Developing Online Freight Transport Exchanges: Theoretical Insights and Conceptual Framing

by

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1 INTRODUCTION
The success of rail freight transport exchanges (FTE) is currently too low to contribute substantially to the EU’s long-term modal shift goals. However, previous studies (Jain & Bruckmann, 2017; Jittrapirom et al., 2017, Montero & Finger; 2017) indicate that online exchanges in various network industries have shown a higher level of maturity (in terms of effectiveness and efficiency) in implementing processes for matching supply and demand of multimodal services on a large scale. This e.g. seems to be the case in the energy industry, road freight transport, urban public transport, and long-distance passenger transport industry. The grand hypothesis underlying this study is that implementation and use of a multimodal FTE using rail and road transport modes enables the acceleration of modal shift from road to rail and a significant improvement of the performance of the rail freight transport industry. It is assumed that establishing such an exchange is feasible following a structured transition and implementation process.

Therefore, this research focuses on studying (i) the drivers of change and impacts of such exchanges on the performance of the freight transport industry, and further based on this (ii) the requirements for significantly improving the matching of demand and supply in (multimodal) freight transport, through the use of online exchanges.

The objective of this paper is to present a way of thinking for further structuring of the research. This is done by developing a theoretical framework, first for comparing the maturity of such two-sided online exchanges in different network industries regarding organizing multimodal services. Secondly, based on these insights, the framework is further used for the design and testing of an online multimodal freight transport exchange (FTE) that enables multimodal transport services using rail and road transport. The framework, finally, aims to facilitate the specification of transition paths facilitating the improvement in the establishment and impact of FTE’s.

FTE’s as independent businesses in network industries have their own specific business model. This has two implications regarding the literature on which this theoretical framework is based. The first implication is that a study of essential characteristics of business models of traditional firms in network industries in general, as well as specifically of those firms that operate as online exchange is required. Secondly, it implies that we need to explore concepts of development in such businesses, aimed at making a transition to a higher maturity than
their present one. Therefore, different theoretical perspectives are explored to identify key building blocks of the theoretical framework aimed at in this chapter.

The choices for the different perspectives are triggered by the following four subquestions:

- How to understand the drivers of change, structure, behaviour and performance of businesses in network industries? (Subquestion 1)
- what are the main commonalities and the essential differences between the business models, behaviour and performance of online exchanges to that of traditional firms? (Subquestion 2)
- how can-the development of capabilities of firms that aim to become a more mature business in a dynamically changing environment be understood (Subquestion 3)
- How can the lessons learned from the previous subquestions be integrated in a coherent, operationalized theoretical framework for this research (Subquestion 4).

With regard to subquestion 1, the literature on frameworks in industrial organizational theory is reviewed. This theory aims at describing the main characteristics of businesses and at identifying key variables which directly influence the transformation of network industries to highly competitive service industries. The transformation reflects adaptive behaviour and improved capabilities of firms in dealing with different complexities and changes they are facing. This concerns changes within their domain (e.g. changes in customer preferences, more competition or the introduction of new technologies like ICT) and in the context of their domain (e.g. changes in economic demand, new regulation on sustainable performance or geopolitical tensions). Typical for the industrial organization theory is however, that it basically limits itself to traditional firms providing services to individual customers, by performing similar activities as services. Such activities are typically organized in a sequential fashion. This implies that online exchanges in network organizations and their collaborative operations receive limited attention in industrial organization theory. Since the online exchanges are basically considered as a network organization aimed at facilitating the exchange of value between firms participating on the two sides of the exchange (known as participants), industrial organization theory has potential limitations regarding the understanding of the exchange’s behaviour.

Therefore, in answer to subquestion 2, next the so-called platform economy theory is reviewed. The major addition to the findings of industrial organization theory is twofold. First, the more specific focus in platform economy theory on distinctive business design characteristics of online exchanges. And, secondly, the attention for innovative practices these exchanges can and should perform to incentivize and influence firms in network industries for joining the online exchange.

For finding answers to subquestion 3, theory on business maturity growth is discussed to understand the complexities of the process of a firm’s development and change for maturity improvement. To that end, notably the classic capability maturity model (e.g. Paulk, Curtis, Chrissis, & Weber, 1993) is discussed and elaborated for exchanges in network industries.

The key concepts provided by these theoretical views, are integrated in a theoretical framework that underlies the remainder of this research, and answers subquestion 4.

This paper is structured as follows (see also Figure 1). Section 2 discusses the frameworks in industrial organizational theory, section 3 discusses the platform economy theory. Section 4 discusses the maturity growth theory and maturity approaches. Based on these theories,
Section 5 describes the overarching theoretical framework structuring the remainder of this research. This framework is abbreviated as OEMF (Online Exchanges Maturity Framework) from here on.

Figure 1: Structure of this chapter

2 INDUSTRIAL ORGANIZATION THEORY

Network industries show different levels of performance regarding a variety of issues related to the functioning of markets. E.g. price transparency is higher in the highly regulated European energy industry than the liberalized rail freight industry. Such differences can be attributed to differences in the capability of the firms, within their related business ecosystem, to make a step forward to a higher level of maturity. Since the early 1950’s, the Industrial Organization Theory (from now on: IOT) provides useful frameworks for a deeper understanding of such differences in network industries.

Based on this theory, comparisons have been performed since two decades on the characteristics and evolution of different network industries in the EU regarding the state of the industries in terms of liberalization, regulation, technological innovation, substitution, etc. (see e.g. European Commission (1999, 2013); Pelkmans & Luchetta, 2013; Finger & Jaag, 2015; Moroz, Nicu, Pavlov & Polkowski, 2014). Such studies show that these industries are evolving all the time. This holds true for various aspects, including their market orientation, maturity in service level and the technological innovation. Various characteristics of these industries, including e.g. infrastructure intensiveness, duplicity challenges, level of sunk costs, and network access issues, determine the behaviour of the firms. Such factors facilitate or hinder the growth of firms in terms of maturity.

This section therefore explores the relevant frameworks within IOT to discover the advantages and shortcomings of these frameworks to improve the understanding of the drivers of change and the structure, behaviour and performance of businesses in the network industry.

Structure Conduct Performance Theory (SCP)

The structure-conduct-performance framework (SCP) (Bain, 1959) supports a fact-based analysis of the current state of network industries. It considers an industry as a basic unit of analysis. It posits that the market structure determines the behaviour of firms operating in that market, which in turn determines the performance of the firm and the dynamics in the market (Voogt, Lemstra, & van Gorp, 2014). The market itself comprises of actors including a variety of firms (including those operating as online exchanges and their participants), institutions (e.g. policy makers, regulators), clients, etc.

The three key concepts of the SCP theory (structure, conduct and performance), are defined as follows.
Structure refers to market structures i.e. all elements and mechanisms that may affect the behaviour and performance of the firms operating in an industry (Bain, 1959, McGahan & Porter, 1997). Variables describing the market structure and its key characteristics include: the sellers concentration (the number of seller firms or organizations in an industry and their comparative shares of industry sales); the degree of product differentiation and barriers of entry (Trucker, 2010; Meilak & Sammut-Bonici, 2015); the buyer concentration and the growth rate of market demand (Bain 1968; Lipczynski, Wilson, Goddard, 2013). A frequently used classification of market structures is based on the theory of competition. This theory makes a distinction between markets in network industries, depending on whether there exists (a) a perfect competition (an ideal outcome, often used for benchmarking), (b) a monopoly (when one firm dominates), (c) a situation of monopolistic competition (e.g. only a few handful supply side firms providing a particular product) or (d) an oligopolistic situation (a small number of firms dominating the market with 60-100% of the market share) (Shepherd, 1985). A differentiation of this type provides reasons for interventions of policy makers and regulators as well as for evaluating whether the interventions have been effective. Such analysis is e.g. based on qualitatively observing and comparing the structure of ownership of the firms in the market, i.e. whether they are state owned or privately owned and by whom (Jain & Bruckmann, 2017).

Conduct, called behaviour in this research, relates to the dynamic pattern of functioning of firms in adjusting to the dynamics in the markets in which they sell or buy (Bain, 1959, 1968). This behaviour applies to the internal as well as to the external functioning of a firm in the market. Internal functioning in this context refer to eliminating duplicate processes to improve operational efficiencies, knowledge development, product and service specialization, etc. The external functioning refers to the forming of partnerships, information sharing across firms, societal accountability, etc. (Chen, Daugherty, & Roath 2009; Leuschner, Rogers, & Charvet, 2013). Further activities relate to product design, branding, advertising and marketing, research and development as well as collusion and merger (Lipczynski et al., 2013).

Performance of the firms and markets in network industries is measured by common economic measures and other indicators representing the broader multi-value / sustainable responsibilities (e.g. results based on their social, ethical and environmental oriented activities). Economic outcomes are often measured in terms of variables like profitability, return on capital employed, and price-cost margin (Figueiredo Junior, Meuwissen, Filho, & Oude Lansink, 2016; Voogt et al., 2014). A broader social perspective is e.g. expressed in terms of the reduction in CO2 emissions and energy consumption. Extensive research has been performed in this regard on the SCP theory to identify different industry and context specific key performance indicators (KPI’s) regarding e.g. finance, sustainability or operational quality. Based on the review of various research papers on the SCP theory between 1956 and 2014, it can be concluded that the SCP theory is a multi-dimensional, multi-interpretable and a static framework supporting the classification of the current state of industries and the market structure in which they operate (e.g. Porter 1981; Lipczynski et al., 2013; Figueiredo Junior et al., 2016). The framework thus supports a systematic description of
i. the market structure of the network industry within a dynamic context,
ii. the opportunities and threats relevant for the development of a firm’s strategy based on the identified external drivers, and
iii. the internal capabilities of a firm to be developed in response to the changes in the external environment,
so that the performance of firms and the market as a whole can be improved (Porter, 1981).
The SCP theory also has some major disadvantages. An important issue is that the industry is considered as the basic unit of analysis i.e. all firms belonging to that industry are considered strictly homogeneous in terms of capabilities they have and the strategies they use (e.g. the response to liberalization is assumed to be the same in all rail freight firms in the EU) (Matyjas, 2014; Meilak & Sammut-Bonnici, 2015). In reality, this assumption of generalization on homogeneity is unlikely to be true and leads to only a partial understanding of the behaviour and capabilities of individual firms. Also, contrary to the assumption of Bain (1959), that a causal linear “one-way relationship” sufficiently represents the relationship between structure, conduct and performance, later research has shown, that the performance of firms can also influence the market structure (Voogt et al., 2014). In other words, the relationship is more likely to be dynamic and reciprocal. Therefore, the SCP theory offers rather simplistic insights in market structures and current behaviour of firms in network industries, especially firms that focus on innovative platform services.

This recognition of dynamics, brings us to the theory of Industrial Dynamics by Carlsson (1992) which posits that understanding the evolution of the industry is key to analysing the current state of a firm’s performance in a particular market and its capabilities. The theory builds upon the SCP theory, but offers an extension of it by focusing on business dynamics and transformation.

**Industrial Dynamics (ID) theory**

ID theory focusses on gaining insights about key drivers of change of economic transformation, industrial development and growth, and therefore in understanding the characteristics of the systems in which the underlying processes of transformation take place (Carlsson, 2016). Regarding transformation, Carlsson (1992) views it in a broad context, i.e. in its evolutionary, institutional, technological, social, political, and geographic context. He argues, that the competence to change is related to the capability of identifying, expanding and exploiting business opportunities based on the past behaviour (Dosi, 1997; Teece, Pisano & Schuen, 1997). Firms in a specific market differ in terms of their history and their capabilities to change and therefore cannot be considered homogenous. This key notion of non-homogeneity is a distinguishing notion within ID as compared to the SCP theory.

