, contracts and responsibility, and business environment of the customer and to second and third-order effects in the network. The risk management framework presented in Table 5 highlights some characteristics of the risk management process in different business models.

**Table 5.** Risk management framework, adapted from [31].

Business model	Risk management characteristics
Input-based model	Company internal risk management process for identifying, describing, organising and executing risk management and control
Outcome-based model	Inter-company cooperation is needed. Risk environment is more complex and entails external risk factors. Sharing of risk knowledge and cooperation among business partners is needed in order to assess and manage risks
Risk sharing solution	Common guidelines and methods for risk assessment, risk management and knowledge sharing are needed for ensuring an adequate level of risk management and risk sharing between business partners. Risk management practices are improved by collaboration practices

In an input based model, both business partners have their own risk management processes according to the ISO/IEC, ERM or some other common risk management standard that meets the business requirements. The outcome based model necessitates close inter-company collaboration. The companies owning and operating major assets are familiar with investment appraisal methods and risks, but for the supplier these risks may emerge as external risks that are difficult to control. For the customer, the actions of the supplier may also build up external risks, e.g. in a case of bankruptcy and losing control of the assets. A value sharing contract aims at sharing risks but it also calls for a common inter-organizational approach for risk management and control.

## 6 Conclusions and Discussion

Automatized and digitalized assets and systems are changing the logistics operations towards more cost-effective, reliable and safe direction. However, the high acquisition cost of the solutions applying novel technology may pose a barrier that prevents customer companies to invest in automatized machines. Novel and innovative solutions are needed to share the risk. The paper contributes to the discussion on the novel business models by addressing two issues, namely *How to leverage the economic barriers that emerge from higher cost of automated solutions?* and *How to share benefits and risks in complex ecosystems?*

In this study, we presented two simplified business models (input- and outcome-based), and illustrated the advantages and disadvantages of those models from supplier's and customer's perspective. We have also developed a calculation model and a MS Excel tool, and applied the tool in calculating the impacts of different business models. From the suppliers' point of view, major disadvantages in the outcome based model include the financial risk due to retaining ownership of the system and the responsibility of the product life cycle in uncertain business environment. The outcome based model could attract new customers as for the customer, the initial investment is low. However, this model has major disadvantages and risks to the supplier. The presented cash-flow models for the case company Port of Santos in Brazil clearly indicate that the customer carries the financial risk in the input-based model, whereas supplier carries the financial risk in the outcome-based model.

The third simplified business model that is based on value sharing could offer a potential solution. A value sharing model could help to solve the problem arising from the economic barrier and to leverage the high cost of automatized machines. A value sharing model would decrease the initial investment required from the customer and this could ease the investment decision. Continuous cash flow would make it an attractive solution to the supplier too. A value sharing model would help to share benefits over the time in an ecosystem. However, the suppliers have to be willing to wait for the profits and also in this model the supplier partly shares the risks prevailing in the customer's business environment.

When several companies are collaborating, they can have value creation opportunities that they couldn't achieve on their own. Thus it is important to make sure that each party captures fair share of the jointly created value. For that reason the value sharing arrangements should be considered at the early stages of the negotiations in order to secure each parties' fair share of the jointly created value. Different kind of value sharing models and can be made to clarify what share each party will get from the jointly created value.

The transition from input-based business to more complicated inter-organisational arrangements gives rise to a variety of risks that are external to the supplier, and the supplier do not have the means for controlling them. On the other hand, the outcome-based model poses also novel risks to the customer from losing the control of the assets to a bankruptcy of the supplier. In addition to the binary relationship, novel business models may involve several organisations. Thus the risk management requires collaboration from all parties.

Even a simplified calculation example show how important it is to build up scenarios and to test the planned business model. For decision makers - let it be a supplier, a customer another partner in the business ecosystem - a calculation model helps to create understanding on the economic consequences on a long run and to test different scenarios. Modelling also contributes to the risk management and helps to discuss and deal with risks by business partners. From the risk management perspective, incorporation of the sensitivity analysis would be a necessary advancement to the model. More research is needed for better understanding of the risks, risk sharing and risk control in inter-company relationships. Further elaboration of the models and tools with industrial stakeholders is required to test the applicability of the ideas in the real business environment.

