Requirements for adopting digital B2B platforms for manufacturing capacity finding and sharing

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Abstract— **This paper discusses the requirements of companies for adopting emerging digital Business-to-Business (B2B) platforms for manufacturing capacity finding and sharing. The requirements of the companies were identified through interviews with 34 companies from 5 countries in Europe, majority of them being manufacturers across different sectors. The study aims to contribute to wider adoption of such platforms among real life companies.**

Keywords— Manufacturing, IT platform, Resource sharing

I. INTRODUCTION

Digital B2B platforms are emerging technologies, enabling construction of digital marketplaces and configuration of dynamic value chains with optimal match of customers and suppliers in terms of capacity and competence requirements. Such platforms aim for enabling the search and optimal matching on a wide number of possible candidates from the supplier ecosystem, using a sophisticated criterion that ensures high level of quality, reliability of suppliers, reduction of costs and short time to close the business transaction. In such digital marketplaces, the capacity shortage problem of the customer is solved, excess capacity of the supplier is utilized, creating a resource sharing marketplace.

Earlier studies have mainly discussed the critical success factors for digital B2B marketplaces. Salo [1] suggests that companies should select appropriate business relationship and form the required relationship-specific digital infrastructure for successful digitalization of the business relationship. Rathi and Given [2] emphasizes the importance of design principles, web usability and search engine optimization for effective design of a successful digital marketplace. Based on 58 in-depth semi-structure interviews with senior level executives across four industrial sectors, Johnson [3] has identified that critical mass, integration issues, value proposition, and leadership participation play critical role for success of the digital marketplaces. However, according to a survey on existing digital marketplaces addressing various supply chain processes (e.g. procurement, engineering, manufacturing), there is a gap between virtual enterprise research and its implementation into commercial practice [4]. This gap necessitates in-depth research studies on practical needs and requirements of real-life companies for adoption of the digital B2B platforms.

This paper investigates the business needs and requirements of industrial companies to use digital manufacturing resource finding and sharing platforms. By identifying the needs and requirements of the companies, the study contributes to wider adoption of such platforms.

II. BACKGROUND

A. Digital B2B Platforms for Capacity Finding and Sharing

A recent report from World Economic Forum (WEF) [5] states that digital platforms change businesses in three ways: value shifts, non-linear growth and trust. Trust is seen as a crucial core value to succeed with facilitation, adoption and the use of B2B platforms. Six principles are identified as critical to build a trustworthy platform ecosystem: security, accountability, transparency, auditability, fairness and ethics. Security is seen as essential for transactions between companies in the same infrastructure, as a platform. Further, the platform needs to be reliable in how it is working, and the stakeholders needs to comply with standards set. However, the operator must be held responsible for the overall accountability of the platform. Transparency is another important factor of the platform, stakeholders needs to be provided with information to understand how relationships are set up, and how the platform use data to facilitate transactions between stakeholders. Another principle identified, is the auditability of the platform, which includes verifying and monitoring transactions in compliance with jurisdiction. Fairness is a core principle for B2B platforms, which should facilitate equitable transactions between stakeholders. Some examples of innovative B2B platforms are listed below:

- MakeTime (https://www.maketime.io/): simplifies the production of CNC machined parts, matching the customer with the most suitable supplier that will make available its production capacity to satisfy the request

- Quirky (https://quirky.com/): a free community-led invention platform that brings real people's ideas to life.

B. Kano Model for Requirements Classification

To classify the interests and requirements of the stakeholders, the so-called Kano Model [6] has proven to be a useful method and been adopted widely by many authors in the literature [7, 8]. The Kano Model for customer satisfaction is illustrated in Fig. 1. The model defines three types of requirements:

- Must-be requirement (Basic requirement): These requirements are the assumed and obvious requirements taken for granted by the stakeholders or customers. Satisfying these requirements will not lead to stakeholder satisfaction, while the stakeholders will be extremely dissatisfied if they are not met. Stakeholders consider these requirements as prerequisites for being interested in the project/product, without explicitly stating them.
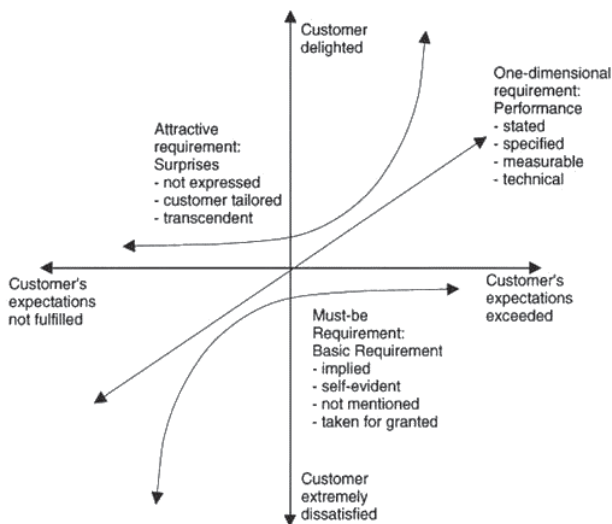
Fig. 1. Kano model of customer satisfaction (Adopted from [9])

