Identifying critical technology actors in waste flow management

Peltola, T., Mäkinen, S.,J.

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Abstract (max 200words)

Waste flow ecosystem could include numerous actors. In particular in developing countries where waste pickers are manually sorting residue. High amount of actors can be considered as an entry barrier for new technological actors. Yet, business potential that relates on waste flow management is enormous globally but without conceptualizing and frameworking the ecosystem in detail level, the business potential is not easily fully discovered. In the present study we followed existent insights in literature and conjoined those business ecosystem theories into existing waste flow management. Finally we came up with conceptualization and framework to address the business potential. Based on our framework, critical technology actors can be identified in the waste flow management and the process for finding critical technology actors and possibilities they enable is cut through. We also discuss about the fruitful avenues to continue the research further.

Introduction

Waste flow management is not just ecological concerns but it is a huge business. To illustrating the business by considering just one country; recycling sector in Brazil is estimated to have a size of R$20 billion annually [1]. However, business opportunities are not convergent globally. On general level waste flow management in developing countries is different than in developed countries. At first, the amount of waste produced varies; in developed countries each person generate municipal solid waste (MSW) ~1,5-2 kg/day, but in developing countries the amount of MSW is appr. 1kg/person/day less [2]. Typically the amount of MSW is positively correlating with wealth and they are both increasing in developing countries, yet the waste management is not congruently enhanced reflecting on issues and challenges in waste flow management. As a summary, the amount of waste will reach the level of developed countries, but the waste flow management remains on the traditional level.

Secondly, solutions and installations for waste flow management that are used in developed countries are not typically possible to be implemented directly in developing countries. The impact of the manual work (by waste pickers, scavengers) is huge, and not only for recycle or reuse aspects of waste but also as economical perspective on municipal scale due to the huge amount of waste pickers. Naturally, the income based on waste sorting is crucial for waste pickers and scavengers. Therefore the business models relating in waste management are expected to be different in developed countries and developing countries.

Huge amount of was pickers reflects on the material flows. Recycling can be addressed in terms of primary or secondary recycle flows. In primary flow, the pre-identified materials are sorted by the users and collected into dedicated bins, for example papers, glass, metals. Secondary flow is enabled by unsorted waste and waste pickers who manually seek materials that they can sell forward. The manually sorted waste goes through middlemen before been reused by recycle industry.

Waste management ecosystem in Brazil can be addressed from city, state or federal levels. There are a few federal laws that obligate state to waste handling. From the federal level the solid waste management has been addressed by Federal Law (n12.305/2010) and Federal Decree (n°7404/2010). The period of transition was intended to be by the end of 2014, and for example all dumps (illegal landfills) would have been outlawed and should be eradicated. However, on practical level many dumps are still open and the law's effective day has been postponed for few years. The movement towards environmental waste management is slow; majority of people in developing countries don't see any benefit for waste sorting or issues relating on open dumps. However, states possess a great independence in waste management and there is no clear united group of stakeholders for all states. Yet, typically the recycling industry on the city level is orchestrated by a limited number of private companies, and those focus on residues at the landfills and sort out dedicated materials. Waste sorting is therefore focusing on pre-selected materials (such as PET bottles, aluminum, paper and glass)

There is a huge amount of waste-pickers in Brazil and even though their status has been elevated (efforts to increase the cooperation between waste pickers, they have given certain rights, and so on), they are considered as the lowest class in Brazil. They usually live in favelas without (legal) access to the electricity, running water, or proper sanitation. Waste valorization by manual sorting is enabled due to the lack of environmental concerns in the higher classes. That implies that changes in the current waste flow ecosystem will reflect also on socio-economic issues that cannot be solved only by implementing any technological innovation into the value chain.

There is a great variation between areas in Brazil. In the rural areas waste flow ecosystem is not closed and waste sorting is minimized or negligible. São Paulo area the waste sorting is good or possible in terms of the low waste amount going to the uncontrolled dumps [1]. The best situation is in Curitiba, capital of Parana (~2million people; 400km SW from Sao Paulo), due to the recycling project ran by the city. The city changes sorted waste to vouchers that can be used for bus rides, school books, food etc. Based on Curitiba's success in waste sorting implies that the minimal investments are required if those are focused on the relevant party (families, households in Curitiba).

Literature review

Since Moore [3] ecosystem related analogies have been used to describe business and relations between companies in addition to nature and natural ecosystems. None of the actors in the business ecosystem are alone; instead a business ecosystem is formed by various actors and there is huge amount of interactions between these actors within the ecosystem. Building on Moore's arguments also innovation capabilities and their success can be addressed with the similar analogy [4]. Adner arguments that within the innovation ecosystem various kinds of actors can be identified that either have direct or indirect impact on the success of

the innovation. The importance of identifying the critical actors and the relation between them reflects on the success of the innovation [5]. Identifying critical actors in the ecosystem enables also unveiling new kinds of business models.

