A Guide for Selecting Revenue Models for Industrial Symbiotic E-Marketplaces

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ABSTRACT
There is a lack of guidelines that help selecting the appropriate revenue models during the early development of an industrial symbiotic e-marketplace. One of the consequences of managers adopting unsuitable revenue models is that e-marketplaces may attract less financial resources. This should be avoided because having financial resources is seen as an important success factor for e-marketplaces.

Previous research has identified revenue models commonly used by business-to-business (B2B) e-marketplaces. However, no research studied the applicability of revenue models during the network development stages of an industrial symbiotic e-marketplace. For each stage of network development it is possible that the applicability of revenue models differs based on the characteristics of the stages.

The literature review that was conducted revealed two distinct stages we called the early stage and the mature stage. It is the early stage that challenges to reach a critical mass of buyers and sellers. To reach the mature stage this challenge should be resolved and consequently network growth becomes self-sustaining. Furthermore, the paper discusses the applicability characteristics of five revenue models commonly used by B2B e-marketplaces. Finally, a guideline matrix was created that presents an assessment of the applicability of the revenue models during all stages of an industrial symbiotic e-marketplace.

The guidelines support industrial symbiotic e-marketplace managers to increase the financial resources and consequently the chance of survival.

Keywords

1. INTRODUCTION
A lot is written about revenue models and the application of revenue models in business-to-business (B2B) e-marketplaces, which from here on will be referred to as marketplaces. However, no research has been conducted to identify the applicability of revenue models during the network development stages of an industrial symbiotic marketplace.

This research focused on marketplaces enabling industrial symbiosis (IS). We used the definition of Lombardi et al. on IS: “IS engages diverse organizations in a network to foster eco-innovation and long-term culture change. Creating and sharing knowledge through the network yields mutually profitable transactions for novel sourcing of required inputs, value-added destinations for non-product outputs, and improved business and technical processes”[26].

An IS marketplace enables organizations to find each other and exchange large streams of industrial waste. Examples of industrial waste streams are organic waste from a food industry, ash as a result of burning coal in a power plant and waste water. The process of finding an organization for IS and the exchange of waste is realized using the tools offered by the IS marketplace. The tools can for example match organizations for IS, optimize IS among organizations and support organizations in making deals.

It seems difficult to mature an online marketplace. Research shows that in the beginning of the 21st century marketplaces struggled to succeed and the majority of them failed to survive [7].

Researchers have found a variety of factors that contribute to success or failure of a marketplace [35][8]. One of these factors is having financial resources. Financial resources are necessary in order to create value for the marketplace users [8].

The development of a marketplace is influenced by a cross-side network effect for buyers and sellers [39]. The network effect explains that the value of a marketplace to a buyer depends on the number of suppliers using the marketplace and vice versa. For each stage of network development it is possible that the applicability of revenue models differs based on the characteristics of the stages.

Our study identified the network development stages along with the characteristics of IS marketplaces for each stage. Next, we researched the revenue models commonly used by marketplaces and evaluated when the revenue models are applicable referred to as applicability characteristics. The revenue models, stages and their characteristics were researched using structured literature review.

Afterwards a guideline matrix was created using the found revenue models, stages and their characteristics. This matrix shows for each revenue model the applicability during all stages of an IS marketplace.

The guideline matrix supports IS marketplace managers to improve their financial sustainability and consequently the chance to setup a mature marketplace.
1.1 Problem Statement
No research has yet identified the applicability of revenue models during the network development stages of an IS marketplace. With no guidelines available, all marketplace managers throughout the world have to figure out for themselves what revenue model to use. This process is more time consuming and prone to errors compared to when marketplace managers can consult a guide.

The marketplace is more likely to generate less financial resources if the manager chooses an unsuitable revenue model. Which will reduce the chance for the marketplace to mature and survive.

This problem does not only occur at the beginning of a marketplace. A marketplace continues to develop because of the network effects. This continuous development can create situations for which different revenue models are suitable. Therefore a manager needs to re-evaluate the suitability of revenue models throughout the entire existence of a marketplace.

Once a marketplace is mature it provides many benefits to buyers and suppliers [7][8][3]. Examples of benefits are access to a broader range of suppliers and buyers and facilitated search for buyers and suppliers. An IS marketplace will indirectly provide even more benefits that are caused by IS. The reason for this is the functionality offered by the marketplace which makes it easier for organizations to find each other and perform IS. An example of an indirect benefit is waste reduction.

1.2 Research Questions
The main research question is as follows:
Which revenue models are applicable for an IS marketplace at each stage of network development?
The following sub-questions are answered before an answer to the main question is formulated:
1. What are the characteristics of the network development stages of an IS marketplace?
2. What are the applicability characteristics for revenue models commonly used on marketplaces?
3. What is the applicability of the revenue models for each stage of an IS marketplace?