- One-dimensional requirement (Performance requirement): These are measurable requirements expressed and demanded by the stakeholders. The satisfaction level of the stakeholders correlates with the level of fulfilment of these requirements.

- Attractive requirement (Surprises): These requirements are not expressed by the stakeholder since they are not expected or been aware of. However, they may lead to greater satisfaction of the stakeholder if they are met.

The foundations of the user satisfaction are established if must-be and one-dimensional requirements are satisfied. The attractive requirements are the extra ones, and if delivered they add to the performance quality. Once the attractive requirements turn to performance requirements (one-dimensional requirement), not delivering them becomes a dissatisfaction factor.

III. METHODOLOGY

The research methodology has mainly involved interviews with industrial companies who may be potential adopters of digital B2B platform. A total of 34 interviews were carried out, involving diverse company types. Traditional manufacturers were prioritized since they will be the main and direct users of the platform. Manufacturers that range from small to medium and large companies with varying types of manufacturing contexts (e.g. process type, discrete manufacturing, technology producers) were involved. Table I shows the number of interviews with each stakeholder type. The 34 interviews were conducted in five countries in Europe, including Norway, UK, Italy, Switzerland, and Portugal. To structure the interviews, a common interview guide was prepared and used to collect data. The interview guide structure consisted of the following sections:

- Introduction. This consisted of clarifying the purpose of the interview, as well as obtaining consent;

- Background. The aim was to collate as much background information with regards to the interviewee within the organization they represented.

- Organization Characteristics. The purpose was to identify the characteristics of the organization.

TABLE I. NUMBER OF INTERVIEWS WITH DIFFERENT STAKEHOLDER TYPES

Company (User) type	# of interviews
Manufacturers	18
Innovation facilitators (e.g. Innovation hubs)	2
Start-ups	4
Service providers (e.g. IT service)	5
Knowledge Providers (e.g. Research institutes)	3
Multipliers (e.g. Industrial clusters)	1
Investors	1

- Market Need and Issues. To identify the interests of the companies to share unused capacity.

- Business relations and barriers. To identify the key challenges and barriers for creating sustainable relationships across stakeholders in their business.

- Adoption Factors. At this stage, key adoption barriers were explored.

- Further Engagement. With the closing of the interview, discussion would take place to establish the engagement strategy with the interviewee.

Among the 34 interviews, twelve were recorded and transcribed, whilst the remainder were conducted by short-hand note taking. The main constructs of the company needs and platform adoption requirements were extracted from the transcribed interviews. The noted interviews were utilized as contribution for verification and enrichment of the codes, and hence validation of the findings.

The results of the analysis were further discussed in a workshop that involved participants from diverse types of companies, such as two textile manufacturers, a manufacturer of industrial automation technologies, several knowledge providers, a multiplier, and service providers. Further sections consolidate and present the findings of the study.

IV. NEEDS AND REQUIREMENTS OF COMPANIES FOR ADOPTING DIGITAL B2B PLATFORMS

A. Building business relationships and networks

Interview results reveal that the business maturity and characteristics of the companies play significant role in their needs and requirements when building business relations. The requirements from the platform will also be influenced by the companies' maturity levels. Based on their business and network maturity, we have classified the companies into two categories; mature (developed) and developing, as summarized in Table II.

Selection of the suppliers involve the following factors and criteria, taking the above discussed business maturity factor into account:

- Location (geographical proximity) is an important factor when it comes to selection of strategic partners, especially for the mature companies. The companies tend to work with suppliers or partners that are closely located to them due to better possibilities for physical meetings and communication.

- Mature companies have the resources and procedures to do tendering and evaluation of several suppliers/providers. For developing companies, this process mainly occurs in a negotiation form.

