Data analytics capability roadmap for PPO business models in equipment manufacturing companies

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Abstract. The objective of this paper is to extend the knowledge of data analytics capabilities and the development process required to implement pay-per-output/-outcome (PPO) business models. To achieve this objective, we conducted qualitative research to study two equipment manufacturing companies in their business model transformation, with a special interest in their data analytics capability development path. The findings were threefold; first we validated the data analytics capabilities necessary for PPO business models synthesised from literature with the selected case companies. Second, two additional data analytics capabilities, namely *capability to influence how performance is measured and analysed,* and *capability to simulate the solution's financial performance)* were identified. Finally, this study presents two different roadmaps on how data analytics capabilities have been developed. The study findings suggest that remote monitoring capability is among the most critical data analytics capability to initiate a PPO business model in the equipment manufacturing industry. This study contributes to business model literature, and information systems literature.

Keywords: data analytics capabilities, pay-per-outcome, business model, equipment manufacturing, remote monitoring, roadmap.

1 Introduction

Supported by advancements in IoT and remote monitoring technologies, new data-driven business models such as pay-per-output/-outcome (PPO) business models are gaining interest among the equipment manufacturing industry (EMI) [1]–[3]. Despite these technological opportunities, many companies have failed in implementing PPO business models due to technological challenges [2], [4]. Since the revenue logic in PPO business model is based on equipment performance and the outcome(s) the equipment creates, the equipment is often complex and the performance (outcome) data often a combination of things, data analytics capabilities play a key role in success of this PPO business model. A critical step for succeeding in PPO business models is the identification, collection and utilization of data [5], [6] and therefore new data analytics capabilities are needed [7].

Extant literature have identified the criticality of these data analytics capabilities for manufacturing companies [8]. For example, [3] studied how manufacturing companies

use data analytics capabilities to support their PPO business model strategies. However, existing literature have dismissed how these capabilities can actually be developed and formalized [9] and how the resources and drivers align during this digital transformation [10].

Therefore, this study focuses on understanding how two manufacturing companies have developed their data analytics capabilities to succeed in their PPO business models. Our research questions are:

RQ1: *What are the major data analytics capabilities required to implement pay-per-output/-outcome business model in equipment manufacturing companies?*

RQ2: *How equipment manufacturing companies can develop data analytics capabilities for pay-per-output/-outcome business models?*

To answer these questions, we investigated two equipment manufacturing companies which have successfully implemented pay-per-output/-outcome business models. We built two capability development roadmaps to illustrate the development process and factors associated with the process, since capability roadmaps are useful for understanding how technology and business drivers interrelate with each other [11].

2 Theoretical background

The global awareness and interest towards data-driven business models among manufacturers have increased in recent years [12]. Pay-per-X business models are types of business models were the ownership of the machine is not usually transferring to the customer but the customer is paying based on use or outcome of the machine [13]. In the literature, pay-per-X business models are discussed in varying terms, such as outcome-based contracts [14], performance-based contracts [15] use- and result-oriented business models, [16] and use- and result-oriented product-service systems [17].

Pay-per-X business models can be divided to different archetypes based on monetizing logic. In a pay-per-use business model the customer is paying based on the use of the solution based on usage time (e.g. Rolls-Royce pay-per-operating hours) [18]. In a pay-per-output/-outcome (PPO) business models the customer pays for the achieved output, outcome or result [13]. Therefore, the payment depend on contractually set quality, performance or output levels [1], [13]. The feasibility of these different pay-per-X business models might vary depending on the industry, product type and company's existing capabilities [2], [19].

Data analytics capabilities are a central set of capabilities needed for implementing pay-per-X business model [3], [16], [18]. According to [7] data analytics capability is an ability to effectively deploy resources and skills to capture, store, and analyse data to improve company's competitive performance. While implementing PPO business models, the company requires: *Capability for remote monitoring:* Being able to remotely monitor how the solution is operating (near-real time). Remote monitoring technologies (RMT) are considered as an important enabler of integrated service solutions [3]. RMT could help improve after-sales services, enabling solutions, and build service ecosystems [20]. *Capability to convince the customer to share data:* Being able to gain access to solution data and any other relevant data, such as maintenance data [21]. *Capability to translate data into value:* Being able to clean, transform and model the data to discover useful information to support decision making [3], [21]. *Capability to*

ensure data privacy and security: Being able to protect data from unauthorized use, disruption, deletion and corruption [3], [21]. *Capability to simulate equipment performance:* Being able to digitally simulate how the solution will perform in varying environments and situations [3].

Although the needed data analytics capabilities are identified in the literature, there are no studies focusing on how these data analytics capabilities have been developed in companies implementing PPO business models.