To understand the transition of a firm Carlsson (2016) suggests four key questions to be analysed. These are briefly discussed as follows.

i. **What is the nature of the “business and economic activities” of the firm?** The strategic, tactical and operational activities of the firm depend on a combination of strategic, organizational, technical and learning capabilities, network industries must achieve (Teece et al., 1997; Carlsson, 2016). These four capabilities are depicted in Figure 2 and explained as follows:
   a. the strategic capabilities relate to a firms’ ability to make innovative choices regarding the markets in which they operate, notably the product design, technological innovation, align goals to customer, societal and regulatory requirement, and organizational development (such as structure, selection of key personnel, competencies etc.),
   b. the organizational capability relates to coordinating various activities of the firm for creating synergies and e.g. optimizing processes for minimizing costs, defining policies for tactical and operational decisions, processes standardization etc.,
   c. the technical abilities, notably important for online exchanges, relate to (the ongoing improvement of) the operational ability in managing operations, and finally,
d. the learning capabilities are related to adaptive learning from success and failures at each organizational level (e.g. management, operations), as well as to signalling and interpreting market signals for the need to proactively respond. Firms with these capabilities can create strategies for reaping benefits from opportunities in the market.

ii. **What are the boundaries of the firm and what is the degree of independence among firms?** Carlsson (2016) observes that pressures from exogenous factors, like intensified global competition, act as drivers of change for firms and organizations in markets, often triggering them to focus on their core business. Further, uncertainties (like fluctuations in the exchange rate, inflation and interest rates) force firms to become more flexible in answering foreseen and unforeseen challenges. Such flexibility, he argues, can be better achieved in smaller units (e.g. firm or a division of that firm) and by differentiating (e.g. standardized) products in the area of specialization in such a way that it is not easy for others to compete with. E.g. electricity as commodity on energy exchanges may be offered as hourly and quarter hourly products; freight exchanges may offer less than a truck load and or full truck load services on freight exchanges; a daily, weekly or monthly ticket in urban transport exchanges, etc. Therefore, related questions offer valuable insights on e.g. why and how firms are decentralizing certain operations, are increasing their reliance on activities outside their core business by subcontracting and outsourcing them, or whether they are collaborating within their network. Such issues can also act as internal drivers of change for e.g. for cost reduction or product/service innovation.

Figure 2: Four types of capabilities which determine the firm’s economic or business competence. Source: Author’s depiction based on Carlsson (1992).

![Figure 2: Four types of capabilities which determine the firm’s economic or business competence. Source: Author’s depiction based on Carlsson (1992).](image)

iii. **Which are the technological changes taking place and in which institutional framework?** Technological changes today form the key driving forces in industries. Carlsson (1992) considers changes in business models to be related to generating, diffusing or utilizing new technology where knowledge (e.g. data and information) instead of goods and services flows between different firms. These firms interact within a given institutional framework with firms that directly or indirectly can trigger, stimulate and regulate the technological innovation. For example, unhindered collaboration of major market actors
in an online exchange can be the basis for new standards for digital tracking and tracing of products. The institutional context includes economic institutions (e.g. markets, banks), governmental bodies (policy and regulation making agencies) and organisations involved in production and distribution of knowledge (e.g. research and academic institutes, entrepreneurs as suppliers and users of the technology) (Carlsson & Eliasson, 2003).

iv. **What is the role of public policy?** With this question Carlsson (1992) aims to understand the actual and the desired role of government and regulatory interventions which are often a reaction to certain market failures. These interventions are generally oriented towards stimulating competition and preventing abuses of market power (Lipczynski et al. 2013). Krueger (1990) observed however, that government interventions may not necessarily reduce or eliminate market failures, and on the contrary sometimes also cause more market disturbances (often not intended). Carlsson (1992) argues that policy interventions can play a significant role in promoting innovative interactions between actors in the industry, establish blended visions and in fact trigger coordinated decisions on new investment strategies.

**Evaluation**

The ID theory is built on the SCP theory. However, it offers a more dynamic perspective on the evolution / development of firms in time, in relation to changes within and outside the firm. The ID theory therefore seems to offer a more advanced framework to analyse the market structure, performance and transformation of online exchanges (considered as individual firms). Particularly important for the theoretical framework under development for such exchanges’ business models are the notions summarized in Figure 2. In addition, the ID theory explicitly addresses that technological, institutional and policy changes are relevant contextual developments that might trigger changes in the firms’ business models. The ID theory thus opens the door to understanding the transformation of firms in markets of industries from a given starting point to the current state and to intended futures. This understanding is at a global level regarding external drivers of change at different stages, and at a basic level regarding a firms’ internal growth in capabilities for change. The industrial dynamics in this context is caused by the process of technological innovations that are introduced by new entrepreneurial entrants in the market. These dynamics have the potential to force incumbents to reorganize themselves and adapt to new changes or to leave the particular market (Carlsson & Eliasson, 2003).

The added value of ID theory as compared to the SCP theory does not imply that ID theory is without problems. The key criticism relates to the difficulty in studying industrial transformations due to the complexity of these processes e.g. due to the involvement of several actors, the variety in nature of involved networks, the fuzzy influence of technological innovation and the lack of clear criteria for determining the boundaries of the system to be studied (Teece et al., 1997). It notably has limitations when applied to online exchanges as their business models are significantly different from that of traditional firms. E.g. exchanges need to apply different strategies for participants at two sides (the demand and their supply side participants), for incentivizing them to adopt the exchange, and accept and prepare for interacting with each other on the exchange. Different strategies towards two different types of participants is not always considered acceptable for traditional firms by regulators (Evans & Schamlensee, 2012; Rochet & Tirole, 2003).

The conclusion is that, despite commonalities, the significant difference between business models of online exchanges and traditional firms limits the applicability of not only the SCP
theory but also the more advanced ID theory for understanding the complexities of online exchanges.

The following section elaborates on the commonalities and essential differences in business model, behaviour and performance of online exchanges, compared to that of traditional firms using Platform Economy Theory. This relates to subquestion 2.

3 PLATFORM ECONOMY THEORY

Commonalities exist between online exchanges within a particular network industry and those between different network industries. E.g. Rochet and Tirole (2003) in their theory on Platform Economy Theory, (from now on: PET) observe that there exists a common underlying business model of online exchanges, even from seemingly different industries. Brousseau and Penard (2007) however argue that “there is no one best business model “and “there are trade-offs among models” depending on what the online exchanges aim to offer. For example, the business model of a commercial exchange is generally developed towards minimizing transaction costs and guaranteed market clearing whereas many freight exchange business models may be more focussed towards offering specialized logistics services instead of guaranteed market clearing. Transaction in this regard is basically composed of two or more interactions on the exchange, one of which initiates the transaction and one that terminates it, the remaining interactions occurring in the middle of a transaction (Nota & Aiello, 2017). Importantly, literature on PET indicates that all business models of online exchanges differ from those of traditional firms (Choudary, 2015). This difference can be explained as follows.

Business models of online exchanges require
i. the operating firm to be capable of making strategic choices e.g. on its market focus and dynamic selection and management of participants (both on demand and the supply side), the added value of the offered services, product definition, pricing, costs, etc. in a highly competitive environment; and
ii. the traditional firms as potential participants to be capable of adopting exchanges / adapting to the requirements of an online exchange for participation.

Traditional firms often have difficulties with both issues, because these requirements imply
i. reflecting critically on the firm’s assumption that the current (path-dependent) way of working will continue to deliver positive business results in future and
ii. understanding the need to change the prevailing business model.

E.g. Scholten and Scholten (2011) argue, that firms intending to connect their business to an online exchange need to make structural changes to their business model, implying that e.g. their products and services have to be adjusted to the rules of the online exchange to make them ready for sail.

To be able to better understand such requirements, one needs to step back to discuss the key design characteristics of online exchanges. The term characteristics, encompasses i. features, ii. behaviour and iii. quality. Kang et al. (1998) define features as distinctively identifiable functional values or manifestations of a particular business model attribute. Based on insights from IOT, the behaviour of online exchanges (considered as independent firms) can be conceived as the level of responsiveness to drivers of change by changing the business model features (Finger and Jaag, 2015, p2). Finally, quality relates to the participants’ measurement and assessment of the degree of excellence of the services provided by the exchange. Quality thus relates to the concept of maturity of services.
Clearly, behaviour and quality are two closely related issues. Where features constitute the design characteristics of the online exchange, behaviour and quality determine the performance of practices. Each practice in this regard is a set of related activities (e.g. related to customer management, acquisition of new participants, exploring market preferences, or operational service management) that when performed contribute most towards effective implementation of an exchange’s key processes (Mettler, 2011). These relationships are depicted in Figure 3.

Figure 3: Relationship between business model attributes, design characteristics and performance of exchanges. Author’s own depiction

Based on these concepts, in order to find answers to subquestion 2, first commonalities and essential differences between business model of online exchange and traditional firms are discussed on the basis of the model’s attributes and features. Then commonalities and differences in behaviour of online exchanges is compared. Finally, attention is paid in a generic way to the performance of exchanges at different maturity levels.

Attributes and their Features

We proceed by recalling the definition of an online exchange selected in Chapter 1, that exchanges apply a matching mechanism to bring the supply and the demand side together in a (digitalized) virtual place where both sides interactively ‘discover’ the price for a product or service on a dynamic basis (Chang, Easley, & Shaw, 2003). Importantly, the exchange itself is not involved in providing any physical delivery of service or resources for offering the service.

Based on literature on PET, a generic and summarizing business model of exchanges is presented in Table 1. The eleven common business model attributes and their possible features as manifestations of the attributes are next discussed.

Table 1: Business model of online exchanges, in terms of attributes and their features.

<table>
<thead>
<tr>
<th>Business Model Attribute</th>
<th>Features</th>
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<tbody>
<tr>
<td>i. Type of Operator</td>
<td>Unrestricted, Private, Consortia</td>
</tr>
<tr>
<td>ii. Bias</td>
<td>Neutral, Biased</td>
</tr>
<tr>
<td>iii. Market Focus</td>
<td>Participants on supply and demand side</td>
</tr>
<tr>
<td></td>
<td>Vertical, Horizontal</td>
</tr>
<tr>
<td></td>
<td>Single Mode, Multimodal</td>
</tr>
<tr>
<td></td>
<td>Geographical boundaries</td>
</tr>
</tbody>
</table>
i. **Type of operator**

The type of operator relates to the level of autonomy that an exchange can exercise in defining strategies and rules e.g. on pricing and boundaries of markets. The definitions of this attribute in literature as depicted in Table 2 below, appears to collide with that of the ownership structure of firms, to be discussed below.

**Table 2: Interpretations of type of operator.**

<table>
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<tr>
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<tbody>
<tr>
<td><strong>Unrestricted</strong></td>
<td>Autonomous, independent single service provider</td>
<td>Public</td>
<td>Intermediaries</td>
</tr>
<tr>
<td><strong>Private</strong></td>
<td>Private</td>
<td>Hierarchies</td>
<td></td>
</tr>
<tr>
<td><strong>Consortia</strong></td>
<td>Consortia</td>
<td>Consortia</td>
<td>Consortia, Cooperatives</td>
</tr>
</tbody>
</table>

**Source:** Grieger (2003), Marasco (2004), Stockdale and Standing (2004)

The difference between autonomous and single service provider defined by Grieger (2003) is fuzzy. Marasco (2004) posits that the type of operator expresses the different types of relationships between participants of the exchange e.g. ‘public exchanges’ are those that have the freedom to define the exchange rules and are accessible to all potential participants on
both sides. Hence, they are to be interpreted as “unrestricted”. Further, exchanges are “private” when they are owned and organized by incumbents (usually service providers) to tightly integrate their demand side participants to their own business (i.e. a firm creates its own private exchange). In that case, access to the exchange is controlled by the incumbent and restrictive, hence private. ‘Consortia’ refer to a special type of private operator, consisting of a group of market participants coming together to create an integrated exchange by bringing together their network of (one side) participants to safeguard certain common interests e.g. competing exchanges offering unrestricted access. A consortium can be restrictive on both sides towards participants or on one side. Finally, Stockdale and Standing (2004) define the type ‘intermediaries’ as exchanges catering to different industries. Further, ‘consortia’ for them cater incumbent firms spread over countries. ‘Hierarchies’ are mostly e-procurement hubs hosted by the government. ‘Cooperatives’ (closer to consortia) are set up by intermediaries that are interested in actively participating on demand and supply side, and who are interested in a particular industry type, a geographical area, or a specific aim (Stockdale & Standing, 2004). The key difference between intermediaries, autonomous and single service provider remains in these definitions fuzzy and rather unclear.

For this research, therefore, the types of operator will be categorized as unrestricted, private or consortia. Unrestricted exchanges are autonomous in their governance and accessible to all potential participants on both sides fulfilling the access criteria. Private exchanges are those that run under the governance of a logistics service provider firm that decides which participant can access the exchange. Consortia concerns a private exchange owned and organized by incumbents (usually service providers) to tightly integrate their demand side participants to their own business.

Information regarding the type of operator is generally found in the “company information” and “About us” windows in the organizational’ s information.

ii. Bias

Exchanges can choose to be either neutral to participants on both sides of the exchange by treating all types of participants the same (e.g. unrestricted exchanges), or be biased in interactions towards one side, e.g. to their owners (e.g. private) (Kaplan and Sawhney, 2000; Marasco, 2004).

In case of a neutral position, exchanges are assumed to guarantee that neither side on the exchange predominates e.g. in the matching of supply and demand process. In case of a biased position, potential participants (e.g. traditional firms) might hesitate in joining such an exchange, due to e.g. a lack of trust regarding protection of competition sensitive data which the supply side could use to demand lower prices outside the exchange (Föhring and Zelewski, 2013).