1.3 Structure of the paper
In section 2 the methodology used to perform this research is covered. Afterwards, in section 3, a theoretical framework is given that describes IS marketplaces and drivers of IS. In section 4 the network effects causing network development are clarified. In addition, the network development stages of IS marketplaces are identified and their characteristics described. Section 5 identifies the revenue models commonly used by marketplaces and their applicability characteristics. In section 6 the previous sections are used to assess the applicability of the revenue models for each stage of an IS marketplace. This paper ends with the discussion, limitations, conclusion and future work.

2. METHOD OF RESEARCH
A structured literature review is conducted to answer the first and second sub-question. The availability of previous research on the concepts separately makes structured literature review a proper method to use.

The first review identified the network development stages of marketplaces and the characteristics of IS marketplaces for each stage.

The second review identified the revenue models commonly used on marketplaces along with their applicability characteristics.

In conducting the structured literature review, the methodology of Webster and Watson [37] was used. A detailed description of our implementation of this methodology is available in section 2.1.

The results of the first two sub-questions were used to create a guideline matrix to answer the third sub-question. This guideline matrix contains the applicability of the revenue models for each stage.

2.1 Structured Literature Review
This section covers our implementation of the structured literature review. First the process of structured literature review is shown. Afterwards the inclusion criteria, sources and search terms are stated.

2.1.1 Process of structured literature review
Figure 1 shows the process of the structured literature review we conducted.

![Structured Literature Review Process](image)

Figure 1 Structured literature review process

2.1.2 Criteria for inclusion
The papers included should:
- Identify the revenue models commonly used by marketplaces.
- Identify applicability characteristics of the found revenue models.
- Identify what causes network development of B2B e-marketplaces.
- Identify the network development stages of B2B e-marketplaces.
- Identify the characteristics of IS marketplaces for the found stages.

2.1.3 Sources
The sources that were used are Scopus [32] and Web of Science [36]. Two abstract and citation databases of peer-reviewed literature.
2.1.4 Search terms
The search terms for the main concepts used are listed below:
- Revenue model: (revenue OR “revenue model” OR “revenue sources” OR “revenue generation” OR liquidity OR pricing OR “financial resources” OR funding OR profit-making)
- B2B: (B2B OR “business to business” OR b-to-b OR “inter institutional” OR “inter organizational”)
- Marketplace: (Marketplaces OR Markets OR Exchanges OR platforms OR hubs OR Portals OR intermediaries)
- Online: (online OR electronic OR “e-” OR internet OR “web technological” OR digital)
- Stages: (stages OR phases OR development OR moment OR growth OR setup)

3. THEORETICAL FRAMEWORK
This theoretical framework is provided to support the statements made in the following sections.

3.1 IS Marketplace
In order to analyze revenue models we need to understand the characteristics of IS marketplaces which are described in this section.

An IS marketplace is an online platform with two user groups. These are sellers and buyers of large streams of industrial waste. The sellers and buyers use the platform to find a match for IS. The platform provides the tools needed to find good matches between organizations for IS. The platform becomes more valuable to buyers when the amount of sellers using the platform grows and vice versa.

The IS marketplaces this research is designed for are neutral and open. Meaning that they are owned by a third party and not by a buyer or supplier of industrial waste [40][21] and that any organization wanting to sell or buy streams of industrial waste can join [40][42] as long as they agree with the terms of use. Another requirement for this research to apply is for the IS marketplace to be the first entrant in the market. The marketplace should sufficiently differ from existing IS marketplaces to be able to coexist [16].

A two-sided market is a platform with two user groups that interact through the platform. A characteristic of two-sided markets is the dependence of the platform value for user group A on the size of user group B and vice versa [31].

As Li and Penard [25] mentioned in their paper, neutral B2B e-marketplaces are two-sided markets, because a seller’s platform value is influenced by the number of buyers using the marketplace and vice versa. Therefore, IS marketplaces can be seen as two-sided markets.

A two-sided market needs to be treated differently compared to a one-sided market. Treating the IS marketplace as a traditional one-sided market might cause problems for the development of the marketplace [10][14].

3.2 Drivers of industrial symbiosis
In this section drivers of industrial symbiosis are listed. These drivers are used to investigate the applicability of revenue models for IS marketplaces in section 5.

Paquin and Walls [34] conducted a literature review on the drivers and barriers of industrial symbiosis and sorted most of them based on the four levels on which industrial symbiosis operates. These are the institutional level, the network level, the organizational level and the individual level.