3 Methodology

Our study implemented a multiple case study of two equipment manufacturers which offer their products through PPO business model to understand what kind of data analytics capabilities they need and how they developed these analytics capabilities to enable the respective PPO business models. The qualitative case study method was selected since we are trying to understand a complex real-life topic [22] and since we are trying to gain deep understanding on the 'how' and 'why'-type of questions regarding their development [23]. The studied companies were purposefully selected [24] to be both offering a) originally standardized installable capital-heavy equipment through a traditional product-oriented business model, and both b) have later successfully implemented a PPO business model.

Case company A is operating in the business of industrial compressed air. The company was founded in 2010 to develop a transformative technical concept for compressed air and to scale it up on the global industrial markets. Already at the time of launching the first product on the market the concept of pay-per-output was defined to be a second go-to-market strategy, to enable faster adoption of the technology in the fairly conservative, risk-averse industrial markets. From the beginning the technical solution used in their products were very high-tech, creating the possibility and capability to make the products not only smart but also quite easily capable to be used in the PPO business model. The products rely on a vast amount of data to operate, and the control algorithm already uses a lot of the data for operation, the same data which is relevant for the PPO business. The company has two parallel business models: in the pay-per-output business model the company charges the customers based on cubic-meters of air the machine has produced. In the pay-per-outcome business model in addition to cubic-meters of air the company get paid as well based on how much energy it has saved.

Case company B has been manufacturing metal bar punching and bending machines since 1963. With over 50 years of experience, the company has become the worldwide market leader in the precision processing of flat materials such as conductor rails, bar stock or profiles. In 2019 the company started to also offer its punching machines through pay-per-outcome business model in parallel with the traditional sell and service business model. Currently the company enables charging the customer based on number of punches parallel to conventional sales channels.

The research team conducted multiple interviews with both company's representatives. All interviews were recorded and transcribed. Respondents were chosen for interviews based on their roles and responsibilities in the development of products,

technology, especially with regard to their respective PPO business models, or knowledge in general. The interviews took place between February -March 2022. We used Phaal et al. [11] capability roadmap framework as a structure for the interviewees. The target was to understand in which order the companies have developed their data analytics capabilities. In addition, based on [25] definition of operational capabilities we asked which drivers, resources & skills, processes & activities have affected the development of these capabilities. We used a web-based tool to map out the timeline to ensure the sequence of events visualized in the result section is correct.

4 Results

This section presents major data analytics capabilities and development process to implement PPO business models in selected cases (See table 1).

Table 1. Needed data analytics capabilities

Data analytics capability	Case A	Case B	Additional comments
Capability for remote monitoring	X	X	
Capability to convince the customer to share data	X	X	*Prerequisite for PPO business model but has not been an issue (Case A)*
Capability to translate data into value	X	X	
Capability to ensure data privacy and security	X	X	*Third party financial partner is responsible (Case B)*
Capability to simulate equipment technical performance	X	-	*Simulation is necessary to ensure equipment reliability (Case A)* *Not needed specifically for PPO business (Case B)*
Capability to influence how performance is measured and analysed	X	-	*New capability* *Third party financial partner is responsible (Case B)*
Capability to simulate equipment financial performance	X	X	*New capability*

4.1 Capabilities required for PPO business model

Regarding the data analytics capabilities required to implement the PPO business model, both case companies agreed that data analytics capabilities presented during the workshop were relevant for the effective implementation of PPO business model except c*apability to simulate equipment technical performance* for Case B. With respect to *capability for remote monitoring*, both case firms confirmed that this capability is essential to initiate the PPO business model. *"…it is essential capability to start with, absolutely because if you don't, i think you shouldn't consider pay-per-X or pay-per-punch or anything. We should all consider the big picture and part of this picture is obviously the remote monitoring. …have to be done remotely…"* (Case B).

Capability to convince the customer to share data was considered as a prerequisite for PPO business model by Case B. The interviewee from Case A stated: *"we didn't need to convince any customer […] that had decided to go for our technology, that can we access the data or not"* However, since the ownership of the equipment belongs to a third-party financing institute in case B, they expressed as not themselves needing this capability.

Capability to translate data into value was categorized as essential capability for PPO contracts. Interviewee from case A stated: *"…for example, billing […] what can be used directly to translate some signals or measurement signals to for example, the power or the some other easily understandable measures […] what most probably at the early stage needs to be developed by company or provider"* (Case A)

Regarding *capability to ensure data privacy and security*, case A stressed that: *"it can be a barrier in this kind of business if it's not very well handled"*. Case B also agreed that is essential for PPO business model, and they highlighted that their existing technology enables data security, so they don't need any additional skills to secure the data.