An innovation ecosystem includes various kinds of actors such as complementors and intermediators [5, 6]. The framework of such an ecosystem is presented in figure 1. Furthermore; according to Adner, these actors can be individual, organizations, or networks. Company's (that is one of the actors) success requires a 'wider lens' for innovation within the innovation ecosystem [5]. It is not enough to have excellent product when the utilization of the product is depending on complementary products or services that may not be available; in these cases customer don't find the excellent product appealing. Additionally, a business ecosystem is not static but changing construct. Roles can change, new actors can pop up, or existent actors can disappear. The dynamic tendency of business ecosystem underlines the value of frequently updated understanding about the value network among managers and sharing that to the organization. Utilizing these communication technology innovations and eliciting communication and collaboration between actors within the whole innovation ecosystem is clearly the next path to follow as these networks are operating (or looking for possibilities to operate) in certain business ecosystems [7].

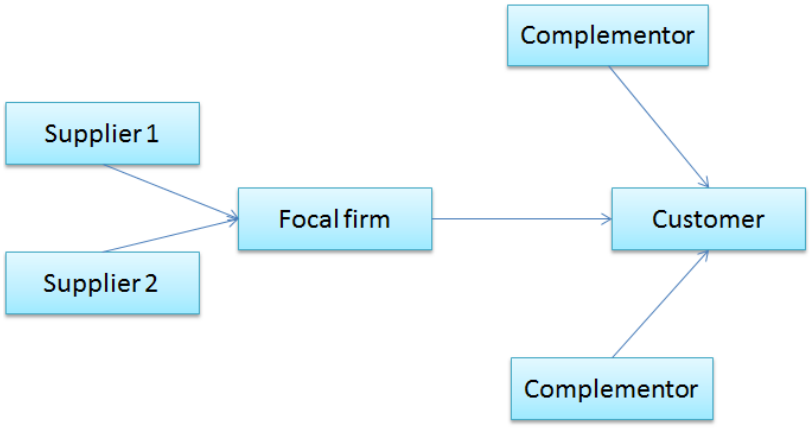

Figure 1. The framework of a business ecosystem (Adapted from [8])

There are two interesting implications based on the ecosystem perspecitive; a) also the ecosystem leader requires interactions with other actors in the ecosystem, b) the strategies utilized by ecosystem's actors should follow their role in the ecosystem [6]. According to Cusumano&Gewer, ecosystem leader requires followers and collaboration as those interactions can be spur innovations and increase the size of the market. Furthermore, complementor(s) can have stronger role than only a side-role in the ecosystem by offering (even crucial) leverage of resources for the ecosystem. That congruently pushed pressure for the finding and identifying various actors in the ecosystem to be able to understand the business model and value network.

Table 1. Dimensions of technology (adapted from [9])

Dimension	Addresses
Product technologies	Innovations required for the product, such as capacitive touch element
Process technologies	Processes required for product manufacturing or delivering services
Core technologies	Crucial innovations for the product (including management innovations), could be used in similar products
Infrastructure technologies	Enabling connections, such as wireless networks.

Business model and value networks should not be separated [10]. Shafer et al. argues that creating value should always be followed by value capturing. If the created value is not captured, nor is the value potential that might had been the crucial element for the strategic decision and the planned strategy is compromised [10]. Only the captured value will be usable for the business model. Furthermore, based on another perspective towards business models, technology is the crucial aspect of the business model [9]. According to the Mason& Spring, the technology aspect can be addressed from four dimensions; Product, Process, Core, and Infrastucture. Actors in the business ecosystem may not have a similar control over these nor those should be treated as 'environmental variables' [11].

Framework for waste flow management

As previously mentioned, stakeholders in the ecosystem can be categorized according to the Adner and Kapoor (2010) framework; such as suppliers, focal firm, complementors, and customers. In the study a Brazilian private landfill was considered as a focal firm (figure 2). It has a municipality as the main supplier but also one of the customers as the landfill produces waste to energy –services for it and in addition to the disposable outcome (such as leachate), the landfill produces sorted residues for recycling industry.

Figure 2. Outlining the framework of the ecosystem

The overall framework presented above is not suitable for identification of business opportunities as it lacks the sufficient resolution and therefore details in the value network are vailed. For example the amount of identified actors in the waste ecosystem depends on resolution of the framework and in particular in developing countries the number of intermediates [such as waste pickers] between households and the landfill are many. As discussed previously, the value networks and business models are intertwined. The key actors are playing the main role in value creation as they define the bottlenecks and the business model is the most vulnerable for any changes in the ecosystems that addresses those key actors. Key actors in the waste flow ecosystem are presented in the Table 2 and depicted in the Figure 3.

