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# Towards a Pay-Per-X Maturity Model for Equipment Manufacturing Companies

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**Abstract**

This Research-in-Progress paper presents a preliminary design of a maturity model for assessing the internal readiness of business-to-business equipment manufacturing companies implementing new, service-based pay-per-x (PPX) business models. By using existing maturity model design guidelines, action design research methodology as well as PPX-related literature and analogous maturity models in fields such as servitization, digitization, Industry 4.0, data-driven manufacturing and product-service systems, this paper explains how the creation of a maturity model could enable a systematic approach to implementing the new PPX business models. The paper will also provide the basis for the PPX maturity model development and validation in the future, while aiding the equipment manufacturing companies in assessing their current as-is situation in the most critical areas of PPX implementation as well as formulating a roadmap towards the implementation.



*Keywords:* Pay-per-use, PPX, Maturity Models, Business Models, Value Creation

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## 1. Introduction

Pay-per-x (PPX) business models can be used to describe non-ownership business models (NOBM), where the ownership of the product is not transferred to the customer, but the customer has a right to use the product. These PPX NOBMs can be divided according to their different earning logic into pay-per-use, pay-per-output and pay-per-outcome business models. [1] In pay-per-use business models, the customer pays for a unit of service (e.g. a wash) [2], whereas in pay-per-output business models the customer pays a fee depending on the usage of the product, measured e.g. with a clearly defined rate of consumption or output [3]. In pay-per outcome business models, the focus is on achieving a specified outcomes such as energy savings, rather than on a set of prescribed specifications [4].

The implemention of PPX business models can be time-taking, complex due to many company functions impacting the implementation, and challenging e.g. because of many novel types of competences that are required. As maturity models have been widely and quite successfully applied in implementations of different, complex systems, and strive for representing an evolution path towards the desired stages of maturity [5], they can also help with the implementation of business models [6]; see also [7]. Consequently, maturity models can help with the implementation of PPX NOBMs, which are among the most advanced and complex from both the technical and business-related implementation perspectives. However, despite the vast amount of maturity models in existence [5], maturity models in the implementation of PPX business models, and specifically in the context of B2B equipment manufacturing SMEs, present a research gap addressed in this paper. As PPX NOBMs relate closely to concepts such as Industry 4.0, servitization, digitalization and product-service systems, the literature review of this research was consequently conducted by reviewing and analyzing maturity models in these relevant fields. Therefore, designing a PPX maturity models in the context of B2B equipment manufacturing companies also define our main research question, which is:

How to design a PPX maturity model for B2B equipment manufacturing companies?

The remainder of the paper is structured so, that first we introduce the main concepts, and explain what maturity and PPX models are. Second, we present the methodological background and choices. Then, through analysis making use of PPX-related literature and maturity models in relevant areas such as Industry 4.0 and digitalization, we present the preliminary maturity model and associated conditions. Lastly, we present our main conclusions and future work.

## 2. Literature Review

### *2.1. PPX Business Models in B2B equipment manufacturing companies*

The advanced PPX business models can provide B2B equipment manufacturing companies with new ways of earning in the globally saturated product-centric industries [8]. Successful PPX business models can lead into technological advancements, in addition to which the service-oriented approach can lead to benefits such as increased customer loyalty, growth in revenues and new innovations and abilities to compete within the market [9]. Moreover, increasing responsibility over monitoring the product use and its efficiency can end up bringing value to the customer [10] as well as improve the overall performance of the equipment manufacturer.

However, implementing PPX business models can be difficult. As equipment manufacturing companies can provide complex and highly customized solutions to their customers, finding new ways of earning can be challenging due to e.g. changing technologies, routines and business processes in general [11]. If companies lack understanding, these changes can have a negative effect on the performance of the equipment manufacturer [12], and potentially lead to e.g. difficulties in achieving expected returns from the new, service-oriented PPX business models [13].