Bias in selection of participants and in matching algorithms can get introduced intentionally (e.g. based on a payment based ranking) or unintendedly (e.g. due to hidden biases in available data, user preferences etc.). Such a bias can be detected by data evaluation, and removed by introducing non-discrimination rules (through self-regulation or transparency requiring measures from a competition authority) (Sliva & Kenny, 2019; Feasey & Krämer, 2019). Marasco (2004) posits that in network industries such a bias can be partly detected through understanding the ownership structure of platforms and the nature and position of participants. Tirole (2017) also suggests to differentiate between an actual bias and criticism based on perceived biases e.g. when only the demand side of the exchange pays for a finalized transaction. Martens (2016) argues that a bias in matching has its limitation due to the
potential loss that may occur if the participants for that reason switch to competitor exchanges.

iii. **Market focus**

Exchanges are created to cater certain markets, but the boundaries of markets are not easy to define (Rochet & Tirole, 2003). Exchange markets can therefore have different sets of features.

The first set of features is related to the type of participants on both sides. E.g. B2B markets (business to business interaction) the focus is on economic contacts between firms (Dai & Kauffmann, 2002). In B2C (business to consumer interaction) many traditional firms adopt an exchange to sell their products and services directly to individuals. Most online exchanges focus on B2B markets with the trend changing towards additionally integrating B2C markets. The C2C markets (consumer to consumer interaction) relates to generally buying and selling of personal assets between individuals e.g. eBay, Uber Rush (Carson, 2017). An example of C2B markets (consumer to business interaction) is Google Adsense where owners of website can allow google to display relevant advertisements on the owner’s websites.

Vertical markets are characterized by the fact that participants on the supplier side offer goods and services to a particular well-defined segment of customers at the demand side; for example, the food industry supplying to retail chains. Horizontal markets in contrast cater to the needs of different participants and industries facing similar challenges; for example, finding carriers for transporting freight from different industries. The products as well as the group of customers in vertical markets are more specific as compared to horizontal markets which have a larger group (and therefore number) of customers and a larger variety of products and required services.

Marasco (2004) further mentions another set of features of the market focus, notably the difference between one mode versus multimodality. This refers to whether the service offered is based on one single mode or on linkages between different modes.

Nandiraju and Regan (2008) note a fourth set of features concerning the issue whether the focus is on a long-term market (requiring suppliers to holding assets beyond one year) or on spot markets. Spot markets e.g. in power exchanges, relate to services delivered on the intraday (same day) or the day ahead (next day) (Boisseleau, 2004, p.9). Morey (2001, p.15) differentiates between bilateral markets (generally long-term markets and less organized) and centralized markets. In bilateral markets one supply side participant pairs up with one demand side participant to finalize an agreement under the terms defined by the exchange. In a centralized or mediated market, the exchange organizes the matching between supply and demand. Morey (2001, p.15) argues that the most efficient markets are those that make use of both the bilateral and centralized forms.

A final set of features concerns the geographical boundary: regional, national, international. Especially in infrastructure intensive industries like rail and energy, this is relevant, because it might have consequences for the availability and compatibility of infrastructural facilities at both sides of the geographical borders, notably important in case of international markets. Related to this are issues of institutional differences at the two sides of a regional/national border (labour law, safety and health requirements, taxes, et cetera; see e.g. Moroz et al., 2014; Marasco, 2004; Boisseleau 2004).

Information on market focus can be found in “About”, “Our offer” etc. on exchange websites.
iv. **Value Proposition**
Exchanges are designed, launched and maintained with a clear aim of enabling interactions between participants on both sides of the exchange. However, Osterwalder and Pingeur, (2010, p.27) stress that the exchange should also add value to this interaction, e.g. by catering to specific existing requirements or even new requirements the participants were not even aware of. The value proposition can relate to economic benefits (e.g. reduction of transaction costs, better access to markets), and/or social benefits (e.g. improving accessibility to certain locations or reduction of road congestion), and/or environmental benefits (e.g. lower level of emissions).

Choudhary (2015) emphasizes that a compelling value proposition is the core of attracting participants on the exchange. The value proposition is so designed that it caters to the need of participants on both sides, and on the basis of which information, goods and/or services are exchanged (Parker, van Alstyne, & Choudary, 2016; Choudary, 2015). Services, in this regard can be either standardized or non-standardized. The value proposition design supports the scalability of the exchange to achieve positive network effects i.e. high volumes of growth in number of supply and demand sides leads to more interactions. Further, it enables the exchange in being adaptable to the changing needs or demands of its’ participants. Exchanges that do not define a compelling value proposition cannot attract sufficient participants to survive. E.g. Marasco (2004) observes this as the reason for the closure of many freight exchanges. Montero and Finger (2017) observe that in transport network industries, finding a value proposition based on intermodal and door-to-door freight transport services is still a challenge.

Value propositions are communicated on all exchange websites as benefits in the form of a key slogan and details can be found under a firms’ information site with headings such as “why us” which usually communicates the benefits they offer to all participants and stakeholders. Some exchanges also present key figures on their added value generated in the past, along with customer references and testimonials.

v. **Key processes**
Based on *PET* there are five key processes an exchange must organize so that the business model can become successful. These processes build the core set of actions that must be completed in order to realize the intended value of the exchange for the market. Parker et al. (2016) define these as

i. ‘organizing liquidity’ i.e. bringing firms from both sides together on online exchanges,

ii. ‘organizing matching quality’ i.e. implementing a basic matching mechanism for the two sides of exchange to reliably find each other,

iii. ‘building trust’ i.e. creating, maintaining and improving trust e.g. through guaranteeing easy and hassle-free transactions while dealing in a transparent way (Grieger, 2003; Marasco, 2004; Boisseleau 2004, Täuscher & Laudien, 2018),

iv. ‘ensuring balance’ as a higher matching mechanism between supply and demand to serve consumption on both sides of exchange, and finally,

v. ‘stimulating innovation’ as a process of optimizing current activities and spilling the network effects to adjacent markets for the benefits of all the participants (Tiwana, 2013).

They argue that the first three key processes constitute the core set of processes for an exchange to be able to function (‘need to have’). The other two refer to additional processes
for finetuning of matching, quality improvement in services, growth in innovation and performance, etc. ('nice to have').

The most important feature and differentiating factor between exchanges is the type of mechanism implemented for "matching supply and demand" (Marasco 2004; Evans et al. 2011, p.50). The mechanism relates to the process of interaction on the exchange. Collecting and applying relevant data for example improves the quality of matching demand and supply side. Further, matching can be automated. Features of matching mechanisms relate to either request for quote (RFQ), auctions (English or seller driven, reverse or buyer driven auctions) or exchange mechanisms (used for price determination). In the research literature, each of these options is associated to a notion of maturity, depending on the extent of mathematical and domain complexity, extent of standardization and automation of the algorithm being used (Nandiraju and Regan, 2008). E.g. Martens (2016) formulates different challenges in creating a perfect matching algorithm; two important issues he mentions is that products offered on exchanges may not always be homogenous and that participant preferences may vary considerably.

The matching mechanisms are described as follows (see e.g. Grieger 2003; Nandiraju & Regan, 2008; Marasco, 2004):

a) RFQ relates to participants on demand/supply side, who advertise their specific demand / services either on a blackboard or a passive bulletin board of the exchange. By doing so, they show interest in being contacted by the other party. Moreover, they do this with a request for information on price, condition of services etc. Exchanges act as clearing house by consolidating the details and bringing the participants in contact. This is generally associated with a basic way of operation.

b) quasi automated auctions, e.g. reverse auctions, enable the demand side to advertise requests for services by specifying details of the required transaction e.g. commodity, origin, destination, expiry terms etc. Interested suppliers bid for a request and generally the lowest bid wins (e.g. Dutch auctions). Hence, this implies a service bias towards the demand side. In English auctions, the supply side posts service offers (usually with a starting price) with quality details for which the demand sides bid and the highest bidder acquires the service. Consequently, the service is biased towards the supply side. This mechanism has a higher maturity than RFQs as it is partially automated, and using e.g. filters that better support organising the matching-quality (Nota & Aiello, 2017).

c) exchanges similar to stock exchange models enable fully automated auctions. E.g. the supply and the demand side simultaneously negotiate prices through a real-time ‘bid and ask’ system with a highly standardized process data and documentation. This mechanism is considered as more advanced. The applicability of such an exchange mechanism is hindered when the determination of prices becomes complex, e.g. for fragmented markets with low price transparency (Pelkmans & Luchetta, 2013; Endemann, 2016). This is presently the case for e.g. cross border rail freight services.

ICT complexities, requirements to the quality and management of data and level of automation of exchange processes usually increases when aiming at more advanced matching mechanisms. For example, a manual negotiation over the telephone or by fax shows a low level of complexity and an easy treatment of data. Matching-quality increases in quasi automated interactions between human beings and software component. In contrast, automated online negotiation related to highly automated algorithms for determining prices,

An integral part of the matching mechanism on online exchanges is the price discovery. The basis of this discovery is a pricing model in which (a) the exchange, (b) the supply side or (c) the demand side set the price by using some form of pricing method e.g. fixed pricing, market pricing or differentiated pricing (i.e. price discrimination) (Täuscher & Laudien, 2018). Both the algorithm for matching mechanism (especially balancing) and the price discovery are the heart of any exchange and therefore details are (generally) not visible from outside.

Processes can be generally found on websites explaining how to use the exchange step by step e.g. under “Get started”, “how it works” etc.

vi. Channels

This attribute relates to how exchanges reach out to their (existing and potential) participants for delivering the value they promise. Osterwalder and Pigneur (2010, p.30) divide these channels in five phases, expressing different strategies. The first phase relates to gaining attention of participants. Features in this phase relate to E-Mail, apps, chat bots, forums, webinars, roadshows, meetings, workshops etc. The second phase concerns evaluating how the value proposition of the exchange helps the participants e.g. through free usage for a certain period (Moroz et al., 2014), feedback forms, benefit calculators, connecting personally etc. In the third phase, exchanges focus on channels enabling the participants in buying the services of the exchange e.g. by communicating different incentives. Fourthly, exchanges use channels to deliver the value they propose e.g. by proactively informing and facilitating participants to search for relevant offers based on a participants’ choice for a possible match between supply and demand. Lastly, exchanges focus on how to continue supporting participants while offering the service e.g. by enabling giving feedback based on surveys or on organizing personal meetings (Choudary, 2015).

Parker et al. (2016) observe that unlike traditional firms which use push systems to contact the participants, online exchanges use pull mechanisms like feedback options to collect data and learn more about the preferences of the participants in order to provide better services in future (Belleámme & Peitz, 2016). Further, feedbacks are also used for rating of supply or demand side to support weeding out non-performing participants.

vii. Revenue Structure

Online exchanges generally generate revenues for their services through different sources. Parker et al. (2016) argue that monetization for an exchange relates to their way of capturing benefits. The profit maximization is based on either fixed (access) or variable (usage) pricing and is dependent on various factors e.g. balancing consumption, nature of externalities etc. (Evans et al., p.11; Osterwalder and Pingeur, 2010, p.36 Pricing is fixed when it does not change for an individual sale, e.g.

a) registration fees (generally monthly, half yearly or yearly) used for accessing the exchange;
b) advertising of services on the exchange
c) flat subscription fees, associated to the offered products and services
d) licenses and software sales depending on the ICT infrastructure being used by the exchange,
e) training and certification for using the exchange (Dai and Kauffman, 2002; Stockdale and Standing, 2004; Marasco 2004, Moroz et al., 2014; Jain and Bruckmann, 2017).

Variable pricing is based on usage of products and services. Transaction fees e.g. are related to charges per transaction, based on e.g. value of the transaction. Once exchanges gather a
critical mass they can shift to volume based subscription fees for products and services. They further strive to retain the participants for primary business by offering value added services at little or no additional cost (Marasco, 2004). These services relate to indirect products and/or services in specific horizontal or vertical markets, supporting basic market functions of the participants (O’Reilly & Finnegan, 2005) (like debt collection or insurances against frauds), or provide for industry specific solutions (e.g. routing solutions or track and trace services) (Marasco 2004, Nandiraju & Regan, 2008).

Such services are often found under the section “products” “services”, “advantages” etc. on websites of exchanges.

viii. Partnerships
Osterwalder and Pingeur (2010, p.42) posit three motivations why exchanges enter into partnerships. Firstly, for gaining economic advantages and more reliable services, e.g. by buying resources and services from suppliers (who are not competitors) instead of owning or developing them. So, this motive refers to the existence of strategic alliances between suppliers and non-competitors. Secondly, for mitigating unforeseen risks by partnering with other exchanges facing similar challenges (i.e. coopetition). Thirdly, for developing or acquiring new businesses and solutions (i.e. joint ventures with other exchanges).