- Depending on the business context and typology, suppliers are not only expected to provide the required

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supply but also expected to contribute to the solutions where the product/service is customized to some degree. While mature companies apply supplier development programs and integrated production development strategies for this purpose, developing companies tend to select the suppliers that can provide such expertise together with the product/service.

- Some sort of trade-offs occurs in both categories of companies, when selecting the suppliers/providers. Such trade-offs include the parameters such as price, quality, distance.

- Searching and finding new/unknown suppliers specific to the product needs happen also in both cases, with varying degrees. Expectedly, developing companies experience this situation to a larger extend.

TABLE II. MATURITY CATEGORIES OF THE COMPANIES

Mature companies	Developing companies
Dedicated departments and teams for performing business processes and activities (e.g. procurement)	Unstructured and limited resources that require cross-functional roles to handle several processes and activities.
Standardized business processes and activities	Non-standardized business processes
Strong position in the market	volatile business characteristics that create many non-standard business activities
Established network of suppliers and customers. Knows whom to work with when suppliers/ partners are needed	Supplier and customer networks are under development.
Supplier selection occur in accordance with pre-defined criteria and procedures	Supplier selection is largely based on the core requirements (e.g. expertise, product specification) of the business activity. The priority is given to identify the core requirements due to limited resources.
Have strategic suppliers/partners with close collaboration	May have strategic partners, but largely operate in temporary relations with suppliers based on varying needs
have efficient communication channels (e.g. IT systems) with suppliers/customers/partners	Limited resources to invest on efficient communication channels
Strict and established procedures, and dedicated resources for ensuring business security, including IPR and data protection	Limited resources to handle the business securing tasks and larger need for external service providers

- Suppliers/partners/providers are characterized in accordance with various criteria, when selecting or maintaining the relationships. Following criteria were emphasized by the interview respondents: (i) earlier experience and history of working with the supplier. (ii) references about the supplier from another company in their network (iii) supplier's KPIs and track record (iv) reputation of the supplier/provider in the market in terms of its product/service quality.

Searching and getting in touch with potential customers is a more active business activity for developing companies compared to the mature companies with established customer networks. Following activities and approaches were emphasized by the respondents for expanding the customer networks:

- Contacting similar companies to the companies that they have worked with earlier

- Participating to industrial and academic events (e.g. conferences, fairs, meetings of the associations)

- Conducting market and trend analysis

- Benefitting from the networks of the internal employees

Business relations with suppliers and customers involve considerable risks that should be mitigated by the platform. Following risks were pointed out by the respondents, affecting the developing companies to a larger extend:

- Unclear tasks after signing the contract, which is a bigger issue for developing companies that have less standardized products and tasks.

- Limited time and resources that may lead to poor decision making of supplier selection

- Lack of precise information about the supplier/provider capabilities and expertise

- Limited choice/options of known suppliers for a specific need

- Lack of transparency on the supplier side due to hesitations to lose or fail business relation with the customer, especially in the case of unbalanced power relations where a developed company constitutes a significant share of the supplier's market

- Uncertain outcomes due to lack of earlier experience with the supplier

Risk mitigation is carried out to some extend through strategies that reduce the investment risks and contractual agreements that define the scope, duration, and limitations of the business activity between the involved partners. Nevertheless, building trust is a key factor to establish and sustain the business relations. Earlier partnership experience, transparency of capabilities, traceability of the business activity, and efficient communication and information sharing mechanisms have been pointed out as important factors for building trust. Finally, following business needs were outlined by the potential adopters to expand their supplier and customer networks:

- Easier accessibility to more options for suppliers/providers relevant to their business with better conditions (e.g. price) and precise information about their capabilities

- Quicker establishment of contacts with suppliers or customers,

- Better visibility in the market and accessibility to customer, which was especially indicated by the developing companies

- Co-creation, co-development, and co-innovation of products/services with suppliers/customers, which applies to both mature and developing companies to varying extends.

- Quicker and more accurate prioritization of new business/product/service ideas through customer/supplier network, which applies to

developing companies and start-ups to a larger extend due to their limitations in resources to commit.

- Expanding the markets for existing products/services

B. Unused Capacity Exchange (Buying/Selling)

Unused production capacity (e.g. machines, lines) and unused workforce capacity (e.g. manhour, expertise) constitutes the unused capacity in manufacturers. The need for unused capacity exchange stems from on one hand companies possessing excess capacity in low demand periods, on the other hand companies which experience capacity shortages due to different reasons. It should be noted that the same company may experience both excess capacity and capacity shortage in different periods.