Overall, the process of implementing business models is consequently still relatively underdeveloped [6; 14] and many business models fail during implementation [15]. Despite this fact, only little research has been done on standardized methods to assess and compare the maturity of business models [16].

Consequently, successful PPX business model implementation requires a systematic approach, that helps the equipment manufacturers to define the operational capabilities needed in the change process [17]. For this, maturity models that have already been widely accepted and used for example in IT management [18], are also being recognized as prospective tools in other areas such as manufacturing and services [19] as well as more complex areas such as product-service systems [20]. Therefore, the argument in this research is that a maturity model can be developed to assess the PPX implementation readiness of B2B equipment manufacturing companies, serving them as a starting

point for assessing the companies' current as-is situation in the most critical areas needed in PPX business models. [21] Moreover, the maturity model provides a starting point for the development of a future roadmap towards the PPX business model implementation as well as overall helps the equipment manufacturers to define and reach the desired outcomes as efficiently as possible by providing them a common language within the company [5; 18; 20; 22].

### *2.2. Maturity Models*

Maturity models are most popularly associated with Capability Maturity Model [23], Crosby's Maturity Grid [24], and Gibson and Nolan [25]'s stage of growth model [26]. According to Lasrado et al. [26], researchers have used maturity models to facilitate (i) self-assessment or third-party assessment (also known as descriptive), (ii) benchmarking or comparison (comparative), and (iii) provide a roadmap for continuous improvement (prescriptive) [18; 22]. Many other scholars [5; 21; 27] argue that maturity models are meant to (i) assess the as-is and to-be situation of organizations, (ii) provide common language and terminologies for stakeholders to facilitate discussion and (iii) provide a shared objective and structure for prioritizing actions [21].

Due to the popularity of Capability Maturity Model [23] and adoption its variants like Team [28], the publication of maturity model related topics has risen steeply over the two last decade and so are terminologies used [26; 29]. Using the meta studies on maturity models by Mettler et al. [30], Becker et al. [5], Pöppelbuß et al. [18] and Lasrado et al. [31], the core components that constitutes a maturity model as used in our paper are:

(i) Maturity Level [Level1… Level n] are levels or stages the describe the archetypal states of maturity of the entity with each level having a set of distinct characteristics [25; 31; 32].
(ii) Dimensions (Xmn, m factors and n levels): "Elements", "Critical Success Factors", "Conditions", "Factors", and "Capabilities" are some of the other terms. Each dimension is divided into sub-dimensions with specific characteristics at each level [31; 32].
(iii) Boundary Conditions [B1… Bn]: Also termed "Triggers", "Dominant Problems" [33] and "Inhibitors", "existential crisis" [34] are specific conditions that the entity has to satisfy in order to progress from one stage to another [31].
(iv) Path to Maturity indicates development in which the entity improves considerably in terms of desired results i.e., capabilities, value creation, performance, etc. while traversing along this path while providing a roadmap for success [31; 33; 35].
(v) Assessment of Maturity: Maturity assessment is the translation of a maturity model into quantifiable factors that can be measured. These assessments can be either qualitative (e.g. interviews) or quantitative (e.g. questionnaires with Likert scales) [36]. Quantitative assessments using Likert scales are self-reported maturity scores (someone from the organization being assessed).

In this paper, the purpose of use of the PPX maturity model is to provide an overview of the company's current as-is situation, internal common language (internal to the company), ability to compare yourself with the companies that have implemented PPX business models and eventually provide a roadmap for an organization to transition from a fully product-oriented set up to one wherein majority of the revenue comes from the PPX services.