Meurs et al. (2020) argue that strategic partnerships are based on the need for e.g. sharing of knowledge and risks, getting access to common markets, and maintaining a long-term cooperative relationship. These partnerships enable value-added services to be offered through a network of collaborating firms.

Features of the attribute partnerships relate to vendors for ICT and industry specific value-added service providers (e.g. telematics partnerships in different countries for track and trace in transport), clearing houses for clearing and settlement of transactions, agencies for insurances services and banks for financial services. A key feature of partnership also relates to whether the functions are completely outsourced to the partner or are performed solely for the exchange (e.g. through a proprietary software). Such features support understanding the strategic choices of exchanges better.

ix. Key resources
For operationalizing the exchange system, Osterwalder and Pigneur (2010, p.39) discuss the need for intellectual resources (e.g. patents, copyrights for algorithms etc.), human resources (e.g. personnel with specialized knowledge) and financial resources e.g. for lending money to smaller firms enabling them to adopt the platform (Stockdale & Standing, 2004). Further, technical resources related to specialized software, hardware and data interfaces (between exchange, its participants and partners) are required (Blaschke et al., 2018). The data captured (e.g. with regard to transactions) is also as a key resource which can be used to draw new insights.

Information on key resources can be found on websites under windows regarding technical requirements, our team, your advantages etc.

viii. Cost structure
Osterwalder and Pingeur (2010, p.45) describe the cost structure related to the expenses incurred in operationalizing the business model e.g. organizing the key processes, offering value added services, acquiring partnerships etc. They categorize the cost structure as i. cost-oriented, as far as focused on keeping the costs of product and service provision low and
ii. value-oriented, as far as focused on creating higher value of products and services.

The features of the cost structure in either case above can relate to fixed and variable costs. Herzog (2018) argue that the proportion of fixed costs on exchanges (e.g. online data storage) may be high in comparison to variable costs (e.g. cost of quality) where the marginal costs are very low, therefore the average cost of operation declines towards zero as the liquidity crosses a certain threshold. Ruggieri et al. (2018) also agree to this and posit that costs of managing online activities is sizeably higher than other costs. E.g. costs related to “organizing liquidity”, which is basically the cost of participant acquisition: the more participants, the higher the liquidity. Therefore, an exchange firm bringing in an existing network of participants could incur lower costs.

The various cost structure elements from literature (Belleflame & Peitz, 2016; Brousseau & Penard, 2007; Martens, 2016) relate to:

i. participant acquisition e.g. one-time rebate, promotion campaign etc.,
ii. research and development or enhancement of algorithm, software features,
iii. expansion in new geographic locations or adjacent markets,
iv. infrastructure cost and cost of customer coordination (e.g. support),
v. insurance and legal framework compliance, cost of regulatory compliance,
vi. customer relationship and lobbying.

ix. **Customer relationships**

The term ‘Customer’ in the context of exchanges relates to the participants on the supply and demand side who order or use the services offered by the exchange. Firms use different features for attracting and maintaining relations with them. Osterwalder and Pigneur (2010, p.32) emphasize that the choice of such relationships has a significant impact on the customer experience. Features of this attribute relate to interaction via human support (e.g. at point of sale, E-Mails, use of telecommunication facilities etc.). Long term relationships are usually maintained through individual personal support with key customers e.g. which offer large business prospects. Exchanges may also offer ready information (e.g. catalogues, frequently asked questions and the like), with easy access (i.e. self-service) for customers or participants of the exchange. More personalized digital services can be offered through automation of processes and using customer profiles e.g. for making recommendations.

Other forms of relationships include communities that encourage e.g. their potential participants to learn from experiences of existing participants (e.g. on supply and demand side participants) by offering possibilities of giving feedback. This way, exchanges succeed in creating trust in the market and learning to understand their customers better. Choudary (2015), posits that scaling up communities (i.e. increasing the participation) is essential for the exchange’s business. This can be orchestrated through influencing the behaviour e.g. by giving incentives for loyalty to participants for continuously creating content for the community (i.e. reward for good behaviour), enabling participants to produce such content by provision of the right infrastructure and protocols, etc.

Last but not the least, actively involving stakeholders/key participants to review products and services or participate in the creation of innovative products and services may be the ultimate form of customer relationships where customers/participants cooperate in adding value to the value proposition of the exchange.

Information on customer relationship can be found at multiple locations on websites e.g. “Customers”, “Contact us”, “Company reports” etc.
Behaviour
As mentioned earlier, behaviour refers to the level of responsiveness to drivers of change by making changes to the business model features. The relevance is that certain behaviour contributes to improving an exchange’s implementation of key practices and performance to its participants. Parker et al. (2016), observe that exchanges continually re-evaluate, design and adjust their business models in such practices to achieve the goals attached to their key processes e.g. by extending their product definition to support requirements on multimodality and providing a consistent high quality of service as a means to achieving goals for the key process “stimulating innovation”. The authors conceptualize such adjustments of the exchange’s business model as a process of growth in maturity. In this respect they explicitly make a link to maturity growth theory, which is a main argument to explore this theory in order to understand how such changes can be conceptualized and operationalized. This will be done in the next section.

Before doing so, it is important to underline that behaviour is closely related to (the measurement of) performance, since behaviour and performance are two sides of the same coin.

Performance
As discussed earlier, the performance of the exchange results from the variety and nature of the exchange’s practices. The success of exchanges lies in how well they succeed in satisfying the participants on both sides, measured in terms of the value of the service proposition as perceived by the participants. Exchanges use key performance indicators (KPI) based on PET to measure and enhance their performance.

The practice, the choice for KPI’s and their operationalization takes place through a goal setting process of the exchange firm and its key stakeholders. Target values set for the KPI’s are based on the exchange’s current situation, its ultimate goal and the resources (e.g. funding) available. As there is no one single business model, this target setting can be different for each exchange.

In the real-world set-up and operations of online exchanges, exchanges continuously evaluate their position in their life cycle and their evolution in the market. Learning from other exchanges about their behaviour and success (and failure) factors is continuously required. Nevertheless, despite mechanisms in place to evaluate and adapt and despite the support from policies and regulatory framework, several online exchanges in practice fail to take off i.e. they do not mature. This is e.g. observed for the rail freight industry in the EU (Klippert et al., 2013; Endemann, 2016; Jain & Bruckmann, 2017).

Therefore, the mapping of capabilities of online exchanges in more mature network industries is necessary but not sufficient for developing a concept for freight transport exchanges (FTE) that is potentially more successful than the ones within this industry. It is also important to draw lessons from the mature network industries with regard to the process of change they make or have made to reach that status. In order to be able to understand these change processes, a further exploration of concepts related to theory on maturity growth is needed, informing us e.g. on which milestones can be reached within a certain time frame, which resources have to be activated for making steps forward, which institutions have be created and how to bring different actors together. This helps to understand the basic challenges of transition from current maturity level to a higher one in a multi-actor network and how to identify and address the conditions, benefits and risks they perceive in defining a transition
path. This exploration of maturity growth theory is presented in the following section, providing an answer to subquestion 3.

4 MATURITY GROWTH THEORY

In this section, the research first gives a broad idea of maturity growth theory, focusing on how organizations can move from one maturity level to the next. Then the concepts that are operationally relevant for this research are presented, basically as alternative combinations of different instruments and methods.

Growing in maturity implies long term gradual changes that affect different domains. This makes the process of change complex. Empirical domains (in this case network industries) are established configurations including actors in an ecosystem, economic-geographical area, etc. Some parts of these configurations tend to resist changes, basically to protect establishing economic and market interests. Resistance is activated once the shared institutions, markets, user preferences, etc. that are typical for the existing system, get questioned regarding legitimacy, societal support and validity (Rotmans, Kemp & van Asselt, 2001; Auvinen & Tuominen, 2014). The present way of working is no longer taken for granted for several reasons, such as external triggers (e.g. new environmental directives), imbalances in societal impacts, or lack of innovative power. The triggers for change (sometimes also labelled as transition) in the transport and logistics system today are often sustainability issues e.g. climate change, modal shift, and new technological and/or institutional innovations (see e.g. Geels, 2011; Smith, Stirling & Berkhout, 2005). Generally, an organized and deliberately initiated process of change is expected to have ecological, economical, as well as societal benefits.

Maturity growth theory emphasizes the importance of carefully analysing the present situation, using explorative and process oriented analytical approaches. Based on gained insights an understanding is developed whether the process and pace of change can be influenced in the desired direction through a series of no regret interventions at different levels and using different instruments. This approach helps organizations to learn and gain maturity in integrating small innovations in their practices, before using the innovation to its full potential at a later stage (Van den Bosch, 2010).

Maturity growth theory can be used for explaining the permeation of technologies into networks of interrelated firms, and for exploring ways to achieve a more sustainable pattern of production and consumption in such settings (Beresford & Pettit, 2017). E.g. Coenen et al. (2019) describe a framework for making a transition toward more mature closed-loop supply chain management under deep uncertainty and dynamic complexity through a series of interventions. The deep uncertainties relate to unknowable and unpredictable situations in the future, therefore cannot be sufficiently reduced by collecting information, and are therefore often ill-treated in processes of change (Marchau et al. 2019). Climate change, cyber-attacks, pandemic, trade wars or new technological disruptions etc. are some of such uncertain situations. Moreover, actors appear to be uncertain due to emerging conflicts regarding certain observations, experiences and deep-rooted beliefs. Examples of deep-rooted beliefs include the fear that, automation and online exchanges can lead to job loss or loss of business due to sharing of business-critical data.

Maturity growth theory can be supportive in understanding how actors from different domains can be supported in moving from one stage to the next in the transition, in developing the capabilities to cope with uncertainties in making trade-offs, and to anticipate sharing benefits and possible risks during the transformation process (Geerlings, Shiftn, &
Stead, 2012). The better stakeholders are able to identify, understand and cope with uncertainties due to significant changes in the system they are part of, the more mature they can act and the more mature their business models will be (Coenen et al., 2019). Therefore, a path to the next maturity level requires addressing differences in actor positions, their perceptions of themselves and the other actors in their ecosystem, the differences in interests and beliefs, and the heuristics for individual and joined decision making.

Therefore, in relation to this research, the maturity growth frameworks that facilitate the stakeholders are explored for:

i. understanding how different actors (rail and road freight firms on demand and supply side, online exchanges, or other service providers) in the EU freight transport industry perceive the market so that shared acceptable goals can be set;

ii. learning from other mature network industries for identifying a transition path agreeable to the actors and that is feasible in its implementation.

iii. learning from more mature industries for defining and implementing mature responses (e.g. understanding business models, processes, practices in the use of online exchanges) at every step in the transition.

Maturity growth perspectives
The idea of maturity models comes originally from the domain of software development and has been successfully applied in evaluating capabilities across disciplines and industries (Proença & Borbinha, 2016). Capabilities of firms, as defined in industrial organization theory, can be related to their strategic, operational, technical and learning processes for making timely adjustments to (external) drivers of change in their market (e.g. new regulations) or for creating a market change themselves (e.g. by introducing technological innovation) (Eisenhardt & Martin, 2000). These reflect the ability of firms to develop the capabilities and behaviour required for obtaining the next higher level of maturity. Hence such capabilities are a firm’s essential assets for enabling the firm’s transformation process (Olsson et al., 2010). Such a transition requires integrating, building, and reconfiguring capabilities as well as resources (Teece et al., 1997). Further requirements relate to organizing shared information (language, laws, measures, methods, data) with other actors and implementing technology (ICT) for offering competitive services to customers (Becker et al., 2009).

Maturity models can be considered as conceptual models that support the structuring of the anticipative, logical evolution or a process of change, based on the acquiring of certain capabilities related to a higher maturity level that is considered essential for a long term sustainable business. To this end, Becker et al. (2009) conclude that the process of change is basically a sequence of planned activities aimed at reaching higher maturity levels.

Maturity models can be classified in terms of process-focused, object- or technology-focused, and people-focused concepts of maturity (Mettler, 2010; Blondiau, Mettler & Winter, 2016). Each of these concepts relate to the extent that a process, a product (or a machine), or individual person has the ability to perform practices at a desired level. This research, in the context of organizing multimodal freight transport services through especially the process of matching supply with demand for online exchanges, notably focusses on process maturity models. Regarding why firms adopt the idea of maturity growth, Blondiau et al. (2016) postulate two major reasons. Firstly, to identify the gaps between actual and desired states in their key process areas and secondly, to ascertain an evolutionary path to achieve the improvement to cover the gaps.
According to Mettler (2011) few publications are available on how to theoretically develop maturity assessment models. Therefore he organizes related literature into common steps followed in the design of maturity models i.e. identify need, define scope, design model, evaluate design, and reflect evolution phase. Thus, researches follow a top-down design approach, where the definition of maturity levels precedes the assessment (de Bruin et al., 2005).

