

Multi-sided digital manufacturing platform supporting exchange of unused company potential

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Abstract—The come to power of the sharing economy paradigm has incentivized the adoption of service-based business models largely relying on digital platforms providing the infrastructure and the ecosystems to sustain market uptake. The manufacturing domain isn't exempted from this trend, witnessing the growing launch of digital platforms with the aim of shifting value proposition towards a model relying on product servitization and share, instead of ownership. Most of the current examples in this domain are very narrowed-scope systems that just connect business providers or, when giving detailed services, these are dedicated to very specific manufacturing sectors (few machining operations available, few materials, etc.). This conceptual paper presents an application and extension of the Digital Platform Model to manufacturing services across Europe. A digital platform, called MANU-SQUARE and aiming at becoming the reference one-stop shop for European manufacturing is envisioned. Provision of customized services that adapt to different users' needs in cross-sectorial domains and coverage of the whole spectrum of value chain activities are its key features. On top of basic services, MANU-SQUARE creates the ground for a self-reinforcing knowledge, innovation and services ecosystem that, by creating more touch points for involved third parties, is able to remix and re-bundle the components making up the offering over time.

Keywords—servitisation, digital platform, multi-sided business models, manufacturing as a service, resource-efficiency.

I. INTRODUCTION

Servitization is nowadays a common trend that has been embraced by many companies in a wide set of industrial sectors moving income generation from the sale of the physical production output to charging the customer for the availability of a service that the product bring forth [1]. This has been applied already both to consumer goods and to capital goods as companies are more and more willing to sell (and buy) manufacturing capacity instead of new equipment making the manufacturing as a service (MaaS) paradigm arise.

Yet this transformation is limited to a change in the bilateral business relationship between machine producers and manufacturers and therefore it doesn't consider systemic effects, such as capacity underuse and suboptimal value networks, thus still retaining the European manufacturing

system from unleashing its full potential. Also opportunities for reuse of wastes or by-products within the industrial ecosystem difficultly emerge thus limiting their enforcement. A step beyond servitization is required.

It appears evident that, to fully achieve the MaaS paradigm, an aggregation and information sharing point is required to give visibility to the manufacturing capacity that any company may want to make available at any location and in any particular field of the European industrial ecosystem.

This characteristic is particularly relevant to either small or new businesses in high-tech sectors seeking for the right supplier or competence who may see their effort hindered by lack of visibility leading to incapacity to find the right partners. To this regards an approach, such as the one here proposed, is needed to support the generation process of innovative product-services, from design to early production stage, with fast and effective match of articulated demand and available supply. In fact, by exploiting the platform-enabled marketplace, technology savvy brokers have the proper visibility over system capacity and can easily arrange scope-driven value networks leveraging on the underlying aware and reactive industrial ecosystem with mutual benefits to both providers and users of manufacturing services.

In this paper the concept behind the MANU-SQUARE platform is described by also giving an outlook about the expected impacts its adoption at European level is expected to achieve. First, the background on which the platform stands out is presented, by giving the reader an introduction to the main theoretical background. The project overall concept and the objectives the platform aims to achieve are then presented. The technological and business elements leading to the platform implementation and to its market uptake are eventually described.

II. THEORETICAL BACKGROUND

A. The advent of Servitization and Product Service Systems

The evolution from an economy of products towards an economy of services has become important in manufacturing since the nineties [2]. The concept of servitization, was firstly coined by Vandermerwe and Rada [3] that defined servitization

as the increased offering of fuller market packages or bundles of customer focused combinations of goods, services, support, self-service and knowledge in order to add value to core product offerings.

While the concept has been minted several years ago, it is in the last decade that it gained mainstream adoption. On one side, manufacturers in developed economies had to cope with fierce competition coming from low wage countries that led to move up the value chain to compete on the basis of value delivered rather than on the basis of cost [4]. On the other side, external driving forces such as the rapid industrial transformation towards a digitally based ecosystem, and the leading role of information technology, let manufacturing servitization become a significant trend followed by companies to strategically reshape their value proposition [5], [6].