## 3. Methodology and Scope

The PPX maturity model (PPX-MM) proposed in this paper will be designed, developed and validated in a systematic and iterative way following the Action Design Research (ADR) approach proposed by Sein et al. [37], while following the maturity model development framework developed Becker et al. [5]. The process is also supported with Mettler's maturity model design framework [38], where the related decision parameters are used to define the scope, overall design as well evaluation & reflection strategy of the maturity model. Moreover, these decision parameters also define the criteria for the expert selection for the upcoming interviews: as the audience for the PPX-MM is defined as both management and technology-oriented, the experts are chosen from companies that have at least some experience in implementing PPX-related solutions in equipment manufacturing companies, either in terms of overall business management or technological decisions. In addition, academic experts in the area of maturity model development and PPX business models are involved in the development process of the PPX-MM.

Becker et al. [5]'s eight step procedure model is divided into three broad phases [29]. Phase 1 includes steps 1-3 which involves defining the overall problem, audience, stakeholders, and scope, reviewing, and comparing existing maturity models and a determining a development strategy. Phase 2 includes steps 4-5, which involves the iterative development of the initial version of the maturity model and documentation using appropriate media for different stakeholder groups. Finally, phase 3 includes steps 6-8, wherein the maturity model is deployed, evaluated in practice, continuously improved till the model is redundant and must be retired [39]. In this research-in-progress paper, the first phase is completed, second phase (step 4) has partially begun, and the third phase will be executed as explained below.

- Step 1 - Problem Definition: The need for a PPX-MM for B2B equipment manufacturers in Finland has been identified. PPX-MM is a combination of process, object, and people-oriented themes. As the problem scope is limited to internal, organisational considerations, the audience is also a combination of different company managers. I.e., the audience and assessors depend on the organisation's management structure, where managers responsible for e.g., business or technological aspects can answer questions related to their specific dimensions.
- Step 2 - Comparison with Existing Maturity Models: Literature review yielded no maturity models addressing the internal PPX implementation readiness in equipment manufacturing companies. Therefore, the research continued with the PPX-MM development process according to Becker et al. [5] next maturity model development phases.
- Step 3 - Determine Development Strategy: The development strategy follows the ADR process and begins with developing the preliminary, theory-based maturity model by combining aspects from the existing maturity models assessed in the literature review. In this case, the assessment focused on PPX-related literature review as well as maturity models that are the most related to PPX.
- Step 4 - Iterative Maturity Model Development: PPX-MM will be developed through several iterations. Currently, synthesis of relevant dimensions identified through a literature review† and two expert rounds of validating the dimensions and initial maturity levels with academic and company PPX experts have been executed. In the future, these iterations and expert interviews will be continued.
- Steps 5-8 - In the future, the steps according to Becker et al. [5] include documentation, developing the maturity assessment tool, evaluating the tool and its results, and finally evaluating the outcome of the PPX-MM, and whether it will be rejected or improved continuously in the future.

## 4. Characterization of a proposed Maturity Model

Our research indicates there are no specific maturity models for assessing the internal readiness of equipment manufacturing companies implementing PPX business models. However, from a sample of PPX-related literature, e.g., [40-42], we found out some of the most relevant dimensions that could be integrated into the PPX maturity model. Moreover, the literature review made use of maturity model- and PPX-related research in areas such as servitization, e.g. [20; 43], digitization, e.g. [44], Industry 4.0, e.g. [45-51], data-driven manufacturing, e.g. [50], product-service systems (PSS) e.g. [52; 53], as well as more generic business model maturity, e.g. [6]. From the literature, 25 of some of the most relevant sources were identified and used to back up the suggested maturity levels and dimensions of the initial, theory-based PPX maturity model artifact. Table 1 shows the derived reference levels:

Table 1 Theory-based PPX maturity levels

| Level | Level name | Description of the Levels |
|---|---|---|
| 1 | Initial/ad hoc | The company is fully product-oriented, and no revenue comes from the PPX services. PPX requirements and benefits are potentially acknowledged or researched, but no concrete measures have been developed or implemented. |
| 2 | Repeatable | PPX requirements and benefits are acknowledged, concepts tested. PPX-related measures are still non-standardized, and measures are based on ad-hoc decisions. |