The definition of a maturity model can be best explained by Rose (2013) who suggests three building blocks for defining such models, namely:

i. determining the purpose of the model including the key process areas to be focussed on,
ii. determining the maturity levels and
iii. developing the expectations for practices of each key process area at every maturity level for a later assessment.

In the first step, regarding the purpose of the model, Mettler (2011), suggests to start by questioning whether the scope under investigation is an emerging one (e.g. a new innovation comes up and therefore there is a need for the firm to make a step forward in maturity to cope with this development), or is there an already known problem that has not been dealt with so far properly. For a known problem, possibly an already developed and implemented model can be applied with appropriate firm specific customization. Such decisions relate to a firms’ development and therefore, integrating and involving both the firms’ management and target audience (e.g. stakeholders, policy makers etc.) from start is fundamental to defining maturity models (de Bruin et al., 2005). Attention must also be paid to ensure that terminologies are commonly understood by all stakeholders, more so when mapping is related to more than one network industry.

Then in the second step, the decision on the number of the maturity levels has to be specified, depending on various factors e.g. how detailed the firm requires the levels to be, or the amount of resources the firm perceives to be necessary to allocate to reach the desired state. King and Kraemer (1984) therefore make the important observation regarding decisions on targeted maturity levels, that firms should focus on incremental improvements in a certain direction. E.g. Blondiau et al. (2016) propose a pragmatic approach starting by fixing a number of maturity levels first and then evaluating it during the evolutionary process of implementing measures to reach these levels.

Finally, in the third step, practices are defined for each maturity level expressing the expectations that must be met by the firm when claiming to have achieved the related capability. In other words: the maturity levels are operationalized in measurable indicators related to various practices. Expected practices relate to prevalent activities of firms, which lead to desired results and thus can be considered as a yardstick for assessing a firm’s stable level of maturity (Kitson & Masters, 1992).

The assessment of maturity at any level (analysing scores on a variety of KPIs related to distinguished practices) helps the stakeholders to clearly identify the organizations’ strengths and weaknesses. This helps to learn about the needs for improvement in the business’ processes, and accordingly specify and prioritize measures for reaching the desired maturity level (Proença & Borbinha, 2016).

Next some maturity models that have been proposed for different network industries will be discussed.
Capability Maturity Model (CMM)

The best known and commonly used model is the Capability Maturity Model (CMM). This is a maturity framework which was originally formulated for the software industry by Paulk et al. (1993), and is an established standard by the Software Engineering Institute. Most maturity models are derived from (or variations on) the Capability Maturity Model (CMM) (Paulk et al., 1993; De Bruin et al., 2005; Narciso et al., 2017). Consequently Albiwi, Antony, & Arshad (2014) in their comparison of various maturity models found that the CMM model is also applicable to firms in other industries since its scope covers important aspects such as risk management, project management, managing and developing the workforce etc. Examples of applications outside software industry are papers on supply chain and logistics (Coenen et al., 2019; Alons-Hoen, Somers, van Duin, 2019), in energy (Uslar & Masurkewitz, 2015) and in public transport (Richrath, Plano & Nesbitt, 2016).

The CMM model is a logical structure of five key elements (Paulk et al., 1993) as shown in Figure 4 below (left). These are

i. the five Maturity levels, which are combined state descriptions (Mettler, 2011) for describing a maturity continuum as the process of evolution (Paulk et al. 1993). Level 1 primarily relates to ad hoc activities (not yet developed as regular practices) and Level 5 represents an optimized state of constant monitoring of processes and pro-active responsiveness to operational and system changes,

ii. Key Process Areas (KPA’s), represent clusters of related practices that, being performed together at each maturity level, lead to achieving important series of goals (Mettler, 2011). These KPA’s relate to strategic, operational and technical practices and capabilities.

iii. the Goals clearly define the scope, boundaries and intent of the desired state of processes connected to the KPA’s.

iv. the Common Features basically form the basis for grouping the practices in the KPAs.

v. finally, the Key Practices signify those infrastructures and activities that contribute most effectively to the establishment of the KPA’s goals (Mettler, 2011).

With regard to the maturity levels, Paulk et al. describe five levels of maturity in software processes, which are to be used to deduce the criteria for maturity assessment. These are shown in Figure 4 below (right) and described as follows:

i. at Level 1 (Initial), firms are dominated by ad hoc processes and success depends on individual efforts;

ii. at Level 2 (Repeatable), firms have established project management processes and the process discipline to repeat success from earlier projects in similar projects. Next,

iii. at Level 3 (Defined), firms have integrated and standardized software processes which are well documented. Therefore, all projects use an approved and tailored version of these processes. Then,

iv. at level 4 (Managed), firms collect detailed measures for software processes and product quality. Both, the software process and product in this regard, are quantitatively understood and controlled. Finally,

v. at level 5 (Optimizing), firms enable continuous process improvement through qualitative and quantitative feedback from processes and from piloting innovative ideas and technologies.

The CMM as presented bears a high conceptual nature. When applied in a certain empirical setting (e.g. the freight industry), it evidently needs further specification and interpretation in that context. A variety of literature exists on such domain specific applications and evaluations (e.g. Proença & Borbinha, 2016; Albiwi, Antony, & Arshad 2014) Three other maturity models
for discussion. Amongst these, the CMMI (CMM Integration) maturity model is derived from the CMM. It addresses issues related to project management and processes for developing products and services. The Business Process Management maturity model (BPMM) also builds on the CMM, but more explicitly covers dimensions such as governance, methods and tools, IT, and culture (de Bruin et al., 2005). The Software Process Improvement and Capability Determination (SPICE) model, developed by the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC), is a set of technical standards documents for the computer software development process and related business management functions. ISO SPICE is also basically derived from the CMM (Mettler, 2011).

Figure 4: CMM structure (left), maturity levels (right). Source: Paulk, Curtis, Chrissis, and Weber (2003, pp. 8, 29)

Capability Maturity Model (CMM) and online exchanges
The CMM has not received much attention yet with regard to the development of online exchanges. An exception, as mentioned earlier, is the publication of Parker et al. (2016). The authors discuss a notion of maturity of online exchanges with three levels of maturity.

In relation to the key processes discussed in the previous section, these three levels can be interpreted as follows. At the first maturity level exchanges try to establish the ‘need to have’ key processes (‘organizing liquidity’, ‘organizing matching quality’, ‘building trust’) by bringing firms as participants from both sides together on the exchange (“create level”). At the second maturity level they aim to improve the balance in consumption ‘ensuring balance’ key process) on supply and demand side (“curate level”). Finally, at the third maturity level they try spilling the network effects over to adjacent markets (“cultivate level”) i.e. establish the ‘stimulating innovation’ key process.

These notions are depicted in Table 3, which constitutes a valuable basis for specifying the theoretical framework in section 5 that structures the analysis and design of freight transport exchanges.
Table 3: Relationship practices, key processes and maturity level, Author’s depiction

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<thead>
<tr>
<th>Practices, contributing to:</th>
<th>Key processes</th>
<th>Maturity level create</th>
<th>Maturity level curate</th>
<th>Maturity level cultivate</th>
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<td>Stimulating Innovation</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

X: clearly recognizable as being part of the exchange’s practices and strategy

At the *create level* an exchange implements practices to achieve the first three ‘need to have’ key processes, “organizing liquidity”, “organizing matching-quality” and “building trust”. Practices contributing to “organizing liquidity” aim at attracting firms from both sides on the exchange to achieve a critical mass (e.g. through defining value proposition). Critical mass relates to the minimum number of participants (or level of demand) required on both sides of the exchange to avoid or minimize interaction failure. This issue is also referred to as the chicken and egg dilemma (Rochet & Tirole, 2003; Evans et al. 2011) and refers to the exchange’s strategic decision on market focus and which side to attract first to bring both sides together. Therefore, exchanges that fall short of this minimum will fail and others that surpass this minimum number are viable and positioned to succeed (Evans & Schmale, 2012). Practices thus try to organize participants on one side (usually supply side) by incentivizing new participants for adopting the exchange, e.g. approaching via different channels and by keeping subscription hurdles low. At the same time, they have to implement practices to create sufficient demand, hence have to install and activate basic mechanisms with that effect. The aim therefore is to improve the “matching-quality” i.e. apply certain mechanisms such as: filters to match relevant supply side with the demand side controls to ensure certain data quality for ease and reliability of search. Such interactions increase the trust in exchange. Thus, the exchange implements actions for “building trust” by offering value to participants as promised, to retain them on the exchange.

Once a critical mass has been achieved, at the next level (*curate level*), practices are applied with the aim of taking the matching quality between supply and demand side to a higher level once the ‘need to have’ processes have been implemented. The additional process is therefore aimed at “ensuring balance”, e.g. by automating the matching. Belflamme and Peitz (2016) argue, that the need for governance (launching market rules) arises when exchanges try to grow. The background is that emerging online exchanges can have negative impacts due to e.g. low hurdles for adoption or registration. This can give rise to non-conformant participant behaviour e.g. fraud by not respecting contractual obligations of finalized transactions or non-payment of services. Thus governance practices are required relating, such as e.g. adopting a code of conduct or rules for verification rules for participants’ registrations. Further, a rise in the number of participants can also lead to e.g. congestion in transactions on the exchange, forcing them to adopt mechanisms to avoid this, e.g. by increasing the threshold for adopting the exchange or limiting continuous activity on the exchange. They can do this by e.g. fixing certain subscription prices for products or services. Practices like these are based on learning from preferences and behaviour of participants e.g. through data analytics. They trigger improvements of the effectiveness of the algorithm automated for matching between supply and demand, and thus managing “balance”.

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Lastly, at the cultivate level an exchange that is well established systematically focuses on practices oriented to the additional process of “stimulating innovation” by adapting to the changing competition, regulations and needs of both sides of the exchange (Tiwana, 2013). For example, by investing in customer relationships and understanding their challenges in operations outside the exchange. Through this, they apply innovative practices for spreading the network effects outside the current markets. Thus exchanges reconfigure themselves by adding value propositions attractive to current participants but also participants of an adjacent market or exchange (e.g. warehousing on freight transport exchange, participants of bilateral trading moving to power exchanges, book keeping for tickets in passenger transport exchanges etc.). At this point, an exchange continues achieving all five process goals.

To all the benefits that exchanges offer, there can be practices that may not necessarily be labelled fair. An example is that one side in an interaction is allowed to know more than the other side (asymmetry in power) or that due to their large network size, exchanges start behaving monopolistically by obstructing the entry of other exchanges into the market or enforcing lower prices from suppliers on the exchange than outside the exchange (Rochet, 2017, Parker et al., 2016, Choudary, 2015; Nandiraju & Regan, 2008). To avoid these negative impacts, governance rules by the regulators are required to guarantee a sufficient level of competition in the market. Exchanges, especially at cultivate level implement the practice of communicating their conformance transparently. This is essential to gain trust from the participants in the market.

Parker et al. (2016) also suggest different ways of measuring the performance of exchange key processes. According to them, processes at “create level” can be measured in terms of – i. the number of active participants, offers or total volume for “organizing liquidity, ii. the average number of transactions per participants for “organizing matching-quality, and iii. the level of perceived risk/trust created through ratings (“building trust”). At “curate level” e.g. the number of frauds/complaints reported and the average number/volume of transactions on each side measure the performance of “ensuring balance”. Similarly, resource investment and speed of change can serve as indicators of the key process of “stimulating innovation”.

**Evaluation**

Mettler (2011) observes three key challenges in applying maturity assessment models: i. most of the models are based on merely looking at ‘good practice’ or ‘success factors’ based on projects that may have demonstrated favourable results to firms or an industry, hence to some degree neglecting the failure factors; ii. the assessment can be biased towards the key informants (i.e. people interviewed) and iii. the compliance to assessment through such maturity models may not necessarily guarantee achieving success.

The main criticism towards maturity models is that they tend to offer insufficiently detailed support for coping with these three challenges in practice. Consequently, thus tends to cause a non-reflective adoption of the Capability Maturity Model (CMM) blueprint (Becker et al., 2010; Kamprath & Röglinger, 2011). De Bruin et al. (2005) in this regard suggest decision parameters for building and testing a maturity assessment model that counterbalances the potentially biased reflection by key-informants. Mettler (2011) also argues that understanding different ways of progressing the level of maturity is a crucial task in the development of a maturity assessment model and especially important when testing the model with respect to its validity.
Despite these challenges, the underlying principle of CMM as a maturity model remains the most popular form in use in the industries. In all maturity models the definition of the first maturity level appears not easy. And the models have received criticism for their necessity for consulting external expertise for specifying the particular maturity model. However, consulting expertise from practitioners in the industry might, in contrast, be considered as a strength of these models, since it forces researchers to follow a participative approach and it improves the bases for validation of the resulting model.