On the excess capacity side, interviews with the manufacturers indicate that there is limited utilization of the non-used capacity. This issue mainly concerns with the lack of awareness on whom to sell, how to setup the links, and lack of trust to the companies external to the existing network. Companies tend to utilize the excess capacity internally, when they experience excess capacity not linked to a specific demand, depending on the business context and typology (e.g. Make-to-Order, Make-to-Stock) they are operating in. Examples of internal solutions to utilize the excess capacity include keeping safety capacities, building up safety stocks (i.e. work-in-process (WIP), final product), continuous improvement efforts, or developing, improving, and innovating the products/services.

On the capacity shortage side, following issues have been pointed out by manufacturers as the main causes: demand variability that make it difficult to plan the capacity accordingly, seasonal or periodical demand peaks, and bottlenecks in operations. The business maturity of the manufacturer is also an important factor for the solutions sought after to overcome the capacity shortage. While large companies have dedicated resources and internal production networks to solve the capacity shortage issues to a higher extend, developing companies have limited resources that may force them to outsource business processes and buy capacity, including production and expertise for short-term non-standard tasks. Few companies indicated having a structured approach to acquire capacity when needed, such as having capacity exchange agreement with a strategic partner. Nevertheless, fire-fighting approach is also applied commonly to handle the capacity crisis occasions.

Having limited resources, developing companies are less reluctant to exchange capacity with actors outside their network. However, mature companies have higher privacy and trust concerns, and are therefore more reluctant to use this option. Obtaining precise information about the capacity (e.g. availability, properties, expertise) and protection of intellectual properties are critical to realize a successful capacity exchange business, regardless of the maturity of the company.

C. Production Waste and By-product Exchange

Interviews indicated that the companies are aware of the economic and social importance and opportunities of utilizing the production waste or by-products. As a well-established and promoted strategy in Europe, sustainability is part of the business agenda of all interviewed company types, including the start-ups. Manufacturers are part of a production waste value chain in different ways such as:

- Selling or buying production waste or byproduct to another company

- Hiring sub-contractors that handle the production waste or byproducts, especially the hazardous ones

- Selling waste to governmental/ public agencies

- Recycling in their own facility or internal network that the company belongs to

Interviewed manufacturers expressed much stronger interest on selling their production wastes or by-products compared to buying the waste or by-products of another company. Following needs and expectations were expressed to consider the latter case.

- The waste or by-product should be at a certain level of quality,

- The transformation of the waste to a usable part/product is not always straightforward or clear. There is need for knowhow that can realize this transformation.

- Buying waste should give better business conditions (e.g. lower material and operating costs)

- Volume should be at a reliable level. There should be continuity in the supply of the utilized waste or by-product.

D. Volume and Critical Mass Requirements

The adoption volume of the platform is one of the main requirements for companies to take part in the platform. Following requirements were pointed out to achieve a critical mass that is not only needed to realize the platform's objectives, but also to acquire participants to the platform.

- Companies would like to see relevant actors to their business in the platform

- Having accessibility to large number of potential customers will augment the interest to adopt the platform

- The companies would feel obliged to join the platform if big actors of their target markets are found there.

- Adoption and usage of the platform by well-known international enterprises would increase the trustworthiness and reliability of the platform

The respondents have also pointed out the necessity of visualizing KPIs that corresponds with their volume and critical mass requirements, such as number of users, economic growth of the participants, and number of businesses triggered by the platform.

E. Functionality and Information Sharing Requirements

The functionality provided by the platform should address the identified business needs and expectations of the stakeholders. Following functionality requirements were pointed out, with an ascending order in terms of advancement.

- Providing listings of relevant suppliers/providers and customers

- Identification and matchmaking of potential demand (e.g. production capacity) and supply (e.g. available capacity) between stakeholders

- Identification and indication of new business or market opportunities for products/services

- Prioritization of new ideas and trends for products/services, which is especially required by developing companies that have limited resources

The respondents stated that they would require to get as much relevant information as possible quickly from the platform, to carry out above stated functions in an effective (e.g. timely and appropriately) way. Some examples of information pieces include the supplier/customer profile, performance indicators, and capacity properties to be exchanged. Despite their requirements to access to information, most respondents stated that they would hesitate to give information to the platform due to security and IPR concerns. As also emphasized by [5], security and trust issues should be carefully addressed by the platform for successful adoption. Few respondents has also indicated the importance of symmetric and fair information sharing, namely there should a balance between what a stakeholder gives to the platform and what it gets.