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## References

1. Frost & Sullivan (2016) Future of logistics - unbundling of the supply chain, Frost & Sullivan
2. Silveira, RMS (2018) Container terminal automation in Port of Santos - a business case analysis. Master's thesis, Center for Maritime Economics and Logistics, Erasmus University Rotterdam. <http://hdl.handle.net/2105/43890>. Accessed 1 July 2020
3. Sims S (2016) The benefits of calculating ROI to measure a facility's performance objectives. *Control Eng* 63(10):49–50
4. Uusitalo T, Hanski J, Reunanen M, Kunttu S (2014) Support for life cycle decision-making in sustainable manufacturing – results of an industrial case study. In: Grabot B, Vallespir B, Gomes S, Bouras A, Kiritsis D (eds) APMS 2014, vol 439. IAICT. Springer, Heidelberg, pp 162–169. [https://doi.org/10.1007/978-3-662-44736-9\\_20](https://doi.org/10.1007/978-3-662-44736-9_20)
5. Kortelainen, H, Saari, L, Valkokari, K, Federley, M, Heilala, J, Huusko, J, Viljamaa, E: Beyond IoT business. White paper. <https://cris.vtt.fi/en/publications/beyond-iot-business>. Accessed 7 Aug 2020
6. Räikkönen, M, Välisalo, T, Shylina, D, Tilabi, S (2015) Supporting asset management decision-making – new value creation perspective. In: Proceedings of the 10th world congress on engineering asset management (WCEAM). Lecture notes in mechanical engineering, Tampere, no 28–30. Springer, Cham, pp 479–486
7. Räikkönen, M, Keski-Rahkonen, J, Kortelainen, H, Tikkanen, M, Valkokari, P, Vehanen, A, Pirttikangas, S (2020) Towards a framework for assessing the customer value of digital solutions. In: eProceedings of the 30th European safety and reliability conference and the 15th probabilistic safety assessment and management conference. Research Publishing Services
8. AUTOPORT. <https://autoport.fi/>. Accessed 8 July 2020
9. Yin R (1994) Case study research: design and methods, 2nd edn. Sage Publishing, Beverly Hills
10. Teece DJ (2010) Business models, business strategy and innovation. *Long Range Plan* 43(2–3):172–194

11. Sjödin D, Parida V, Jovanovic M, Visnjic I (2020) Value creation and value capture alignment in business model innovation: a process view on outcome-based business models. *J Prod Innov Manage* 37(2):158–183
12. Chesbrough H, Lettl C, Ritter T (2018) Value creation and value capture in open innovation. *J Prod Innov Manage* 35(6):930–938
13. Ulaga W, Reinartz WJ (2011) Hybrid offerings: how manufacturing firms combine goods and services successfully. *J Mark* 75(6):5–23
14. Visnjic I, Jovanovic M, Neely A, Engwall M (2017) What brings the value to outcome-based contract providers? Value drivers in outcome business models. *Int J Prod Econ* 192:169–181
15. Azarenko A, Roy R, Shehab E, Tiwari A (2009) Technical product-service systems: some implications for the machine tool industry. *J Manuf Technol Manage* 20(5):700–722
16. Ng I, Xin Ding D, Yip N (2013) Outcome-based contracts as new business model: the role of partnership and value-driven relational assets. *Ind Mark Manage* 42(5):730–743
17. Davies D (2004) Moving base into high-value integrated solutions: a value stream approach. *Ind Corp Change* 13(5):727–756
18. Vorster, M (2014) Lower equipment acquisition risk, not cost. *Construction equipment*, April 2014
19. Tukker A (2004) Eight types of product-service system: eight ways to sustainability? Experiences from SusProNet. *Bus Strategy Environ* 13(4):246–260
20. Baines, T, Lightfoot, H (2013) *Made to serve what it takes for a manufacturer to compete through servitization and product-service systems*. Wiley, Hoboken, p 53
21. Väiläsalu, T (2003) From availability performance guarantees to production capacity sales. *Promaint*, pp 10–12. (In Finnish)
22. Taran Y, Boer H, Lindgren P (2013) Incorporating enterprise risk management in the business model innovation process. *J Bus Models* 1(1):38–60
23. ISO/IEC 31010 (2019) Risk management - risk assessment techniques
24. ISO 31000 (2018) Risk management – guidelines
25. Committee of sponsoring organizations (COSO) (2014) *Enterprise risk management: integrated framework*. COSO, New York
26. CAS (Casualty actuarial society) (2003) *Overview of enterprise risk management*. ERM community, Arlington
27. Kaplan RS, Mikes A (2012) Managing risks: a new framework. *Harvard Bus Rev* 90:3–13
28. Hallikas, J, Varis, J (2009) Risk management in value networks. In: *Supply chain risk. International series in operations research and management science vol 124, no 1*, pp 35–52
29. Kleindorfer, PR, Wind, Y (2009) The network imperative: community or contagion? In: Kleindorfer, PR, Wind, Y, Gunther, R (eds) *The network challenge: strategy, profit and risk in an interlinked world*. Wharton School Publishing, pp 3–24
30. Uusitalo, T, Palomäki, K, Kupi, E (2014) Managing risks in service value networks. In: *Proceedings of the sixth world congress on engineering asset management (WCEAM)*. Lecture notes in mechanical engineering. Springer, Heidelberg, pp 239–321
31. Ahonen T, Reunanen M, Ojanen V, Pajari O, Lanne M (2010) Maintenance communities – a new model for the networked delivery of maintenance services. *Int J Bus Innov Res* 4(6):560
32. Davies A, Brady T, Hobday M (2006) Charting a path toward integrated solutions MIT Sloan. *Manage* 47(3):39–48