The overall conclusion from the afore discussion is that the CMM Model offers a sufficiently attractive frame of thinking to structure the maturity analysis in this research.

5 THEORETICAL FRAMEWORK

Based on the preceding review in the sections 2.2 - 2.4, this section presents a theoretical framework that builds on the business concepts provided by the platform economy theory and adopts the way of process thinking in the maturity growth theory. The theoretical framework takes the shape of a basic CMM for online exchanges in network Industries (interpreted as making a change in business model features) and specifies practices and the exchange’s behaviour at different maturity levels. The model aims to improve our insights on capabilities required in the proposed transition of multimodal FTE to a higher maturity level. This answers subquestion 4 that asks for an integration of the lessons learned from the previous subquestions, into a coherent, operationalized theoretical framework for this research. The framework (called the Online Exchanges Maturity Framework (OEMF)) takes shape in terms of:

- the specification of theoretical levels of maturity, practices, key performance indicators and capability expectations;
- specification of the heuristic for data collection for the maturity assessment of the performance of an exchange;
- a description of the nature and process of transition that should take place to move from a lower to higher maturity levels.

First, to better understand the differences in maturity of exchanges, the research specifies the theoretical maturity levels, inspired by Parker et al (2016) and the CMM framework as discussed in the previous section.

Based on Parker et al (2016) and Choudary (2015) a distinction in three levels: the maturity levels create (maturity level 1), curate (maturity level 2) and cultivate (maturity level 3) is made, whereas the CMM framework adopts a more refined distinction in five levels. For the proposed framework OEMF, this research argues that the three maturity levels create, curate and cultivate, are a good starting point for performing maturity analyses, instead of trying to seek for more detailed maturity level definitions such as suggested by the CMM framework. There are three reasons for this. Firstly, as discussed in literature above, the transparency of information, especially in rail freight, is not given. Secondly, identifying three different levels is already a large challenge because of the diversity of firms, activities, processes, etc. Further differentiation would most probably give false certainty. Thirdly, there is also complexity involved in comparing the diversity of activities and processes of firms in a transparent way with exchanges from different network industries. Therefore, differentiating the maturity levels beyond the given three at a starting point might hinder making progress in the analysis and cause too much fuzziness. This mapping is shown below in Table 4.
Table 4: Relationship maturity level in CMM Theory (Paulk et al., 2003) and Platform Economy Theory (Parker et al., 2016), Author’s depiction

<table>
<thead>
<tr>
<th>CMM Maturity Level</th>
<th>Maturity level create</th>
<th>Maturity level curate</th>
<th>Maturity level cultivate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeatable</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Defined</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Managed</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Optimizing</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

X: relation between the maturity levels

Accepting these three levels of maturity as a structuring principle for classifying exchanges, the earlier described links to the five key processes that are, according to platform economy theory, crucial for understanding the level of business maturity (see Table 3) are adopted.

An exchange operates at a basic level (maturity level ‘create’) when it focuses on the following three key processes:

- effort is put into regarding organizing, measuring and improving the liquidity,
- attention is paid to improving the level of matching-quality organized on the exchange,
- effort is put into building, maintaining and improving the participants’ trust that the transactions on the exchange are finalized and dealt with in a transparent way.

These three key processes reflect the desire of the exchange “to exist”.

To operate as an exchange at a higher maturity level, requires not only focus on these three “need to have” key processes, but also implementing additional key processes. More specifically, an exchange operates at the second distinguished maturity level ("curate"), when it develops and implements a key process aimed at systematically ensuring the balance between the interests of the participants at the supply side and those at the supply side. This key process reflects the desire of the exchange “to consolidate and strengthen position”.

Finally, an exchange that operates at the highest maturity level (“cultivate”) has, in addition to the aforementioned four key processes, also developed and implemented a systematic strategy for stimulating innovation. Innovation is necessary to develop more attractive value propositions than others in the market to all participants. Hence, this reflects the ambition of the exchange “to be a frontrunner” in its business domain.

The focus and performance of these 5 key processes can be measured as follows:

As indicated earlier, liquidity deals with the number of participants that not only subscribe to the exchange’s products and services but are also active in terms of either making demands or offers. So, liquidity in case of physical products, can e.g. be measured in terms of volumes; in other cases (such as services) the number of offers and volume of demand may be more relevant. Further, liquidity at each maturity level may be measured differently e.g. when further classifications of participations, products are clearly defined.

The matching-quality complements liquidity, as it characterizes the performance of the exchange in organizing successful interactions on the exchange between the supply and the demand side. Therefore, not only the number of active participants is important but also the number of transactions (successful interactions) per participant. These indicators offer
insights in the degree of focus towards participants in the market for improving liquidity as well as the possible need for improvement in the matching mechanism between supply and demand.

Next, trust relates to the level of perceived risk of participating on the exchange, indicated by the participants on each side. This refers to the ability as well as the intention of the exchange to offer the promised value to the participant. The ability of the exchange to organize safe interactions can e.g. be measured by the feedback that is given by the demand side to the supply side or vice versa.

Ensuring balance regards two aspects. The first aspect concerns the average consumption from demand side, in terms of e.g. volume: the focus is on realizing an increase for every active participant. The second aspect is that any fraudulent activity that occurs during interactions are captured, monitored, reported, removed and in the future avoided so that it does not take place again and to make the exchange safe. For this, it can define and apply rules (market rules, exchange rules etc) to make sure that the participants are acting in compliance with these. Further, the exchange can offer additional value-added services to ease the challenges that participations might be facing in their business in an endeavour to organize balance.

And finally innovation can be measured in terms of the resources an exchange invests into adapting practices to changing requirements. Besides these, some societal KPI's can be added, given the context of this research. This notably can be related to the extent of reduction of CO2 emissions in a specified period, as an expression of the modal shift that is realized.

Exchanges establish these key processes by initiating, implementing and maintaining a variety of practices that contribute to the realisation of these key processes. Consequently, in order to be able to perform an analysis on and conclude on the maturity of a particular exchange, these practices and actual performance have to be analyzed. In line with maturity growth theory, notably the discussed CMM model of Paulk et al. (1993), the variety of practices can be clustered in three KPAs depending on the specific focus and the process goals they aim to achieve: the market related KPA, the operations related KPA and the technical KPA. This distinction has the following background.

First, the market-related KPA encompasses the strategic practices that require capabilities for making choices regarding the exchange’s development strategy and market focus, the definition of products and the management of current and potential exchange participants. The objective is to align the practices to achieve the value proposition (aimed at benefits for the participants / service users) the exchange promises to offer. Hence, it relates to decisions regarding business model features for the market-related attributes, e.g. product and service design, the matching (between two sides) and pricing strategies, choosing a market focus, building customer relationships, or systematically responding to competition. Such practices are aligned towards basic requirements and intended benefits of the participants on the online exchange (at supply and demand side in the market), which explains the label ‘market related KPA’ in this theoretical framework.

At “create” maturity level the market-related KPA is characterized by ad hoc or basic products and value-added services, not necessarily with a clearly defined market focus. Based on industrial organization theory, this characterizes a low maturity in strategic decision making processes.

At the next higher level, the “curate” maturity level, the market-related KPA, implies that the product and service definitions are expected to show a clearer market focus that results from
learning out of the “create” maturity level. Accordingly, the exchange attempts to offer formalized value-added services, that can be monitored based on the interaction data. Thus, standard learning procedures for a better control on curation are implemented.

At the “cultivate” maturity level, the market-related KPA implies that the exchange is expected to have gained the full trust of the ecosystem, due to sufficient liquidity and matching quality it has managed to organize. At this stage innovation should be possible in terms of offering multiple products e.g. by organizing multimodality, thus ranging over different markets. Therefore, capability expectations relate to stimulating initiation of innovative ideas and pilot projects for defining and / or aligning it’s products and services towards improving efficiency of existing participants in the market. Further for spilling the network effects also to adjacent markets. Efficiency, in this context, need not only be understood in terms of profit, but also contribute to societal and environmental goals i.e. seeking not only a contribution to profit, which is critical for existence of the exchange, but trying to find ways to also contribute to people (social) and planet (ecological) interests.

Secondly, the operational KPA encompasses practices that require capabilities regarding standardization of certain processes and policies and continuously optimizing these for running the exchange efficiently. Practices focus on implementing and coordinating organizational activities to achieve an optimal operational efficiency. Operational efficiency is measurable in terms of output gained for the input expended. Further, these practices focus at a consistent communication to the participants within the ecosystem of the exchange. Such practices include process standardization, monitoring, controlling, automation and continuous service improvement (optimization) of operations. Notably, data analytics is an important underlying practice for monitoring and service improvement. Moreover, industrial organization theory stresses the relevance of practices such as regular information sharing with partners and participants. In order to gain maturity in such practices, systematically repeating and evaluating them enables the process of learning and preparing to move to the next higher level. Thus, practices requiring capabilities related to operationalizing tactical, operational and learning activities are a part of the operational KPA.

For the operational KPA the create maturity level expresses that operational processes and policies are ad hoc and individual efforts are made for practices bringing participants on one or both sides to the exchange.

The curate maturity level for the operational KPA expresses the following situation. To enable the participants to use the products and services effectively, an exchange is expected to possess capabilities for operationally standardizing the matching processes and related policies for repeating transactions successfully i.e. to balance consumption on both sides. Therefore, for successful curation, the processes are expected to be monitored and controlled i.e. standardization of analytics for the processes should be possible.

With regard to the operational KPA, the exchange at cultivate level is expected not only to ensure automation of matching for all products and services for price discovery, monitor and control, but also to optimize the processes e.g. by understanding the requirements on multimodality better. This is a bigger challenge, since these processes now have a higher complexity due to the different markets and products that are being catered to. Capabilities related to setting goals and following these are expected. Therefore, the active use of automated analytics should be enabled, where the systems of participants and partners are scrutinized for efficiency and data security.
Finally, the technical KPA in the context of online exchanges relate to ICT-technical operations, including supportive practices that require capabilities regarding data availability, data security and data integrity as well as choices regarding the nature of the technical interface of the exchange with relevant systems of participants and partners.

The classification of practices related to technology follow the reasoning, that practices on making a choice for the technology relate to the market related KPA, that the implementation of decisions pertain to the operational KPA and that the support organization is related to the technical KPA. This interplay with different KPAs is due to the fact that exchanges as firms are based on digital solutions and services.

With regard to the technical KPA, the curate maturity level indicates a situation that the ICT solutions are relatively basic, possibly in a prototype stage, allowing free manual entry of data without consistency checks to capture the maximum possible information for understanding requirements. Such systems are therefore not technically interfaced or integrated with any external systems of partners or customers.

The curate maturity level for the technical KPA implies, that the exchange enables maintaining data integrity and showing accuracy for monitoring the processes, both for safety and improvement of services for the participants. In case an exchange is able to establish the curate maturity level for each of the three KPAs, the exchange is systematically able to organize a good and stable level of matching between the supply and demand.

Finally, a technical KPA at a cultivate level is expected to fully ensure the technical availability of the system and the data to enable innovation, which is obviously more complex than in the curate phase, due to a significantly higher usage of the exchange by the market.

Practices clustered in the KPAs
With this understanding of linkages between the key processes, KPAs and their maturity levels, the practices of each KPA and their KPIs as a basis for data collection and assessment of exchanges in real world are discussed. This step finalizes the OEMF. These are derived from the expected practices of different exchange business models as discussed earlier in this chapter in relation to relevant literature.

First, the practices and KPIs for the market related KPA are discussed. The practices in this KPA relate to the process of making strategic decisions on the exchange that continuously leads to the benefits offered to the customers. These practices are:

(a) the “strategic management” practice, that comes from industrial organization theory. It relates to the processes that an exchange (as firm) implements for achieving benefits (compelling value proposition) promised to the participants on both sides. Firms define and implement their strategy by continuously optimizing their strategic choices on their business model attributes (including pricing, product differentiation or targeted market) for achieving the appropriate value proposition. Further, firms make strategic choices on technological changes by either generating or utilizing them to make business changes and to make knowledge (data and information) flow between firms. Capability expectations relate to the (economic, societal and environmental) goals aligned to the benefits offered and compliance to the regulatory requirements. In the maturity growth way of thinking, improving clarity of market focus of different products, optimizing or creating new products for organizing multimodality, and optimizing value added services accordingly, in a stepwise fashion leads to higher maturity. The KPI to measure this practice is the “average improvement of the benefit
for each participant on each side over all products and services since last period in conformance to regulatory requirements”.