Intermediaries such as an IS marketplace can encourage IS participation. They make it easier for organizations to get in touch and discuss possible IS opportunities. Establishing IS agreements using an intermediary increases trust among organizations.

Institutional drivers of IS are related to the involvement of the government. An example is government regulation to create pressure and stimulate organizations into IS.

Network level drivers of IS are proximity, actor roles and actor diversity.

The distance between two organizations willing to exchange industrial waste influences whether an IS agreement is established.

Anchors and scavengers are the actor roles. Anchors are organizations that provide many streams of industrial waste and scavengers are organizations that depend on being able to use the industrial waste streams of other organizations and can therefore buy much industrial waste.

Actor diversity is diversity in the industrial waste offered and requested by organizations. It is key to find matches for IS. Having this diversity creates stability and resilience in the network, which in turn creates certainty.

Other influencing factors of IS that were not defined as drivers are trust, shared norms and social ties.

On the organizational level organizations rather perform IS with organizations that are reliable and provide quality outputs.

An individual level driver of IS is the presence of a champion. Champions are individuals who are able to motivate firms to apply IS and help with the exchanges. Champions help diffuse IS in the network.

Another driver that was not listed under a specific level is having prior small scale success in IS.

Other influencing factors of IS mentioned by Lombardi et al. [26] and Chertow [12] are self-interest and having large streams of industrial waste that altogether requires much money to dispose of.

An organization’s actions is influenced by what is best for its economic position. Organizations typically make IS agreements out of self-interest, the emergence of ecological benefits is a consequence, not a driver of IS.

4. NETWORK DEVELOPMENT
This section discusses the results of the first sub-question related to characteristics of the network development stages of an IS marketplace.

The first sub-question is formulated as:
What are the characteristics of the network development stages of an IS marketplace?

First, the network effects causing network development are clarified. Afterwards, the network development stages are identified and their characteristics described.

4.1 Network effects
This section provides a detailed description of the network effects causing the IS marketplace to develop.
Network effects are key to develop a successful two-sided market [13][33]. An IS marketplace is a two-sided market enabling exchanges between buyers and sellers. Therefore an IS marketplace is affected by network effects [44]. There are two types of network effects at work. These are cross-side and same-side network effects [14].

The cross-side network effect for buyers and sellers influences the network development when growth of the seller user base causes the buyer’s platform utility to increase the buyer user base and vice versa [14][39]. Buyers have more offers of industrial waste to select from once more sellers join the platform and sellers have an increased chance of selling their industrial waste once more buyers join the platform. This means growth of users on side A causes an increased platform utility for current and potential users on side B, which in turn causes side B to grow and increase the platform utility of side A. This results in a positive feedback loop where growth of one user group causes growth of the other user group [17].

Same-side network effect appears when a user’s platform utility is influenced by the amount of users on the same side [17]. This influence can be positive and negative [14]. For example, sellers of an IS marketplace will likely prefer to have less competition of other sellers. On the other side, potential sellers will be attracted to the platform when a lot of sellers already use it. [10]

The influence of the network effects means that a user’s platform utility is not only influenced by the platform itself, but also by the other users [33][5]. When more organizations start using the IS marketplace, the platform utility for sellers and buyers increases [13][17]. The impact of network effects on platform utility depends on the strength of the network effects [2].

The platform benefit users perceive consists of their platform utility reduced by the participation costs. For the marketplace to be attractive to users, a positive platform benefit is required. The platform utility should outweigh the participation cost [2]. Not all sellers will have the same platform benefit. The same holds for buyers. Individual circumstances and preferences will have an impact on their platform benefit [5]. For example, some have to invest more in order to properly use the marketplace and to perform industrial symbiosis. Therefore users will join over time and not all at once [22]. The organizations with a positive platform benefit will most likely join before organizations that first need an increase in platform benefit for adoption of the marketplace to be beneficial. This increase in platform benefit can among others be caused by organizations joining the marketplace as it will raise the network effect and therefore the platform utility and the platform benefit.

4.2 Network Development Stages

This section mentions the network development stages of an IS marketplace and describes the characteristics of each stage.

Using the results of the literature review, we identified two stages in the development of an IS marketplace to self-sustainability. In the first stage, the early stage, a critical mass of sellers and buyers has not been reached. In the second stage, the mature stage, a critical mass has been reached. This corresponds to the stages of online platforms found by Chen et al. and Zhuang [11 and 43].

4.2.1 Early stage

The early stage begins at the launch of the IS marketplace when no organization is registered as user and network effects have no impact on the adoption of the marketplace [6][14].