F. Business Support Requirements

Another critical requirement for the successful adoption of the platform concerns with the degree of platform's interaction with the business relationship that the actors will build up. Respondents have stated mixed views on this aspect. Some of the respondents required that the platform should be accountable for the business activity when it is triggered by it, which will increase the trust to the platform. Others stated that the role of the platform should be limited to match-making of demand and supply between the actors, and the contractual agreements should be made outside of the platform.

Nevertheless, identified alternatives of the platform's role when the activity is triggered through the platform is listed below:

- monitoring and visualizing the business activity with the supplier/customer,

- providing traces of the business activity with the supplier/customer

- handling the contractual agreement for the business activity

- providing legal support for the involved actors of the business activity, if the agreements are not met.

V. CLASSIFICATION OF NEEDS AND REQUIREMENTS

Based on the identified needs and requirements for adopting digital B2B platforms, the framework in Fig. 2 is proposed for classification of thee needs and requirements of industrial companies. The framework adopts and modifies the introduced Kano model in accordance with the outcomes of the study. The framework consists of the following three dimensions:

- Adoption volume: The "x-axis" of the framework addresses the adoption volume of the platform. Along the x-axis the adoption volume increases. Critical point is regarded as a degree of adoption volume and appointed as the centre of the framework.

- Known requirements: The "upper side of the y-axis" addresses known requirements of the potential stakeholders. It consists of stakeholders' interests and needs, and functionality, information, and business
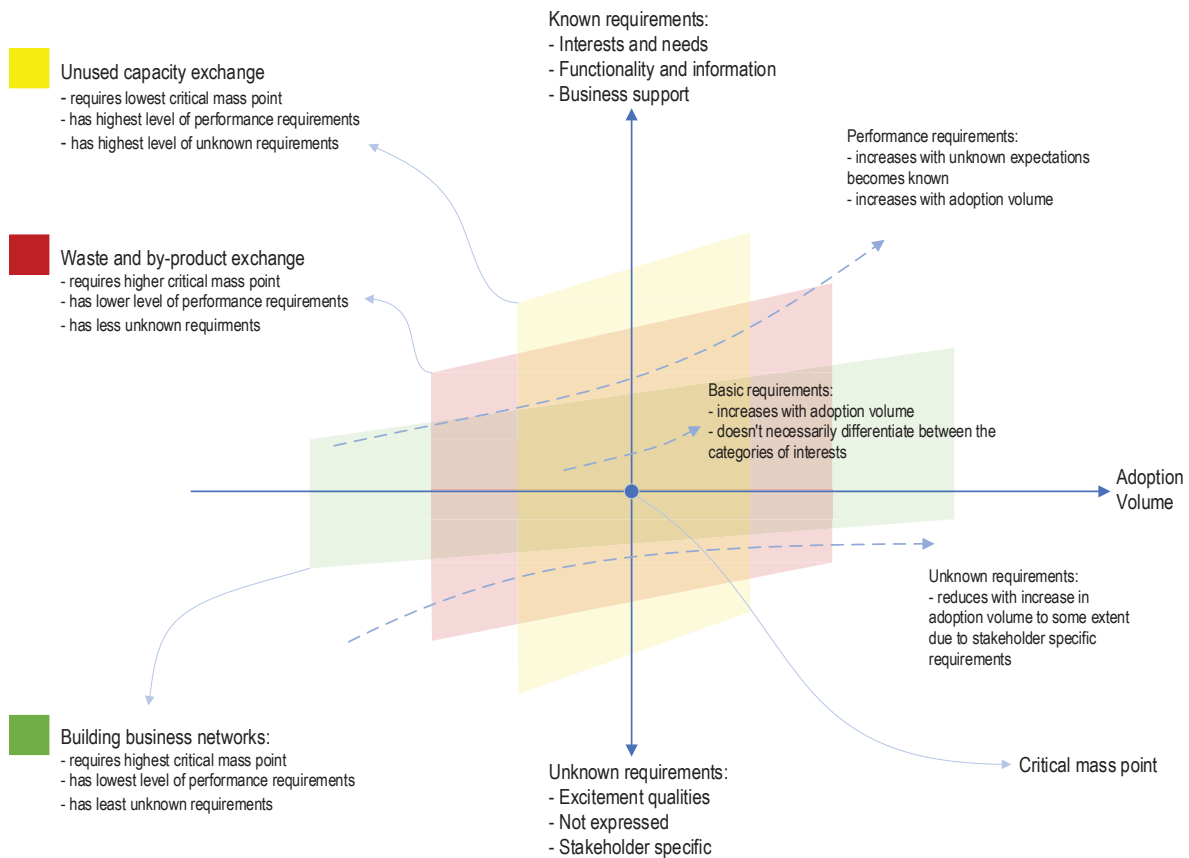

Fig. 2 Framework for classification of the stakeholder interests and requirements

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support requirements from the platform. Along the upper side of the y-axis the level of advancement of the requirements increase.