The concept of servitization gained popularity under more than a single definition: the work carried out on product-service systems (PSS) ([7], [8], [9], [10]) is particularly closely related. Many of the principles are indeed identical, with differences coming from the motivation and the geographical origin of the research communities. PSS is a Scandinavian concept which is closely coupled to the debates on sustainability and the reduction of environmental impact [11].

In both the contexts, the transition of pure product manufacturers towards pure service providers involves the decreasing of tangible product content in favour of an increasing intangible service content [12]. In such kind of approach, three categories are generated in terms of degree of service content:

- product-oriented services: the business model is still mainly geared towards sales of products along with some product related services;
- use-oriented services: the traditional product still plays a central role, but the product's ownership stays with its provider, and product utilization is available to its user in a different form, and sometimes shared by multiple users;
- result-oriented services: the provider and customer in principle agree on a result, and there is no pre-determined product involved.

As argued by Jin et al. [13], the difference between the proposed models lie in three aspects: (1) value realization: the traditional manufacturer achieves the value through the tangible products, servitization manufacturer emphasizes the value realization by offering customers the whole solution; (2) technological process: the traditional manufacturer only cares about the production itself while servitization enhances a human-centered concept that emphasizes knowledge accumulation and transmission; (3) organization mode: the traditional manufacturer achieves scale economy through the vertical or horizontal integration; servitization manufacturer emphasizes network cooperation to realize knowledge sharing and optimization of resource distribution in collaboration.

B. The taking-off role of platforms in the manufacturing domain

The sharing economy has emerged in recent years as a disruptive approach to traditional B2B and B2C models by giving access to underutilized resources at a fraction of the cost

to whom cannot or do not want to buy new products, and as the chance of making an extra income, for those who already own such underutilized resources [14]. Being “business models that allow multiple sides (producers and consumers) to interact [...] by providing an infrastructure that connects them” [15], platform models have strongly proliferated over the past years, reducing transaction costs and facilitating exchanges that otherwise would not have occurred [16].

Platforms create value in two principal ways: the first one is facilitating transactions between different types of individuals and organizations that would otherwise difficultly find each other. Obvious examples include Uber, Google Search, Amazon Marketplace, and eBay. The second one is providing services or products on the top of technological building blocks used as a foundation. An example is the iPhone, which has hundreds of thousands of applications developed by innovators all over the world using Apple technology as basis [17].

The disruption provided by platform models is thus deriving from the transformation of value chains into multidimensional value networks. In a nutshell, benefits for consumers arise from platforms' offerings of a range of services that ensure: consumer convenience (time saving, accessible at any hour of the day, personalization, simplified transaction system, home delivery), reduced information asymmetry (through rating systems, comparison tools, simplified terms and conditions), improved awareness (ads promoting goods and services that the user was unaware of, more accessible product information), greater choice (diversity of products and sellers), monetary benefits (offering packages of goods and services, promoting deals, reducing costs of access to information) and additional sources of income (consumers can sell their products on marketplaces, offer services through sharing economy platforms) [14], [15], [16], [17], [18].

Attempts to establish the MaaS paradigm in this way has already begun and resulting manufacturing platforms are available either to specific domains, such as 3D Hubs [19] for the additive manufacturing, or to regional ecosystems, such as MakeTime in the US [20].

The success of the described platforms largely depends on the ability of easily connecting B2B customers minimizing efforts, reducing costs and shortening times in the interaction and provision of services. To reach this objective it is necessary to have flexible markets and institutions capable to adapt their policies to the needs of economic models changing so fast. Europe has largely missed the first wave of digital platforms, indeed, despite it having been always very good at inventing new technologies and digital concepts, yet it struggles with the commercial exploitation of these ideas. The fact that Europe struggles with the commercialization of ideas, including in the area of online platforms, is noticeable when looking at the number of European platforms compared to other parts of the world, especially North America and Asia [21].

C. Open innovation for stakeholder engagement in Product Service Systems design

Consumers' enrolment, recruitment, engagement or involvement in innovation processes is a subject of research in

the last decades [22]. Consumers have been traditionally engaged primarily to validate new product concepts but some companies are now soliciting consumer insights and ideas to jump-start the “fuzzy front end” of the innovation process. Some novel ways to gain competitive advantage break the rules of engagement with consumers [23]. Companies are experimenting with non-traditional approaches that seek upfront inspiration and actual ideas from creative consumers who have a passion to innovate.