The goal is to trigger the network effects. Brunn et al. mention that in order to do this an initial group of buyers and sellers need to adopt the marketplace and make transactions on it [7]. This initial group is the critical mass. A critical mass is defined by Guo et al. as: “The point at which sufficient individuals in a system have adopted an innovation so that the innovation’s further rate of adoption becomes self-sustaining” [19].

Growing the user base to reach a critical mass of sellers and buyers is the main struggle at this stage [42][5]. There are no network effects at work to increase the platform utility. It will not be beneficial for buyers to join the marketplace if there are no sellers present to perform IS with and vice versa [30]. This is the chicken-and-egg problem that two-sided markets need to solve [42][31].

Speed is of importance when setting up an IS marketplace [43]. The marketplace that is the first to create a larger user base of buyers and sellers will induce stronger network effects [43]. Consequently, organizations will be more attracted to that particular IS marketplace compared to other IS marketplaces and is therefore more likely to become the market leader [7][21]. Since the IS marketplace is the first market entrant, it has first mover advantages [7]. But if an inappropriate strategy is used to get both sides on board another marketplace might catch up [14].

The IS marketplace will enter the second stage of development once a critical mass of both sellers and buyers is on board and using the marketplace. Another possibility is for the IS marketplace to be unable to reach a critical mass. In that case participation will most likely reduce to zero and result in the failure of the marketplace, as researched by Evans et al. [15].

4.2.2 Mature stage

At the mature stage, a critical mass of sellers and buyers has adopted the IS marketplace and the network effects influence the platform utility of sellers and buyers. Further growth of the user base is now self-sustaining [19][33]. The positive feedback loop created by the cross-side network effect has begun [17].

At this stage failure of the marketplace is also a possibility. The marketplace might for example not be scalable enough to keep up with the growing user base [14].

5. REVENUE MODELS

This section covers the second sub-question by providing the applicability characteristics for revenue models commonly used on marketplaces.

The second sub-question is formulated as:

What are the applicability characteristics for revenue models commonly used on marketplaces?

A revenue model consists of the value offered, the revenue source, the pricing strategy, and the actors paying for the value [1].

The value offered by an IS marketplace is not a product or a service, but the opportunity for buyers and sellers of industrial waste streams to find matches for IS through the use of the IS marketplace and its tools.

In the sections below the revenue sources and the pricing strategy commonly used on marketplaces and the actors paying for the value will be covered.

5.1 Revenue sources

This section provides the revenue sources commonly used on marketplaces and their applicability characteristics.
The revenue sources commonly used on B2B marketplaces are registration fees, subscription fees, transaction fees, advertising and fees for value-added services [7][41]. The above mentioned revenue sources will be described in the following sections.

5.1.1 Registration fee
Registration fees are paid at the moment an organization joins the marketplace, before they get access to the sellers and buyers on the marketplace and any transaction can be made.

This revenue source is excellent to increase the profit of the marketplace [9] and it stimulates transactions as users can make unlimited use of the marketplace [44].

A disadvantage is that registration fees discourage organizations from joining the marketplace [44]. The organizations will worry about the number of users of the other side. They will decide to register or not based on the size of the user base and their estimation of whether enough users will be attracted by the marketplace.

5.1.2 Subscription fee
Subscription fees are very similar to registration fees.

When using subscription fees organizations will have to pay in order to get access to the sellers and buyers on the marketplace and their offerings and requests. The similarities continue as both revenue sources have the same advantage. The revenue sources stimulate transactions as the organizations can make unlimited use of the marketplace [41]. It also has the same disadvantage that the upfront fee discourages organizations from joining [7].

There is however a difference. Unlike registration fees where the payment happens once at the moment of registration, subscription fees are paid regularly [41].

5.1.3 Transaction fee
Transaction fees are paid when two organizations decide to make a transaction. For an IS marketplace, a transaction takes place once organizations establish an IS agreement. This revenue source is often used by marketplaces with a divide-and-conquer strategy [9].

Transaction fees work very well to expand the user base of a marketplace [9][41]. Users are less concerned about the number of users on the other side and whether the other side will reach critical mass when deciding to join the marketplace. The reason is that the user only pays in case he makes a transaction on the marketplace.

Transaction fees encourage more user to join the marketplace, but at the same time it confines the amount of transactions they make [44].

Transaction fees should only be used in case the transactions are noticeable so the marketplace can keep track of them [9][44].

5.1.4 Advertising
Advertising has many advantages. It is easy to apply and relevant advertisements can be valuable to users [7]. Furthermore, advertising can generate much revenue if reaching the audience of the marketplace is worth a lot to advertisers [16].

When using advertising as a revenue source, advertisers experience a cross-side network effect because a large user base makes the marketplace attractive for advertisers [18].