† In this research-in-progress paper, we present the initial model based on literature reviews alone.

| | | |
|---|---|---|
| 3 | Defined | PPX measures are standardized, enabling the implementation of small-scale solutions in specific PPX business models. |
| 4 | Advanced | PPX measures monitored and optimized for use in specific PPX business models. |
| 5 | Optimized | PPX measures optimized and integrated across the company. Optimization enables understanding causality through automated and prescriptive PPX measures, as well as the implementation of PPX in any possible and feasible market in an agile manner. |

Based on Mettler's maturity model design framework [30] as well as Becker et al. maturity model development process [5], 7 most critical dimensions were derived from the literature review. The number of dimensions was kept at 7 due to the limited cognitive capacity for memory, attention and perception, consequently ensuring understandability of the developed maturity model [54]. Similarly, the scope was restricted to the internal readiness of the B2B equipment manufacturing companies, again ensuring the design requirement of understandability of the model for the target group [5; 22]. It was seen, for example, that considering customer readiness could potentially complicate the readiness analysis within the equipment manufacturing companies.

In terms of the dimensions, the PPX-related literature emphasized aspects such as organizational governance needed to manage changes related to e.g. system integration [55] and overall processes [56]; strategy needed to systematically implement the new business models with appropriate resources [53; 57]; risk management capabilities needed to mitigate emerging risks [40; 53]; open-minded culture needed to accept the new business models [56] as well as competences needed to execute PPX business models efficiently [40]. Finally, operations and processes related to e.g., production, logistics and marketing that are not covered in the other dimensions were also emphasized, as they are needed in overall value creation and the implementation of PPX business models [40; 57; 58]. Moreover, literature and maturity models related to the more technologically advanced business models such as Industry 4.0 also emphasized the importance of technology and data analytics in e.g., prescriptive and automated processes needed in value creation [45-51]. The findings and dimensional descriptions are summarized in table 2:

Table 2. Theory-based PPX maturity model dimensions.

| Dimensions | PPX | MM | Description |
|---|---|---|---|
| Organizational Governance | [55; 56; 59] | [20; 43; 46; 47; 52; 60; 61] | Organizational governance consists of the standards, rules and regulations that define how different systems and processes for PPX business models are built and who takes responsibility for them. It considers how data and information is governed and who owns it, ensuring quality, structure, usability, access, and availability of PPX data & information. Organisational governance is divided into three subdimensions i.e., system, people, and data & information governance. |
| Strategy | [53; 55; 57; 59] | [20; 44; 48; 51; 52; 60-63] | Strategy consists of the plan of action for overall company goals and use of resources that are the most critical in PPX implementation and maturity. The dimension deals with planning PPX activities & goals and aligning them with the company vision. Consequently, it is also about allocating resources to PPX business models as efficiently as possible. Strategy is divided into three subdimensions i.e., business strategy, strategic alignment, resource allocation. |
| Risk Management | [40; 53; 55; 57] | [51; 52; 60; 61; 63-65] | Risk management consists of the processes, methods and competences needed to identify, analyze and mitigate emerging PPX risks related to business (including financing, customer acceptance, business model cannibalization, contracting, market-related and legal risks), operations (including risks related to changing internal systems and processes) as well as risks related to data in terms of data security and leakage. Risk Management is divided into three subdimensions i.e., business, operational, cybersecurity risks. |
| Competences & Culture | [40; 56; 57] | [40; 47; 49; 52; 60; 61; 66] | The dimension consists of the most critical competences that are needed in PPX business model implementation, such as co-creation with customers, process, product and service engineering and design as well as marketing and sales. The dimension also describes culture in terms of collaboration, sharing knowledge across the company departments as well as attitudes towards changes needed in the PPX business model implementation. Competences & culture is divided into two eponymous subdimensions i.e., competences, culture. |
| Product & Production Technology | [53; 55; 59] | [20; 45; 47; 50-52; 60-62] | Product & production technology consists of the implementation of technologies related to hardware, software, connectivity, and cloud, that are the most critical in the optimization of product lifecycle benefits and risks in PPX business models. The subdimensions are: (1) Smart Product & Factory i.e., implementation of product and production-related hardware and embedded software, (2) Connectivity i.e., technologies that enable connectivity to the |