(b) the practice “product and service definition”, that comes from industrial organization theory. This practice implies that key decisions are regularly taken and evaluated regarding the definition of products and services for achieving the benefits (value proposition). An example concerns the level of product differentiation for retaining a niche market that is associated with higher costs for customers when switching to competitors. In contrast, products and services that conform to market standards facilitate cooperation and make switching cost for participants from competitors to the exchange low. In either case, the product and services are defined in terms of units that can be exchanged as information, product or service in a unique way. They either answers a current need or create a market need not yet discovered by others. The assumption is that the more well defined and standardized the product attributes are, the higher and the faster the matching can be achieved over multiple modes. In the CMM way of thinking, continuously optimizing the products and services leads to a gradual increase of the benefits for participants and due to that also to market consolidation, and is therefore a sign for a higher maturity of the practice. Thus, a logical way of measuring this practice is the “average reduction in transaction cost per participant over all products and services since the last period”.

(c) the “subscription and product/service pricing” practice, that is based on platform economy theory. The theory argues that participants (on supply and demand side) are offered benefits based on products and services answering their needs, and therefore they would subscribe to the exchange. The key decision on pricing for the products and services accessed via subscription, relate to balancing the level of services for which participants would be ready to pay (e.g. higher quality of service costs the participant more, higher payments by a supplier for greater market access etc.). In practical terms thus, appropriate prices for road and rail participants will be required. Through subscription, the liquidity can be better monitored and controlled and matching between demand and supply side can be faster (reducing the time required to find the preferred matching supply for the demand). Rebates and incentives are applied for achieving balance, i.e. to increase the usage of the subscribed products and services (and thus improve liquidity) or e.g. organize balance when demand or supply is in excess to the other side. In the maturity growth way of thinking a mature exchange first automates these rebates and services, monitors and controls them, and further continually optimizes the pricing so that participants on both sides actively consume the multimodal products and services. The success in performance of the practice can be assessed by the “relative increase and decrease in frequency of rebates and incentives for subscription since the last period”. Basically, a higher frequency indicates that the products and services are not yet attractive for participants, a lower frequency indicates that a balance has been achieved. This also provides an insight in the revenue structure (how is payment for access and usage of products and services organized) that otherwise may be not observable due to confidentiality reasons.

(d) the “market and stakeholder management” practice, that is based on industrial organization theory. This practice is associated with making a strategic choice for certain social interaction mechanisms for building relationships with stakeholders in the market. This is required to reduce the risks the stakeholders perceive and to gain trust. Stakeholders include participants (existing and new), investors, partners (service providers e.g. for financial settlement or ICT services and competitors who act as (pre-competitive) cooperation partners), regulators, knowledge institutes (e.g. academics).
Firstly, the idea is to strategically balance the interests between different stakeholders and to create a win-win situation for all sides. This is especially relevant for multimodal exchanges where different modes are competitors in the market and come together to offer their services on the exchange. In the maturity growth way of thinking, the mechanisms are optimized to understand markets and stakeholders by proactively interacting with them (e.g. to understand the needs of the market and improve products and services accordingly, offering training, support and recommendations on how to use exchange’s products and services etc.). Thus, the performance of the process can be evaluated measuring “the relative average growth in return on investment (in terms of (e.g. monetary) benefits) over each channel since the last period”.

Secondly, decisions on key partnerships (e.g. for clearing and settlement, technical support, or participant’s access on other exchanges), are also influenced by choices regarding products and services, market focus etc. And here, notably the specification of the rules of the game are relevant (e.g. regarding data sharing or quality standards). Therefore, also the number of partners (as stakeholders) for different services is, indicative of the exchange’s strategic market and stakeholder decisions on (i) outsourcing activities to focus on its core business, (ii) covering larger market reach and (iii) managing the partners. The performance of this aspect can therefore be measured by the “average number of partners that the exchange selects for each service”.

(e) the practice “market rules” that originates from platform economy theory. This practice relates to improving matching quality and balancing the average consumption of products and services on both sides of the exchange. Maturity in this regard relates to the ability to define governance rules without a bias to either side. This could be e.g. (i) a bias towards either side of the exchange (e.g. allowing access to products and services, setting prices on exchange, providing supply information of one demand side to another etc.), and/or (ii) a bias towards market rules for participants (e.g. prerequisites for joining the exchange and accessing products.). In the maturity growth way of thinking, meeting regulatory requirements in organizing multimodality expresses a higher maturity. The assumption is that this is possible (and leads to success) when the exchange can operate autonomously (i.e. independent of its ownership structure) and be neutral in deciding the rules that are equally favourable for its participants on both sides. Thus, the performance of this practice can be measured in two ways. First the “relative growth in average number of transactions on each side over all products and services since the last period” and secondly the “average number of frauds and complaints per a fixed number of transactions since last period over all products and services”.

(f) the practice “design of algorithm” that comes from platform economy theory. This practice relates to making decisions on providing a unique matching algorithm of product and services at different levels that sets it apart from others, both in ease and speed of interaction. The prerequisite is that despite different features (e.g. technicalities of the network industries involved, such as rail and road transport), such algorithm is able to match demand and supply over different modes using the product definition as basis. In the maturity growth way of thinking continuous optimization in the design of this algorithm, in order to meet (the changing) market needs of both sides and to organize a price discovery mechanism, especially in multimodality, leads to a higher maturity. The assumption is that the best price discovery mechanism takes place when trust has been gained in the exchange. Therefore anonymity of participants in matching leads to a discovery, that is (i) beneficial for both sides and (ii) for the ecosystem (better benefits for all, e.g. in achieving environmental goals). Offering transparency by regularly communicating the price index improves the trust participants have
in the exchange and facilitates competition in the market. The performance of this practice can be measured in terms of “the average time for an exchange to communicate price (index) figures related to the finalized transactions for all its products and services”.

(g) the “integrating adjacent markets” practice, that comes from platform economy theory. Exchanges expand their market by moving their network boundaries by adapting the products and services of participants outside the exchange i.e. from adjacent markets, as an answer to solve the needs of the participants on the exchange. In the maturity growth way of thinking mature exchanges continuously monitor and make strategic choices regarding integrating adjacent markets by optimizing their portfolio of products and services e.g. for organizing multimodality. In this fashion they strive to maximize the benefit to all their customers. The performance of this practice can be measured in terms of “the relative growth in total number of participants (or volume or market share) for new products and services since last period”. Further, efforts in innovation of products and services can be set in relation to the growth in number of participants on the exchange. Therefore the measure “total investment in new projects to bring participants on the exchange” can be helpful in the evaluation of the performance.

(h) the “organization development” practice, that comes from industrial organization theory. It relates to the process of making strategic decisions regarding the development of its main resources (intellectual, technical and human). These are required to offer an attractive value proposition through innovative product design and operational excellence in services. This requires the following activities. First, interpreting market signals (new entrants, collusions, technological innovations etc.) that also include changes in regulation. Next, based on this, making strategic choices on skills and technology required (developing, buying, outsourcing, training etc.). Since technological innovations constitutes a major driver of markets, making key decisions on the choice of the technology for the exchange also implies choices regarding i. how to capture new data, and ii. the amount of effort to generate new insights from existing data in order to create innovative products and services (e.g. for adjacent markets). In addition decisions have to be taken on the organization structure in order to be able to respond to market changes internally (e.g. start cross functional teams to support participants, implement an agile way of working) and externally (e.g. outsourcing support tasks that do not involve the risk of losing confidential information or a core competence to the outside world). In the maturity growth way of thinking, the organization development supports the right allocation of funds to prepare and implement strategic decisions and is therefore key to innovation in order to stay ahead in a context of severe market competition. Capabilities in decision making are related to balancing the available funds by setting the right priorities, and to organizing new funding (e.g. through investors, or participation in research programs). One way of measuring the performance of this practice is the “total budget for new technology, product and service design initiatives, trainings, and resource acquisition since the last period”.

Next the practices and KPI’s for the operational KPA are discussed. As described, the focus in this KPA is on practices on operationalizing the key operational processes of the exchange (from participants joining the exchange to finalization of transaction) in such a way that process efficiency contributes to the overall performance. Controlling and optimization takes place based on the standards and policies on operational quality defined, as well as the goals set for process efficiency. Based on industrial organizational theory, this applies to coordinating activities for operations in firms. The practices are:
(a) the “communication” practice, that basically comes from industrial organization theory and in a more advanced interpretation from platform economy theory. It implies using different channels as operationalization of the strategic choices regarding interacting with the stakeholders (especially participants) of the exchange. Communication is needed for gaining the trust of the stakeholders. It relates to the process and policies for clearly communicating the promised value proposition and service quality delivered to its participants in a standardized, transparent, regular and highly satisfactory way. Importantly, the communication takes into account the participant’s preferences or profile (e.g. language, geographical specifications etc.). In this way, the practice aims at gaining trust in the exchange and improve customer satisfaction. By introducing a system of FAQ’s, answering questions in participant’s preferred language, online personal assistant, key account manager to solve issues etc., the exchange not only communicates, but also allows for feedbacks and individual questions. In the maturity growth way of thinking, this implies that the communication is continuously optimized and made seamlessly available through automation and a personal interface. Moreover, it enables to use of data analytics to learn from interactions and improve services. One way of measuring the performance of the practice is the “number of channels used for communication over all services for all languages”. Another measure for the process performance can be “share of individualized contacts (i.e. feedbacks) for each channel over all participants since the last period”.

(b) the “registration” practice, that comes from platform economy theory. It serves as the entry point to the exchange, aimed at making the exchange a safe place to interact. The registration can be seen as a two-step process. The first step is initiated by a new participant who enrols (or is consulted to enrol) to an exchange. On the basis of this initial information, the exchange initiates the second step i.e. request for valid documents and information that an exchange requires to formalize the registration. Therefore, registration rules serve to improve matching quality and balance on the exchange. The requirement is that clearly defined standards and policies (e.g. quality assurance verification procedures) are in place that are regularly communicated to the market. In the maturity growth way of thinking, a standardized, continuously optimized process structurally improves the safety of participants on the exchange. The performance of the practice can be measured in terms of “relative improvement in average time required to certify a participant for registration on the exchange since the last period”.

(c) the “operationalizing auctions” practice, that comes from platform economy theory. It is the operationalization of the algorithm designed for matching the demand with supply as expressed by those who have received entrance to the exchange. The assumption is that, clearly defined standards (e.g. on logic of matching, scheduling matching, communicating results etc.) and automation of matching steps (i.e. no manual intervention) facilitates faster matching of demand with supplies. Operational efficiency in this process implies continuous optimization of the process at every step (e.g. through standardization of contracts) to achieve the best possible matching results for the participants. The assumption is that transparency related to process execution and non-discrimination (e.g. no manual intervention in price discovery) increases trust and stimulates more participants to join the exchange. Similar to registration, the performance of the practice can be evaluated by “average time required for an automated transaction (Start to finish)” and “relative growth in number (or gross value) of the finalized interactions since last period”.

(d) the “clearing and settlements” practice, that comes from platform economy theory. These theories state that on finalization of an interaction, the promised service must be provided
and payment to the supplier(s) and exchange must take place in a timely fashion. There exists a risk of not fulfilling the finalized contract, either due to not paying for service or not delivering the service, from either side exists, which causes harm to the participants and the reputation of the exchange. Evidently, this must be avoided. In the maturity growth way of thinking, standardization and automation improves the maturity of the practice. Higher operational efficiency and maturity is achieved when a central agency (partner) fulfills the clearing and settlements and handles situations when the process is finalized according to the standards. Thus, the efficiency of the agency is continuously monitored by the exchange, e.g. by applying data analytics. The idea is that the faster and the more risk-free processes are completed, the higher the frequency of consumption on the exchange is. This is supported by a standard process of risk mitigation. The practice can be measured by “reduction in average number of delays and failures to pay or deliver an obligation since the last period”.

(e) the “data analytics and information sharing” practice, which originates from the notion in industrial organization theory. This practice refers to the fact that key performance indicators are required to optimize key processes and communicate results to customers. As already mentioned, transparently communicating the results of transactions to the participants and stakeholders (markets, institutes, public, voluntary organizations) in a standardized and automated fashion (using different channels) leads to an increase of trust in the exchange. Similar to other practices, clearly defined standards and policies have to be implemented for the analytics. These relate to what to inform (defaulters, price index, complaints, customer references...), when to inform (e.g. the frequency), and how to inform (e.g. using which channel). The performance of the practice can be measured by “average time elapsed for updated transaction related analytics since last communication”. Another measure for this practice can also be “average progress of implementation of data analytics requests”.