Therefore, the applicability of advertising depends on the size of the user base. The marketplace will need to have a sufficiently large user base for advertisers to be interested [29][41] and to make advertising work as the main revenue source [28]. However, advertising might not be appreciated by the users when misapplied [7].

5.1.5 Fees for value-added services
The value-added services are beneficial for improving the customer relationships and consequently for maintaining the user base [27].

The availability of value-added services makes the marketplace more valuable to buyers and sellers, which means less resistance at the moment an organization needs to decide whether or not to join the marketplace [4]. Therefore, implementing value-added services makes it easier to reach a critical mass of buyers and sellers.

Fees can be charged for the value-added services. This revenue source is applicable before and after a critical mass of user has been reached [27]. The services are optional [7]. Similar to transaction fees, an organization only pays in case it decides to make use of a service. Fees for value-added services should therefore not discourage organizations from joining the marketplace.

A valuable type of services a marketplace can offer to generate revenue are consulting services [27]. An example is helping organizations to successfully start using the marketplace.

A disadvantage of charging fees for value-added services users encounter is the repeated consideration whether to pay for a service or to skip the service and do it themselves [7].

5.2 Pricing strategy and the actors paying for the value
This section covers the pricing strategy commonly used on marketplaces and the actors paying for the value an IS marketplace provides.

Pricing strategies for two-sided markets has gained a lot of attention from researchers [19][31]. A strategy should be used that regards buyers and sellers as two distinct, yet interdependent user groups [38]. Prices have to be set for both sides whilst taking into account that setting a price for sellers does not only have an impact on sellers joining the marketplace, but also on the buyers’ demand for the marketplace and vice versa [31][14][10].

The pricing strategy of an IS marketplace should allow for the influence of the network effects on pricing [39][42]. An example of the influence of network effects builds on the fact that platform utility for sellers and buyers increases due to network effects when more organizations start adopting the IS marketplace, as stated in section 4.1. The increasing platform utility causes an increasing returns to scale. This means that users are willing to pay more for a marketplace that has a larger user base [14].

Even though both types of network effect influence the optimal pricing strategy, platforms with a pricing strategy founded on same-side network effect are said to be rare. It is preferable to focus on the cross-side network effect [15]. Zingal et al. [44] confirm this. They state that cross-side network effect has a great impact on the optimal pricing strategy of two-sided markets such as IS marketplaces.

It is common for two-sided marketplaces to apply an asymmetric pricing strategy [24]. Two-sided markets such as the IS marketplace can generate revenue from both sides, but research shows that generating revenue from both sides will result in a
less profitable situation where more organizations will refrain themselves from joining the marketplace because the price is too high [2]. Bhargava even states that it can be hazardous to charge both sides of a two-sided market, as it increases the possibility of not reaching a critical mass on either side [5].

Due to the impact of cross-side network effect, research has resulted in the finding that a good pricing strategy for a two-sided market should include subsidizing one side and charging more to the other side [9]. This is called price discrimination [31]. A two-sided market can subsidize side A to attract more users on that side. This will consequently increase the platform benefit for users of side B. The increase in platform benefit enables the market to raise the price for side B and therefore compensate for the loss of subsidizing side A and generate revenue [10][31][14].

This type of strategy where one side is subsidized (divide) and the other is charged more (conquer) is called a ‘divide-and-conquer’ strategy [9].

5.2.1 Divide-and-conquer

Some questions arise when using subsidization [5][14]. This section provides answers to the questions which side to subsidize and which side to charge for access to the subsidized side.

Deciding which side to subsidize is not always evident. Factors found in previous research that help decide what side to subsidize are mentioned below. The resulting characteristics of the subsidized and the charged side are presented in table 1.

Bakos et al. [2] suggests, in case one side has a weak and the other a strong cross-side network effect, to subsidize the side that has a weak cross-side network effect and generate revenue from the side with a strong cross-side network effect. The strong cross-side network effect increases the platform utility enabling the marketplace to raise the price.

Vogelsang [33] mentions two characteristics of the side that should be subsidized. The first characteristic is having the highest demand elasticity. Meaning that the demand changes noticeably when the price is altered. The first claim is supported by Eisenmann et al. [14]. The second characteristic of the subsidized side is that its presence provides a big increase in utility for the other side [33].

Other researchers [29][20][44] support the second claim. The side that increases the platform utility of the other side the most should be subsidized. Therefore the side that benefits the most of a new member on the other side should be charged a higher price [44]. This difference in benefit can result in the situation as mentioned by Bakos et al. [2] where one side, the side that has the largest benefit, has a stronger cross-side network effect than the other side and should therefore be charged.