| | | | |
|---|---|---|---|
| | | | internet and machine-to-machine communication in PPX products and production processes, and (3) Cloud i.e., cloud-based applications, platforms and databases enabling the company-wide access to information related to PPX products and production processes. |
| Data Analytics | [57; 58] | [20; 43-45; 50; 52; 61] | The dimension deals with different methods such as descriptive or diagnostic analysis; software tools such as Excel & BI tools and technologies that support data collection, processing, combination, visualization, and application. Data analytics is specifically about the technologies utilized in analytics, so it excludes the technology utilized in products or production processes. Data Analytics is divided into three subdimensions i.e., data collection, transformation & processing, visualization, and decision making. |
| Product Lifecycle Processes | [53; 55-57; 59] | [20; 46; 47; 49; 52; 60; 61; 63] | Product lifecycle processes is about the collection of processes related to the beginning, middle and end of life of the product lifecycle that are the most critical in the optimization of lifecycle benefits and risks in PPX business models. These include operational processes such as product engineering, service design, manufacturing, sales, logistics, provision of services such as maintenance, disassembly, redistribution and reusage of the PPX product. |

## 5. Conclusions & Future Work

Our maturity model is the first approach towards a systematic maturity modelling for PPX implementation in B2B equipment manufacturing companies. In this research-in-progress paper, we have discussed the preliminary design of this PPX-MM, developed from an analysis of PPX-related literature as well as analogous maturity models in areas such as servitization, digitization, Industry 4.0, data-driven manufacturing and product-service systems. This initial PPX-MM can be considered as an important contribution in the emerging domain of PPX-MMs among equipment manufacturers, where there are currently no existing maturity models. In addition, this research provides a foundation for empirical verification of the dimensions, level descriptions, and other related maturity measures.

Currently, the literature review has provided guidelines for designing the PPX-MM using Sein et al. [37] iterative ADR process together with maturity model design framework by Becker et al. [5]. The process includes steps from problem definition aided by Mettler's [38] decision framework to the literature review and the creation, implementation, and evaluation of the maturity model. As a result of the literature review, the initial dimensions of the theory-based PPX-MM include organizational governance, strategy, risk management, competences & culture, product & production technology, data analytics and various product lifecycle processes. Moreover, 5 reference levels for PPX maturity were derived from literature, including the first, initial/ad-hoc level, where the company is fully product-oriented; the second, repeatable level; the third, defined level; the fourth, advanced level and finally the fifth, optimized level, where PPX measures are optimized in any possible and feasible market.

The PPX-MM has several important implications for practitioners. First, it provides the equipment manufacturing companies a means of assessing their current readiness to implement PPX business models, potentially helping in identifying any critical issues or bottle necks that should be addressed and focused on in the implementation process. Second, the maturity model can provide a basis for the creation of a roadmap towards the implementation of PPX business models. Third, the maturity model can provide a common language within the company, and finally, the model can enable comparing your company to others in the industry.

Future work would involve to further refine this preliminary model, verify the levels and dimensions through PPX expert interviews, workshops and focus group discussions. The developed version of PPX-MM would then be used to conduct self-assessment in five Finnish equipment manufacturing companies, which will help in designing and validating the model and provides a basis for the development of a web-based PPX maturity assessment tool, that can be used as a step towards planning the implementation of PPX business models. In the future, this internal PPX-MM can also be modified to fit the needs of analysing PPX readiness in other areas such as with customers or in the context of an ecosystem. When used by multiple companies, benchmarking tool can also be created.

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