The Open Innovation paradigm, that Chesborough [24] defined as the counterpart of the Closed Innovation one, adopted by most of the big firms until begin of 2000, is based on the assumption that “*Not all the smart people work for us. We need to work with smart people inside and outside our company*”. Following the Open Innovation approach, firms open the search of new brilliant ideas to the contributions coming from outside the company, which means not only single persons such as customers, innovators, designers, but also creativity and challenges provided by other companies that cannot realize brilliant ideas on their own. However, one serious limitations in this approach is the absence of research targeting the perspective of the contributors. Contributors are commonly treated merely as a resource, an effective and efficient way to improve innovation processes. As a result, the exchange relationship and power balance between an organization and its contributors are not researched and present claims of open innovation as an approach for democratizing innovation lack the support of well-grounded studies. Hence, there is a need to examine the relation between firms and external contributors, with a focus on the contributors.

Internet technologies have allowed consumers to express their opinions and creativity, allowing radically new ways for companies to co-develop products [25]. Electronic Arts, a maker of computer games, ships programming tools to its consumers, posts their modifications online and builds their ideas into new games. Non-traditional approaches to conventional forums call for three shifts in mind set: separating the consumer involvement process into two distinct stages so as to give “divergent thinking” the prominence it deserves; recruiting creative, articulate consumers who are passionate about the subject matter and can contribute energetically in a demanding front-end setting [26]; and using imaginative, powerful interaction techniques and exercises to stimulate consumers to think imaginatively. Focused idea-generation competitions are a new phenomenon [27], enabled by the development of specialized software applications. Cash or other prizes generate interest and drive participation [28]. The market sees now open innovation platforms that are either generic (e.g. OpenIdeo or Innocentive) or company-specific portals, launching contents and campaigns to retrieve contributions from customers and suppliers to solve challenge (such as HypeInnovation), or commercial solutions, like Spigit, that offer a combination of web services to collect, identify, create analytics, and evaluate ideas as for commercialization potential. However, these supports end with the concept development: all such systems are isolated from the other phases of product lifecycle not having any interface with the tools used to further evaluate technical and economic viability,

that is if and how the ideas can be supported by sustainable business models and supply chains to realize them.

III. MANU-SQUARE CONCEPT AND OBJECTIVES

A. MANU-SQUARE overall concept

The MANU-SQUARE concept comes into being from the acknowledgment of the limitations that current approaches to the sharing of manufacturing capacity present. Not only these approaches limit their field of investigation and application to specific subsectors of the industrial ecosystem significantly downscaling their possible business impact but they also narrow their view on manufacturing capacity alone, neglecting complementary yet fundamental assets that, as a matter of fact, make up the authentic wealth of the European industry.

MANU-SQUARE recognizes this gap and takes a step beyond the mere facilitation of production capacity exchange. The full potential residing in the industrial ecosystem is much more than just unused machinery (Figure 1).

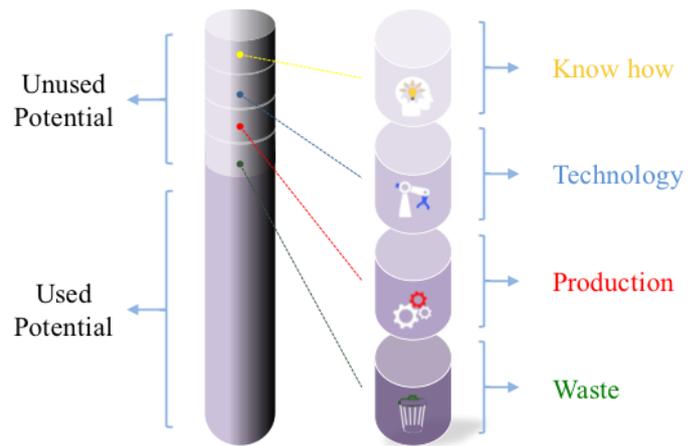


Figure 1: Decomposition of used and unused potential residing in the MANU-SQUARE industrial ecosystem

It lies in the vertical and transversal know-how that the companies have built up over decades of thriving business in a wide spectrum of industrial fields. It is embodied by the on-the-edge technologies they have developed through years of innovation and research. And, yes, there is also potential in the resources they consider as by-products or wastes and traditionally represent a burden whereas they could become an opportunity if opportunely recirculated in a broader environment.