Table 1 Characteristics of the subsidized and charged side

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<tr>
<th>Characteristics of the subsidized side</th>
<th>Characteristics of the charged side</th>
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<tbody>
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<td>2. Benefits the most from an increase of the other side</td>
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<td>3. Highest demand elasticity</td>
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It is typically the buyer side of an online two-sided platform that is subsidized and the seller side that is charged for access [23][29]. This is supported by Barratt et al. [3] as they stated that the seller transaction fee is the most used method to generate revenue in B2B e-marketplaces.

Furthermore, many online marketplaces facilitating exchanges started off by charging both sellers and buyers. They noticed that the buyers were not keen on having to pay in order to buy [3]. This points to demand elasticity on the buyer side.

Chen et al. [11] performed a study similar to ours. They researched the optimal pricing strategy for another e-marketplace. The marketplace they focused on is a ‘regional logistics information platform’, which is a two-sided market with buyers and sellers of logistics. This research resulted in the finding that the sellers benefit more from a new buyer than vice versa. This was due to the stronger cross-side network effect for sellers. Therefore they advised to charge more to the sellers and to subsidize the buyers. This is in accordance with the first two characteristics the subsidized and charged side should have as mentioned in Table 1.

This leads us to state that buyers should be subsidized and sellers should be charged for the IS marketplace.

6. APPLICABILITY OF REVENUE MODELS IN IS MARKETPLACES

This section covers the third sub-question by combining the results of the previous sections and showing the applicability of the revenue models for each stage of an IS marketplace.

The third sub-question is formulated as:

What is the applicability of the revenue models for each stage of an IS marketplace?

As shown in section 5.2, it is common for marketplaces to use an asymmetric pricing strategy and due to the cross-side network effect a divide-and-conquer strategy should be used where the buyers are subsidized and the sellers charged.

In the sections below the applicability of the revenue sources and the pricing strategy commonly used by marketplaces is described for both stages of an IS marketplace.

Table 2 is the guideline matrix showing the applicability of the revenue models commonly used by marketplaces for each stage of an IS marketplace.

Research has indicated that revenue may be generated using only one fee type, but a combination of fee types is often more appropriate. The main reason is to keep possible competition at bay. [7]

Table 2 Degree of applicability of revenue models commonly used by marketplaces on IS marketplaces

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|--------------------------------------|-----------------------------------|
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* required that suitable advertisements are used and correctly applied.

6.1 Revenue sources in the early stage

6.1.1 Registration fees and subscription fees

Both registration fee and subscription fees require an upfront payment which lowers the benefit of the marketplace. If one or
both of these revenue sources are selected in the early stage, less organizations are willing to join the marketplace. This is not a good strategy because the critical mass of sellers has not been reached yet.

Therefore, registration fees and subscription fees have a low applicability in the early stage. Instead of stimulating marketplace adoption they discourage organizations from joining the marketplace. This reduces the chance of reaching critical mass and allows possible competition to catch up.

6.1.2 Transaction fees
Transaction fees are highly applicable in the early stage. The organizations will worry less about the number of users on the other side as they only have to pay once they make a transaction. It stimulates organizations to join the marketplace, improving the chance of reaching critical mass and reducing the chance for possible competition to catch up.

6.1.3 Advertising
The user base of the marketplace is very small at this stage. Due to the cross-side network effect of advertisers, advertisers with suitable advertisements will most likely not be interested or willing to pay to reach a small user base. Generating revenue using advertising has therefore a low applicability in the early stage.

6.1.4 Fees for value-added services
Similar to transaction fees, no payment is required to join the marketplace. Therefore, it will not lower the benefit of the marketplace and discourage organizations from joining the marketplace. In contrast, value-added services raise the benefit of the marketplace and improve the customer relationship. The availability of value-added services facilitates getting sellers and buyers on board and reaching critical mass.

Generating revenue from fees for value-added services is highly applicable in the early stage.

6.2 Revenue sources in the mature stage

6.2.1 Registration fees and subscription fees
At this stage, growth of the marketplace is self-sustaining as a result of the network effects triggered by reaching critical mass. Therefore, registration fees and subscription fees are highly applicable at this stage.

As mentioned in section 5.1.1, organizations are sceptical on the number of users present on the other side when an upfront fee is required. This is especially a problem at the early stage, but at the mature stage this uncertainty has disappeared.

Additionally, the increase of platform benefit caused by the network effects results in a marketplace more valuable to organizations.

Therefore, many organizations will be willing to pay an upfront fee to gain access to the valuable marketplace and its user base.

Using one or both of these revenue sources in the mature stage will increase the profitability of the marketplace whilst stimulating users to make transactions.