The companies' opinions from capability to simulate equipment performance from technical point-of-view were slightly separated. Case A had this capability on different levels (component, subsystem, system), and even stated that it is in their case a necessary capability: "*if I would do something different now, i would actually start from there. Already […] in the in the very first stage to do kind of capability do for the system simulation, […] before, that simulation capability, we actually […] started with the testing, we tried to do before we got this kind of capability*". For case B this capability wasn't deemed to have a connection with the PPO model especially.

On top of these, we identified two additional capabilities: *Capability to influence how performance is measured and analysed*, and *capability to simulate equipment financial performance*. This was brough up by both companies, that there is a need to show the financial outcome of the PPO contract for the customer. *"honest discussion to show really the real performance and the real… potential savings and whatever it is, is it power consumption, or to produce the heat or what's then needed. […] to transfer that to […] already reliable data"*.

Only case A highlighted the need of *capability to influence how performance is measured and analysed* (See table 1). The interviewee stated that since PPO involves measurement of equipment performance, specific standards for measurement would be useful in their industry, currently there is variation. They also stressed that companies should be able to develop these standards, to be able to calculate the outcome of the equipment, and to be able to convince the customer of the outcome's validity.

Both case companies identified that even more than the *capability to simulate equipment performance* from technical point of view, they need the c*apability to simulate equipment's financial performance*. According to the interviewees, since PPO contracts lock the customer in for a longer period, it is very essential to be able to show financial benefits to the customer and to understand their own costs in the long run. Regarding this, case B pointed out that this is critical capability but, in their case, the third party handle it.

4.2 Data analytics capabilities developing roadmap

Case A: Case A data analytics development roadmap is presented in fig 1. The development of data analytics capabilities was initiated already at the beginning when the development of the current technical concept was started. The reason for implementing remote monitoring technologies (RMT) was that the company's customer was located far away from company's headquarters, but the company still wanted to know how well the machines are performing. The company's investors specifically required this. The key resource for implementing RMT was several company experts, who had experience on these technologies from previous companies. The RMT was already implemented to company's equipment in the test laboratory, and therefore implementing it to first customer was easier. From the beginning the company decided to build RMT over mobile network which therefore didn't require connection through the customer's network. Due to this the interviewee stated that they didn't need to convince the customer about data security or privacy nor having the whole discussion about this.

Being a newcomer on the market, some customers had concerns about the technology readiness and the company size. To counter this, the company proposed to the customer a pay-per-output business model as a risk mitigation method. In the industry of Case A, the accuracy of output measurements is not traditionally very high. Therefore, Case A realized that they need new capabilities to influence how things are measured and analysed since the customers were getting confused by the manufacturers' mixed messaging. Throughout the development of the technology, the capabilities to translate data into value were developed and used.

As a newcomer in a traditional industry the company started early on to develop capability to simulate financial value of the machine so the customers would better understand the cost and benefits in long run. Soon after the idea of pay-per-outcome business model was introduced.

At a later phase some of the customers also wanted to integrate the machine into their own IT-systems. This required new connections between company's and customer's system and in this point data security issues were highlighted the first time. However, since the products were developed already using newest technologies, the company was capable to do this without additional investments.

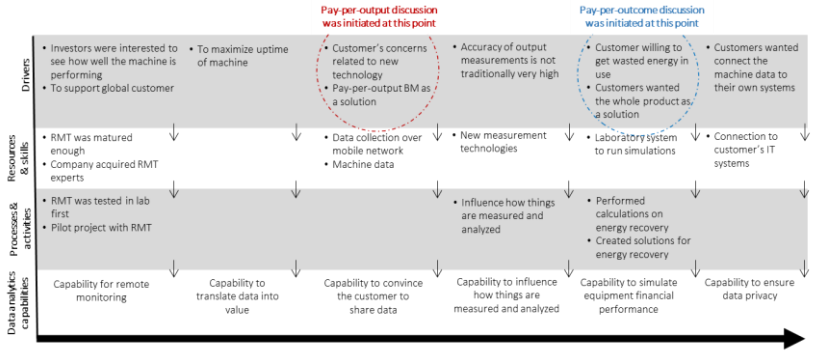

Fig. 1. Case A - Data analytics capability development roadmap

Case B: Our study found that Case B followed a different strategy to develop certain data analytics capabilities (See fig 2). The company decided to collaborate with a third-party financer and outsource some of the key activities to them. The company started to develop data analytics capabilities for its traditional business model in the 1990. In the beginning the company already translated data into value by solving customer issues using the data when physically in the customers premises. Always visiting customers to be able to troubleshoot the equipment wasn't efficient, so the company started to develop Capability for remote monitoring to be able to solve issues quicker and to save cost of travelling. To do this the company had to have Capability to convince customer to share data through their network but according to interviewee the benefits of the remote monitoring were in that time big enough that much convincing was not needed. Through the years the company develop their data analytics capabilities using several different technologies as the technology matured.