This unused potential is vibrantly sleeping and it needs to be released through a new holistic paradigm where manufacturing servitization and cross-company contamination bring innovative product-services from conception into life. MANU-SQUARE takes this tacitly existing potential and gives it visibility on the platform. In a way it creates a set of digital playfields where companies can profit from their own unused assets by selling them as a service while taking advantage of

the other's presence to complement their own capabilities (

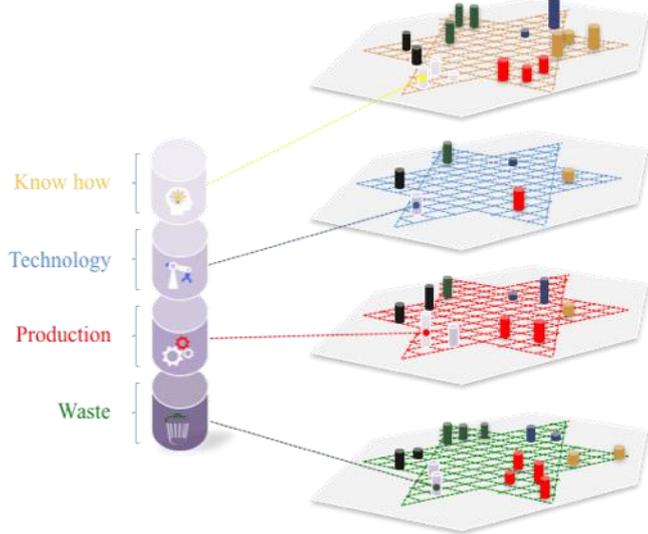


Figure 2).

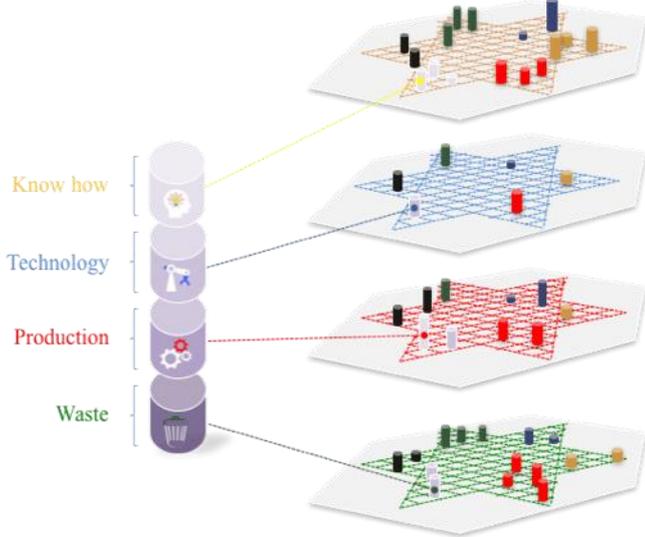


Figure 2: allocation of unused assets on platform playfields. Companies matchmake their assets with those deriving from other stakeholders of the platform to complement their own capabilities.

Being part of the game means being able to expand the virtual portfolio of resources to draw from, going beyond what is internally owned. The extent to which the playfields can enhance the companies' internal capabilities is magnified by the multiplying effect offered by the cross-sectorial nature of the platform-enabled ecosystem. In fact, vertical well-established supply chains entirely belonging to specific industrial fields tend to follow business-as-normal paths rarely pushing their steps outside their traditional positioning.

The explicit availability and structured representation of what is offered in the ecosystem makes it possible, through the platform-provided services, to address a plethora of heterogeneous needs that the actors approaching the ecosystem could neither be able to solve nor be economically interested in if they have to figure them out and manage on their own. The

platform thus adapts its behaviour to the nature of the upcoming request and takes it under its umbrella providing the most fitting customized support.