6.2.2 Transaction fees
Due to the self-sustaining growth at this stage, it is no requirement anymore for the revenue source to stimulate growth of the user base.

Transaction fees can still be used to generate revenue, but it is not the most profitable revenue source. Furthermore, using transaction fees will reduce the number of transactions on the marketplace. Therefore, this revenue source has a medium applicability.

6.2.3 Advertising
A critical mass of buyers and sellers is using the marketplace at this stage and further growth of the marketplace is self-sustaining. Due to the size of the user base and the cross-side network effect of advertisers, advertisers will be interested and willing to pay to reach the user base. Generating revenue using advertising is therefore highly applicable at this stage.

When using advertising as a revenue source, the marketplace manager should keep in mind not to use unsuitable advertisements or to misapply the advertisements otherwise the advertisements might not be appreciated by the users.

6.2.4 Fees for value-added services
As mentioned in section 6.2.2 stimulating growth of the user base is not a requirement for the revenue source anymore in the mature stage. However, this revenue source is still highly applicable at this stage. In addition, offering value-added services will improve the customer relationship and consequently maintain the user base. This can be helpful when competition enters the market.

6.3 Pricing strategy in the early stage
This section covers the applicability of the pricing strategy in the early stage.

As mentioned in section 4.2.1 a critical mass of buyers and seller has not been reached in this stage. Therefore the pricing strategy cannot depend on the influence of network effects. The first users of the IS marketplace will base their decision to join the marketplace on the value of the marketplace itself [5], the price charged and their estimation of how well the marketplace will succeed in attracting user for the other side [9]. The value of the IS marketplace itself will be low, because the value comes from finding a good match with an organization on the other side [17].

However, the divide-and-conquer strategy is useful to help solve the chicken-and-egg problem of getting a critical mass of both sides on board [17][29]. The IS marketplace will be more attractive to buyers because they are subsidized. This will result in buyers joining the marketplace. Once enough buyers joined the marketplace to create cross-side network effect for the sellers, sellers will start to join [14].

Subsidizing buyers might not be enough incentive for the initial buyers to adopt a marketplace [6]. Therefore an additional stimulant is needed [30].

Li et al. [25] mention what is important for buyers to join a B2B marketplace. In the early stage buyers prefer quantity over quality. The number of sellers and waste streams available on the marketplace is important for buyers to join the IS marketplace.

An anchor using the IS marketplace can provide the stimulant needed for they have the ability to provide many streams of industrial waste. As mentioned in section 3.2, the presence of an anchor is an important driver for IS [34]. Once an anchor adopts a two-sided market such as the IS marketplace, it has the ability to attract many buyers to the marketplace [14]. This method is used by two-sided markets [7][14] as well as eco-industrial parks with organizations performing IS [12].

6.4 Pricing strategy in the mature stage
This section covers the applicability of the pricing strategy in the mature stage.
As mentioned in section 4.2.2 a critical mass of buyers and seller has registered for the IS marketplace to reach the mature stage. Therefore the pricing strategy can depend on the influence of network effects. Consequently making the divide-and-conquer strategy highly applicable for the IS marketplace to attract organizations and generate revenue [38]. The strategy makes proper use of the cross-side network effect as described in section 5.2.

7. DISCUSSION AND LIMITATIONS

In this research we identified the applicability of revenue models at each stage of an IS marketplace. This helps the marketplace manager to select a suitable revenue model to generate revenue for financial stability. However, a revenue model is only a part of the business model. Naturally, our developed guidelines for financial stability will only be effective if the remaining components of the business model are appropriately developed.

In two-sided markets such as the IS marketplace it is considered best to have a pricing strategy where one side is subsidized and the other is charged. In other words, it is considered a risky strategy for the IS marketplace to charge both buyers and sellers. Therefore, only the pricing strategy charging sellers has been evaluated in this research.

As mentioned before, same-side network effect affects the platform benefit. This effect can be positive or negative. Especially when the same-side network effect is negative can it affect the price users are willing to pay for the IS marketplace. For example, when there are too much sellers offering the same waste stream on the marketplace. Marketplace managers should monitor the same-side network effect and adapt the prices charged accordingly.

The two types of network effects mentioned in the research can both be split in the effect of a new member registering on the marketplace, as included in the research, and the effect of a new transaction on the marketplace. For example, more transactions will also attract organizations to the marketplace [43].

The five revenue sources discussed in this paper are revenue sources commonly used by marketplaces. There most likely are other revenue sources that are used less frequently by marketplaces. These revenue sources might also be applicable at one or both stages of the IS marketplace.

The revenue sources’ applicability characteristics mentioned in this research are not complete. However, the applicability characteristics covered were sufficient for this research to identify whether revenue sources have a low, medium or high applicability at each stage of the IS marketplace.