- Unknown requirements: The "lower side of the y-axis" addresses the unknown requirements of the stakeholders. Along this side the level of unknown requirements increases.

Modifying the basic, performance, and excitement quality concepts of the Kano model, the framework defines three types of requirements:

- Basic requirements are the obvious ones that are assumed to be satisfied for adoption of the platform. An example is that adopting the platform should provide some sort of value to the user, such as easier accessibility to potential suppliers. Basic level of requirements increases along with the adoption volume, however does not necessarily differ between categories of interests.

- Performance requirements are the expressed ones that should be satisfied to increase the adoption of the platform, achieve the critical mass, and ensure well-functioning of the business relations and activities. An example is that the platform should provide match-making of demand and supply sides related to a business relation and activity of interest.

- Unknown requirements are those that haven't been expressed yet since the platform is under development and the stakeholder analysis involved limited number of representatives from different stakeholder types. There will be stakeholder-specific and company-specific requirements, with involvement of other companies.

Three interest categories are mapped across the three dimensions and requirement types:

Interest category 1: Unused capacity exchange:

- requires lowest critical mass point since the business activities will involve limited number of actors with higher degree of specifications on the sector, business context, production capacity types, and areas of expertise, depending on the capacity type.

- requires highest level of advancement when it comes to performance requirements since the business activities will require more detailed information sharing (e.g. properties of the capacity to be sold/bought) as well as higher degree of business support (e.g. protection of intellectual properties).

- has highest level of unknown requirements since high degree of specifications of the business activities will involve high degree of specific requirements.

Interest category 2: Waste and by-product exchange

- requires higher critical mass point since the business activities will have higher degree of opportunity to involve companies across different sectors or contexts as long as the waste or by-product has an identified usability.

- requires lower level of advancement when it comes to the performance requirements since the level of

information sharing and business support will be concerned with non-critical business interests such as production waste utilization for the companies.

- has lower degree of stakeholder specific requirements compared to the interest category 1, therefore less unknown requirements.

Interest category 3: Building business networks:

- requires highest critical mass point since the companies are interested to have better accessibility to large number of suppliers and customers to broaden their networks. Satisfying this interest will also contribute to volume expectations of the above two categories of interests since larger supplier and customer networks will help identification of possibilities for unused capacity and waste exchange.

- requires lowest level of advancement when it comes to performance requirements since lower degree of information sharing (e.g. basic information about the company's profile and match-making of potential suppliers and customers) and functionality (e.g. matchmaking) can support this activity.

- has lowest level of unknown requirements since the stakeholder-specific requirements from the platform will be limited in terms of functionality, information sharing, and business support. The variability occurs when it comes to the types of suppliers and customers relevant to the stakeholder's business.

VI. CONCLUSION

This paper has focused on the identification of needs and requirements of companies for adopting digital B2B platforms for manufacturing capacity finding and sharing. Such platforms act as a virtual marketplace bringing the available production capacity, as well as other virtual and physical assets, closer to the production demand to obtain the optimal matching. The study was mainly based on interviews conducted with potential adopters of the platforms. The interviews involved 34 respondents from various types of companies with priority given to the manufacturers that have been identified as the key users of the platform. Even though the results should be considered preliminary given the limited number of respondents, interesting findings have already been pointed out. While building business relationships efficiently and utilizing unused capacity are common interests for the companies, adopting a digital B2B platform needs to overcome the critical mass and information sharing constraints. These constraints imply varying levels of challenges depending on the interest. For the unused capacity exchange interest, information sharing requirements and constraints are significant. While companies demand as much information as possible, they may hesitate to provide information to the platform due to trust issues. For finding and building business relationships, critical mass should be achieved to attract the companies. This issue makes the community-building activities along the development of the platform a critical success factor. As a next step, in order to increase the reliability of the proposed requirements, an online survey with structured questions will be designed and conducted. Future research is also needed to design and conduct use case scenarios to investigate the integration of digital platforms into business processes.

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