The role of the MANU-SQUARE platform coaching doesn't cease with the setup of a coherent yet limited in time and scope framework of relationships but it aims also at channelling the course of the new product-service development along the many stages it has to go through before flowing into the market. All along this process, depicted by the innovation vortex of Figure 3, the ideas under elaboration are constantly exposed to the contamination introduced by the industrial actors participating in the ecosystem as well as by the customers who are encouraged in this way to be proactive characters towards more technologically-advanced and market-fitting results.

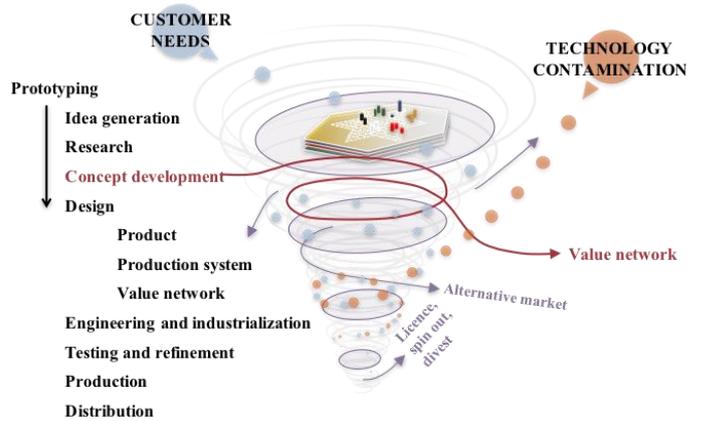


Figure 3: the MANU-SQUARE vortex integrates open innovation in the platform ecosystem by contaminating all along product development lifecycle, customers' needs with platform stakeholders technologies and innovation proposals.

B. MANU-SQUARE Objectives

By following the approach proposed in the previous section and by leveraging on the technological architecture presented in the next chapter, MANU-SQUARE grounds its concept on 4 objectives that provide a comprehensive approach towards valorisation of industrial assets:

- I. **To make European unused manufacturing capacity emerge towards its reintegration in the loop and the creation of local efficient value networks.**

The main purpose of the MANU-SQUARE platform is to showcase the available manufacturing capacity that European producers cannot capitalize at the current state of things and are willing to offer as a service fostering its transformation into a tradable commodity and its dynamic exchange in a marketplace.

Grounding on the matching algorithm integrated in the platform and relying on its reputation mechanism that promotes mutual trust, companies can access to a European-wide pool of well-characterised potential partners bringing their technologies and updated manufacturing availability, for both speeding up the request for quotation (RFQ) process and improving its efficiency.

The cross-sectorial nature of the envisioned ecosystem allows traditional companies offering their manufacturing services to go beyond a mere saturation of internal resources opening new market opportunities as demand is coming from a wide range of previously unexplored fields.

II. To support innovative SMEs and start-ups in finding the optimal suppliers to transform their business ideas into new product-services

The platform becomes a facilitator for unleashing the full innovation potential residing in SMEs and start-ups bringing new ideas or new technologies, competences and processes into play, recognising that the tougher gap to be filled, from concept to market, lies in finding the fitting collaborations to both cover all the technological development steps and to setup a viable value network ensuring economic feasibility of the new business and environmental sustainability of the production.

This is achieved through the integration of a pool of Innovation Managers within every project that, by leveraging on the platform tools and on the cross-sectorial competences of its associates, perform feasibility analyses of the new concepts and configures the optimal value network that combines new technologies and processes brought by the innovative SMEs and start-ups with traditional companies' unused production capacity and competences thus creating win-win situations for all the stakeholders.

III. To seamlessly involve actors all along the entire value network including consumers for cross-fertilisation of product-service solutions and underlying technologies

MANU-SQUARE recognises that, in order to remain competitive on the global markets, European companies need to early intercept the emerging demand coming from consumers and to make the most out of the creativity potential and opportunities residing in the industrial ecosystem at any level to achieve game-changing solutions.