The same holds for the factors that help to decide which side to subsidize. These may not be complete, but they are sufficient to state that buyers should be subsidized and sellers charged

The applicability of revenue models as covered in section 6 has not been validated. The results are based on the findings of the structured literature conducted for this research. To the best of our knowledge these results will help guide the IS marketplace manager when selecting a revenue model. The results can be validated by conducting an expert evaluation or a case study.

8. CONCLUSION

This research has been conducted to investigate which revenue models are applicable for an IS marketplace at each stage of network development. We first answer three sub-questions that subsequently provide answer to our main research question. Our first sub-question was formulated as:

What are the characteristics of the network development stages of an IS marketplace?

The early stage and the mature stage are the distinct network development stages of an IS marketplace.

The early stage is the first stage of an IS marketplace. The user base is absent or small and the network effects have no or very little impact on the number of organizations using the marketplace. During this stage the goal is to grow the user base to reach a critical mass of buyers and sellers that consequently triggers the network effects. Attracting these initial users is a challenge as no buyer is interested in joining the IS marketplace if no seller is using it and vice versa. This is the chicken-and-egg problem of the IS marketplace.

The mature stage is the second stage of an IS marketplace. A critical mass of buyers and sellers has joined the IS marketplace to reach this stage. The critical mass of users triggers the network effects to start influencing the number of organizations using the marketplace. Further growth of the user base is now self-sustaining.

Our second sub-question was formulated as:

What are the applicability characteristics for revenue models commonly used on marketplaces?

A revenue model consists of the value offered, the revenue source, the pricing strategy and the actors paying for the value.

The value offered by an IS marketplace is the opportunity for buyers and sellers of industrial waste streams to find matches for IS through the use of the IS marketplace and its tools.

The revenue sources commonly used on marketplaces are registration fees, subscription fees, transaction fees, advertising and fees for value-added services. Registration fees and subscription fees are applicable when the initial users have joined and the marketplace has thereby proven to attract users. Furthermore, transaction fees and fees for value-added services are applicable to extend the user base. Finally, advertising is applicable when the user base is large.

An asymmetric pricing strategy is commonly used by marketplaces. Due to the cross-side network effect a divide-and-conquer strategy should be used where the buyers are subsidized and the sellers charged.

Our third sub-question was formulated as:

What is the applicability of the revenue models for each stage of an IS marketplace?

In the early stage transaction fees and fees for value-added services are highly applicable. Both revenue sources help to reach the critical mass of buyers and sellers. All other revenue sources have a low applicability.

In the mature stage registration fees, subscription fees, advertising and fees for value-added services are highly applicable. These sources can generate much revenue in combination with the self-sustaining growth. Transaction fees have a medium applicability, because charging fees for transactions restricts the number of transactions organizations make on the IS marketplace.

An asymmetric pricing strategy, subsidizing buyers and charging sellers for the IS marketplace, is highly applicable in both stages. This strategy helps to reach the critical mass of buyers and sellers in the early stage and properly uses the cross-side network effect to generate revenue in the mature stage.
In the early stage this pricing strategy might not be sufficient to reach the critical mass of buyers and sellers. Therefore, an anchor should be convinced to join the marketplace to attract more buyers and consequently more sellers.

Our main question was formulated as:

Which revenue models are applicable for an IS marketplace at each stage of network development?

The applicability of revenue models has been assessed for each network development stage of IS marketplaces. For this assessment characteristics of each network development stage, applicability characteristics of revenue models commonly used on marketplaces and drivers of IS were used. The results of the assessment have been presented in a guideline matrix. These guidelines support the managers of IS marketplaces to improve the financial sustainability and consequently the chance to setup a mature marketplace.

9. FUTURE WORK

Our research has created a foundation for research identifying the applicability of revenue models at the stages of an IS marketplace. The research can be extended in several ways.

To start with, the applicability of other revenue sources and pricing strategies can be identified for each stage of the IS marketplace.

Furthermore, competing marketplaces and their revenue models can be taken into account when evaluating the applicability of revenue models. This can be split in two situations. The presence of competition at the moment of entering the market and the emergence of competition after the IS marketplace has entered the market.

In addition, the research can be extended by conducting this research for closed and non-neutral IS marketplaces. These are IS marketplaces with restrictions for organizations that can join the marketplace and where the marketplace is set up by a buyer or seller of industrial waste streams respectively.

This research can be extended in two more ways. The guidelines this research provides can be validated using one or more of the methods suggested in the discussion. Furthermore, an identification of what combinations of fee types are applicable at each stage of an IS marketplace can be made.

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11. REFERENCES