(f) the “training and education” practice, which comes from industrial organization theory. In the context of this practice, firms operationalize their strategic decisions on organizational development (e.g. investment in training and education etc.) to align the responsiveness of their key resources to the new proposed value proposition. This applies to both, implementing exchange practices for current participants and supporting new participants in adopting the exchange. In the maturity growth way of thinking, standards and policies exist for systematically implementing decisions of organization development to timely acquire the planned capabilities. Mechanisms are in place for monitoring and controlling continuous learning i.e. development, acquisition and implementation of capabilities in the organization. The activities should be in conformance to regulatory requirements or exchange rules e.g. following boundaries of data sharing (e.g. privacy regulation) while offering new products and services through data intelligence. The performance of this practice can be measured “average number of days spent in education for key employees since the last period based on planned initiatives”. As an implementation of outsourcing tasks, exchanges systematically organize channels to incentivize participants to work without financial gains for them. E.g. communities in which participants as expert users answer questions of other participants or new participants. Thus the performance of the practice can also be measured by “relative increase in the number of participants that answer more than x queries for the exchange since the last period”.

Finally the practices and KPIs related to the technical KPA are discussed. These are:

(a) the “service organization” practice, that stems from the insight, that participants require supportive services for the products and services they buy from firms. Decisions on different channels are operationalized to support the participants (both existing and new) to find
answers to their queries. As argued before, exchanges try to grow in terms of liquidity on the platform. Hence, standards and policies should be in place to solve issues that hinder completion of interaction in a fast and transparent way. Further, other issues should be solved to monitor and control the status of the issues e.g. through an automated ticketing system. Thus, accuracy in capturing problems, by offering different classifications of issues in language of the participant and other specifics for the supply or demand side, location (e.g. country), enables to realize a level of supportive services that is significantly better than manual systems and competitors. In the maturity growth way of thinking optimization to achieve higher maturity takes place when regular feedbacks on the quality of support (self help or direct interface) is enabled and visible to other participants for use. Complexity in the support organization for exchanges with a reach over different time zones can be better organized when data (information) is consistent in all languages and available 24X7 real time. Finally, tracking of issues and monitoring is enabled when systems (of participants, partners and exchange) are interfaced with each other. The performance of the practice can be measured by “percentage of issues closed over total issues since last period”, and “average rating of the participant feedback on service support since last period”.

(b) the “process automation” practice, which comes from industrial organization theory. The practice refers to the idea that firms specialize themselves in their products and services e.g. in terms of technical aspects, in such a fashion that it is not easy for others to compete. Further, they use automation to improve their operational service quality (e.g. higher accuracy in data instead of inconsistencies due to manual systems). In the maturity growth way of thinking standards and policies are automated for ensuring e.g. data integrity, data safety and data transfers from and to the exchange. Higher accuracy of data allows improved visibility on bottlenecks in services, which can be monitored and controlled, therefore improved upon. Optimization for higher maturity takes place when the systems of partners and participants are, based on standards and new technologies (e.g. sensor based systems), interfaced with the exchange. This implementation is continuously updated using state-of-the-art technology (infrastructure and software) available in the market to facilitate participants and partners to connect to the exchange with ease. Thus, security and real time availability of data can be enabled 24X7 in real time. The performance of this practice can be measured by the “relative growth in process efficiency improvement in exchange processes (percentage output versus the effort invested) since the last period (in terms of time or financially)”, percentage of integration of exchange with partner and participant systems since the last period”.

Based on the above specifications, the proposed theoretical framework (OEMF) for this thesis is summarized in Table 5.
Table 5: The basic online exchanges maturity framework (OEMF). Source: Author’s depiction

<table>
<thead>
<tr>
<th>Practices (reference to theory)</th>
<th>KPI (relative change in value since the last period)</th>
<th>Maturity level 1 - CREATE</th>
<th>Maturity level 2 - CURATE</th>
<th>Maturity level 3 - CULTIVATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Organizing Liquidity, Organizing Matching Quality, Building Trust</td>
<td>Ensuring Balance</td>
<td>Stimulating innovation</td>
</tr>
<tr>
<td>Market related KPA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategic Management (IOT)</td>
<td>Benefit (social, economic, environmental) improved on average for each participant(^1)</td>
<td>No standard product definition</td>
<td>Product defined with broader market focus</td>
<td>Multiple products traded, each with clear market focus. Product optimized over multiple modes</td>
</tr>
<tr>
<td>Product and service definition (IOT)</td>
<td>Average reduction in transaction cost per participant over all products and services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subscription and product/service pricing (PET)</td>
<td>Increase or decrease in frequency of rebates and incentives for subscription</td>
<td>Adhoc or no value-added services</td>
<td>Value added services formalised, monitored and controlled</td>
<td>Value added services optimized for customer efficiency and societal goals (e.g. reduction of CO2 emissions)</td>
</tr>
<tr>
<td>Market and Stakeholder management (IOT)</td>
<td>Average growth in return on investment over each channel(^2); Average number of partners for each service(^3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market rules (PET)</td>
<td>Growth in average number of transactions on each side; Average number of frauds and complaints (^3,4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design of Algorithm (PET)</td>
<td>Average time to communicate price (index) finalized for transactions over all products and services(^4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integration of adjacent markets (PET)</td>
<td>Growth in total number of participants(^5) for new products and services; Investment in new project to improve liquidity(^1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization development (IOT)</td>
<td>Total budget(^6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational KPA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication (IOT)</td>
<td>Number of channels used for communicating all services for all languages(^5); Share of individualized contacts (i.e. feedbacks) for each channel over all participants</td>
<td>Adhoc, Processes and policies are not clearly defined and communicated</td>
<td>Processes, policies are defined, standardized, monitored and controlled for operational activities</td>
<td>Processes and policies are standardized, automated and optimized. Goals are controlled; communicated externally, internally</td>
</tr>
<tr>
<td>Registration (PET)</td>
<td>Improvement in average time required to certify a participant for registration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operationalizing auctions (PET)</td>
<td>Average time required for an automated transaction(^2); Relative growth in number (or gross value) of finalized transactions</td>
<td>If at all, few and far apart performance indicators</td>
<td>Analytics processes within each sub process are standardized.</td>
<td></td>
</tr>
<tr>
<td>Clearing and settlements (PET)</td>
<td>Average number of delay and failure to pay or deliver an obligation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data analytics and information sharing (IOT)</td>
<td>Average time elapsed for updated transaction related analytics(^3); % progress in implementing data analytics requests</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training and education (IOT)</td>
<td>Average no. of days spent in education (^4,5); Increase in the number of participants answering queries for the exchange(^6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical KPA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Organization (IOT)</td>
<td>% of issues closed over total issues; average rating of the participant feedback on service support</td>
<td>Manual systems in place, inconsistencies possible</td>
<td>Data integrity, accuracy enables monitoring and tracking for improvement of services</td>
<td>Systems are completely integrated, and interact with each other. Data security, 24X7 availability in real time ensured</td>
</tr>
<tr>
<td>Process automation (IOT)</td>
<td>Growth in process efficiency improvement in exchange processes(^11); % of integration of exchange with partner and participant systems</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** 1: on each side over all products and services in conformance to regulations; 2: in terms of benefit or economic growth; 3: per every 1000 transactions over all products and services; 4: Absolute value; 5: or volume/market share; 6: Total for new technology, product and service design initiatives, trainings, resource acquisition; 7: from Start to finish; 8: since last communication; 9: for key employees, based on planned initiatives; 10: more than x queries; 11: % output versus the effort in terms of time or financial improvement
Maturity assessment and transition

The final phase in the specification of the OEFM concerns two steps: i. the specification of the heuristics for assessment of maturity and ii. the formulation of the concept of transition.

The first step is based on the analysis of exchanges using the questions on the current state of practices as operationalized in the OEMF in relation to the elaborated KPI’s. The collected data enables the interpretation of this current state in terms of the specified maturity levels for the five overall KPI’s. Rules are therefore required on i. how to assess the maturity level of each KPA related practice, ii. how to aggregated the maturity levels of practices to a maturity level for each KPA, and finally, iii. how does this sum up to the maturity level of the exchange.

Table 6 provides the rules for the maturity level assessment for KPA level. The rules for aggregation are conditional. All conditions mentioned in the table for a particular KPA maturity level, must be fulfilled by the practices for the KPA to be at that level. The maturity level of the KPA is then similarly evaluated as at Maturity Level 1 (create), Maturity Level 2 (curate) and Maturity Level 3 (cultivate). Thus, a KPA is at Level 1 if more than one of its practices are at Level 1. That is, the exchange requires to take actions to successively improve the maturity levels of such practices first, in order to make a transition to the desired maturity KPA level. A KPA is at maturity Level 2 when majority of its practices are at Level 2, and if at all, only one practice is at Level 1. Finally, a KPA is at maturity Level 3 when majority of its practices are at Level 3, and if at all, only one practice is at Level 2. A KPA at Level 3 does not have a practice at maturity Level 1. This is depicted in Table 6 below.

Table 6: Aggregation of KPA Maturity Level to Exchange level

<table>
<thead>
<tr>
<th>KPA</th>
<th>Maturity level 1 - CREATE</th>
<th>Maturity level 2 - CURATE</th>
<th>Maturity level 3 - CULTIVATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KPA at Level = 1</td>
<td>KPA at Level = 2</td>
<td>KPA at Level = 3</td>
</tr>
<tr>
<td>Practices 1..n</td>
<td>More than one practice is at Level 1</td>
<td>Majority of practices are at Level 2</td>
<td>Majority of practices are at Level 3</td>
</tr>
<tr>
<td></td>
<td>If at all, only one practice is at Level 1</td>
<td>If at all, only one practice is at Level 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All other practices are at Level 3</td>
<td>No practice is at Level 1</td>
<td></td>
</tr>
</tbody>
</table>

Next, the research discusses how to aggregate to the maturity level of the exchange, based on the maturity level of the KPA’s. Based on literature, the value proposition (products and services, clear objectives), market focus etc. are crucial for the success of an exchange. The strategic decisions made in these practices have an implication on the operational and technical practices. Thus, the rules for the evaluation of maturity level are as follows. An exchange with market related KPA at maturity Level 1 is, irrespective of the maturity level of other KPAs, at maturity Level 1. For an exchange with market related KPA’s at maturity level 2, the products are defined and services formalized (as per OEMF). Thus, it is evaluated at maturity level 2 when either of the two following conditions are true, i. when both, the operational and the technical KPA, are at maturity Level 2 or higher, or, ii. when only one of the aforementioned KPA’s is at maturity Level 1. In other words, for market related KPA at level 2, if both the other KPA’s are at maturity level 1 then the exchange is at maturity level 1. Finally, an exchange with market related KPA at level 3 is evaluated at maturity Level 3, when both KPA’s are at level 2 or higher. Such an exchange has the capability to transition to higher maturity level. If either the operational or the technical KPA is at level 1, then the exchange is
at maturity level 2. Should both these KPAs be at maturity level 1, then the exchange is at maturity Level 1, i.e. it is still at the create maturity level. The decision of evaluation of the maturity level of the exchange is therefore depicted as follows in Table 7.

**Table 7: Aggregation of KPA Maturity Level to Exchange level**

<table>
<thead>
<tr>
<th>KPA</th>
<th>Maturity level 1 - CREATE</th>
<th>Maturity level 2 - CURATE</th>
<th>Maturity level 3 - CULTIVATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market related</td>
<td>KPA at Level = 1</td>
<td>KPA at Level =2</td>
<td>KPA at Level =3</td>
</tr>
<tr>
<td>Operational and Technical</td>
<td>The KPA’s are at Level = 1, 2, or 3</td>
<td>The KPA’s are at Level 2 and 3</td>
<td>The KPA’s are at Level 2 and 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If at all, only one KPA is at Level 1</td>
<td>No practice is at Level 1</td>
</tr>
</tbody>
</table>

With regard to the second step: the picture of where each exchange stands serves as the starting point for sharpening ideas on desired transitions aimed at reaching a higher general level of maturity. The ambition level of the exchange is based on the most mature practices analysed over all the exchanges. Actions for transition from the present level of maturity to the next higher level of maturity can then be implemented to shape the stepwise transition that an exchange then has to make.

Such a stepwise process (ideally integrated in the strategic management process) implies that standards and policies exist for a change process. Such a process is required to regularly analyse the current state of the exchange with stakeholders (including key partners) at a defined frequency i.e. in terms of the maturity level of practices, KPA’s and exchange. Based on how the practices have shaped now in terms of maturity, the ambition level can evaluated (achievable, must be set higher or lower). Actions must be then decided upon, constituting a transition to a higher level. Transition thus implies that targets are set for this change. Such actions include mobilisation of knowledge, making investments and making strategic choices in terms of products, services, new markets, ICT, etc. Plans of actions are then defined, based on the gap to be achieved. Finally monitoring is taking place and implementation of activities is continuously controlled. Optimization takes place when continuously lessons are learnt from failures and successes and adjustments in the process are accordingly managed. A generic process of change is depicted below in Figure 5.

**Figure 5: Generic process of maturity evaluation and change (Source: Author’s depiction)**
REFERENCES