A few years ago, a third party approached the company and suggested the that they could finance and offer the company's machine through pay-per-output business model. According to the interviewee the third party had Capability to simulate equipment financial benefits and Capability to ensure data privacy and security. Therefore, the company did not need to develop additional capabilities to offer their pay-per-output business model.

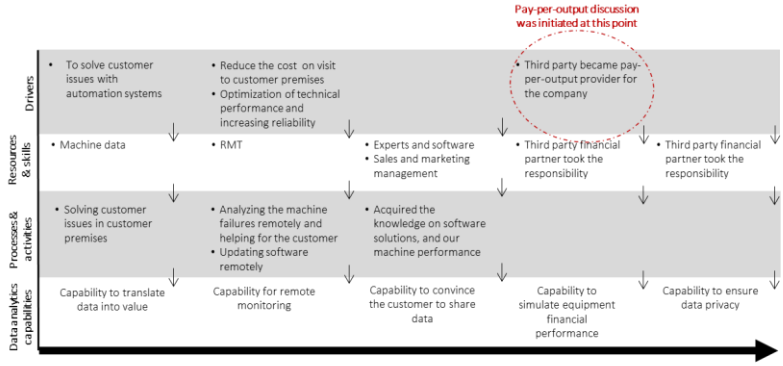

Fig. 2. Case B - Data analytics capability development roadmap

5 Conclusions

The contribution of this research is three folds. First, our research shows that in order to succeed in PPO business models the company require seven different types of major data analytics capabilities, namely *Capability for remote monitoring, Capability to convince the customer to share data, Capability to translate data into value, Capability to ensure data privacy and security, Capability to simulate equipment technical performance, Capability to influence how performance is measured and analysed, Capability to simulate equipment financial performance*. We derived five data analytics capabilities from scientific literature and validated them. In addition, compared to earlier studies [3], [21] we identified two additional data analytics capabilities, *Capability to influence how performance is measured and analysed, Capability to simulate equipment*

financial performance. Moreover, to authors' best knowledge, this is the first paper studying how data analytics capability development process can be developed for PPO business model implementation and to build roadmaps of data analytics capabilities development in equipment manufacturing companies. By illustrating two different case companies' data analytics capability roadmaps, this study has shown how companies can align key resources, and activities to develop required data analytics capabilities to implement PPO business model. We showed that to implement PPO business models, companies do not need have all the data analytics capabilities in advance.

Secondly, even though both case companies followed distinctive paths to develop data analytics capabilities, the need of remote monitoring capabilities were highlighted. Compared to earlier studies [3], [16], [18], [21] which have not made distinction between the priorities of data analytics capabilities and therefore have not studied in which order these could be developed, this study showed that remote monitoring capability was among the most critical data analytics capability to initiate PPO business model in EMI. Remote monitoring capability was an important prerequisite to other data analytics capabilities and the PPO business model. Both selected case companies have integrated RMT in their machines prior to implement PPO business model. This RMT integration has provided an opportunity to acquire and analyse the data. Almost all other capabilities were built on this RMT capability.

Thirdly, we showed, that it is possible to strategically mitigate the risk of developing some of the data analytics capabilities through a financing partner. This partner would take the responsibility of acquiring some of the needed capabilities.

This study makes some practical implications as well. We revealed what kind of data analytics capabilities a company must develop in order to succeed in a PPO business model. With this, practitioners can estimate how ready their organization is for PPO business model implementation and how to prioritize the resources. To succeed in PPO business model implementation, the company does not need to internally develop all the data analytics capabilities, they can adopt a strategy of outsourcing. PPO business model implementation is a continuous process, and data analytics capabilities can evolve along with the transformation. Roadmaps presented in this study could help managers how to integrate resources and skills to develop these capabilities.

The limitation of this study relates to the research theme and case selection criteria. Since the objective of this study is to identify major data analytics capabilities needed to implement PPO business models in equipment manufacturing companies, we did not focus on the data analytics capabilities implementation process, and how they work in a real-life situation. Therefore, the results might not be applicable to other industries with different kind of equipment. In future, we will validate these two data analytics capabilities by studying large sample. However, this offers interesting future research avenue to study development of data analytics capabilities in other industries. Secondly, we haven't focused on profitability of these PPO business models over time, so we can't evaluate the impact of these capabilities on the success of the PPO business model. Therefore, in future studies the development of profitability could be studied along with the data analytics capability development to find out does some capability have distinguishable effect on profitability.

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