Table 2. Key actors in the waste flow ecosystem in a developing country

Role	**Name**	**Dimension of technology actor**
Supplier	Households	-
Supplier	Municipality	-
Intermediate	Waste transportation (such as trucks)	Infrastructure
Intermediate	Waste pickers	-
Intermediate	Waste container owners	-
Intermediate	Recycling wholesaler	-
Intermediate	Crushing machinery	Product
Complementor	Investors	-
Complementor	Incineration	Process
Complementor	Waste sorting machinery	Product
Complementor	Recycling facilitator	-

Identification of technology actors among all actors in the waste flow management ecosystem is a based on value blue print perspective on ecosystem. The role of government is huge as it sets and controls laws and regulations as well as is active actor in the waste ecosystem. In the framework governmental actor is present through Municipality and Investor. As indicated in the Table 2, four main technology actors can be identified in the ecosystem that define the performance of the waste flow. Suppliers, namely Households and Municipality, are not technology actors, yet they supply material (as unsorted waste) to the ecosystem through waste containers, waste pickers, and recycling wholesaler. Waste is transported by various kinds of vehicles between actors and finally it will reach the landfill or the recycling facilitator. When recycling wholesaler has also role of recycling facilitator then it can be considered also to be complementor to the landfill (in terms of sorted material). The role of Investors can be considered as complementor due to their ability to enable existence of recycling wholesalers/facilitators. Furthermore, there can be pointed out incineration as the technology actor, as technology innovations relating to incineration reflects directly on the performance of the waste incineration at the landfills. Interestingly, none of the identified technology actors have Core technology dimension. That implies that at the moment waste flow is not nest of broad technological innovations that are used widely also other fields.

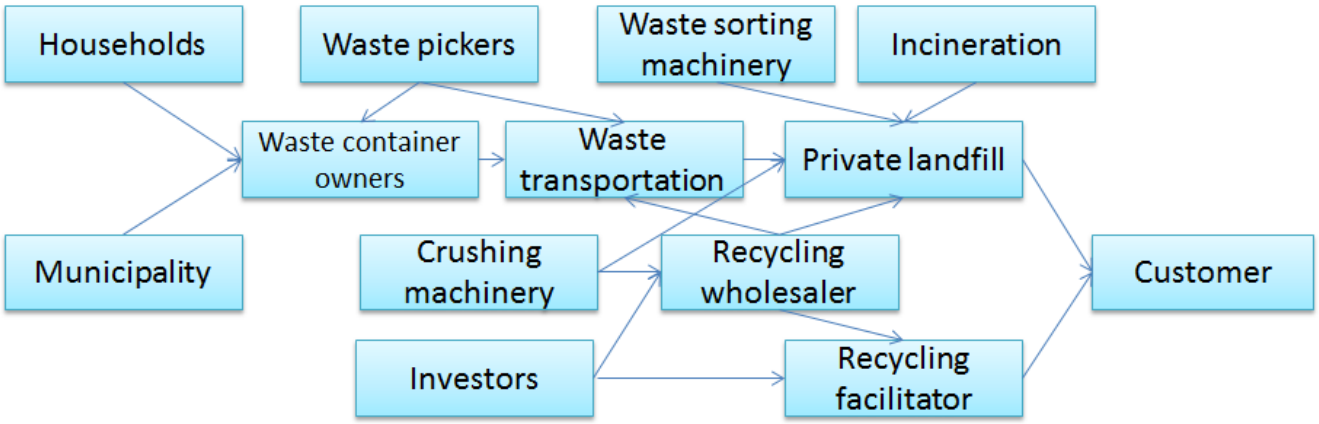

Figure 3. Waste flow ecosystem

Business models that are based on technological innovations that replace any existing technology actors are different than those that introduce new technology actor into the ecosystem. Introducing new actor might also require a management innovation [5, 12] and in that scenario the understanding the value network and actors in the ecosystem are required. In terms of waste ecosystem in developing countries the huge amount of informal actors possesses great social, political, economic, and environmental forces that cannot be underestimated. Yet, identified actors in the ecosystem will help organizations to find way to capture the value potential.

Conclusion

The waste flow ecosystem is diverse in particular in developing countries. Amount of waste is increasing with wealth yet without sufficient waste flow management. Environmental and social issues but also business opportunities are huge. The present study addressed waste flow management in developing country and conceptualized the waste flow ecosystem following seminal works of Moore [13] and Adner & Kapoor [8]. Furthermore in the study business models and value networks are connected to ecosystem perspective [10].

Based on the conceptualized waste flow ecosystem technology actors can be identified. The roles of technology actors are many; they for example enable the logistics and waste valorization through automatized waste sorting, and they can be used for waste to energy transformation. Especially when introducing new technology actor into the waste flow ecosystem roles of the key actors should be understood to be able to capture the potential value of the business model.

As the present study is based on Brazilian context, any other developing country might have somewhat variation with actors in the waste flow ecosystem. However, in practice the amount of actors are huge and those might have overlapping multiple roles in the ecosystem. The tremendous challenge to capture the value in the waste ecosystem in developing countries requires further studies. In addition to the country specific perspective, an interesting framework would be based on synthesized ecosystems of several developing

countries and even some country specificalities might be compromised, the synthesized framework can enable stronger propositions.

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