To this end, the MANU-SQUARE platform supports an Open Innovation approach in a twofold fashion: on the one hand, it promotes consumer involvement by exposing a social section that reverberates the product-service ideation process to collaboratively define ideas and concepts, exploit community feedback for better aligning development to actual needs; on the other hand, it acts internally by opening this process to hints and collaboration candidacies from the ecosystem associates thus exploiting the huge cross-fertilisation potential offered by the cross-sectorial nature of the platform.

IV. To coordinate the whole MANU-SQUARE ecosystem towards a better use of resources and a more sustainable European manufacturing

The MANU-SQUARE platform aims at complementing its single value network creation with a holistic coordination of the ecosystem level. This is concretised by an information-enabled sharing of resources (including energy, waste and by-products) and coordinated resources flow management across different value networks and different sectors following the nature-inspired industrial symbiosis paradigm.

Indeed, the lack of visibility over the type and level of resource consumption prevents the identification of valuable opportunities such as the re-use of by-product that would be otherwise wasted or a more balanced use of energy. The MANU-SQUARE platform creates value by sharing information and building a unified flow vision of resources allowing an easier identification and exploitation of synergies between companies and also supporting the localisation of production, to reduce logistics costs and consequently the environmental impact. A sustainability assessment layer, integrated in the platform, allows for continuous monitoring and fact-based decision making resulting in a more resource-efficient production of the ecosystem as a whole.

IV. MANU-SQUARE IMPLEMENTATION DOMAIN

A. MANU-SQUARE ecosystem

The MANU-SQUARE ecosystems brings together those subjects that, at different levels in the value chain, concur to the achievement of the proposed objectives, namely (i) Manufacturers with unused capacity and materials, (ii) Start-ups and innovative manufacturers, (iii) Innovation managers, (iv) End-users/Prospective consumers; (v) Potential financiers; (vi) Software developers. For each of them, a quick description of their profile is given below.

Manufacturers with unused capacity and materials: the first group of target users includes manufacturing companies with unused production capacity (also including providers of KETs, where the problem of unused capacity is amplified) and, more extensively, materials and by-products (being themselves an unused resource). The MANU-SQUARE ecosystem will enable these target users to find potential users for their unused capacity. The value proposition carried by the platform contemplates: (i) quick matching of the most suitable production requests. Being based on a common and shared ontology, both offer and demand for production capacities are described in a comparable way, this enabling easy (also semantic-powered) combinations abating the initial searching costs; (ii) access to a list of potential suppliers and their available capacity, each qualified with a reputation profile; (iii) decision support tools enabling sustainability-aware choices of transactions (this abating the transaction costs); (iv) transaction security assurance thanks to the blockchain-enabled tracing of information exchanges among transactors.

Start-ups and innovative manufacturers: the second group can be tagged as "the innovators". They are either start-ups (but also single innovators having a concept or innovative idea) or pre-existing (traditional) companies looking for partners supporting them in the transformation of this concept into an actual, marketable product-service solution. Kind of support they need strongly varies in accordance to the size of the company, the maturity of the innovation project and the novelty of the involved technologies and solutions. Value proposed by the platform is elicited in the following services addressing:

- identification of the best supporting innovation manager. Especially SMEs need external support from a broker or innovation managing entity that guides them during the project and drives their choices, starting from the product

conceptualization up to suppliers identification and selection;

- support in value-chain design, with proper algorithms enabling the identification of the more sustainable actors to be involved;
- support in best suppliers identification, based on the reputation mechanism;
- (external) contact with potential financiers: the platform will be linked with external crowdsourcing platforms and venture capitalists aimed at providing valuable contacts with potential financial partners to interested start-ups;
- end-users involvement in product-service early assessment, supporting early choices on products shapes and functionalities;
- transaction security assurance, increasing the trust in open-innovation initiatives.

Innovation managers: they handle a combination of the management of innovation processes, and change management. They usually deal both with product, business process, and organizational innovation. Innovation management includes a set of tools that allow managers and engineers to cooperate with a common understanding of processes and goals. Innovation management allows the organization to respond to external or internal opportunities, and use its creativity to introduce new ideas, processes or products: it is not relegated to R&D; it involves workers at every level in contributing creatively to a company's product development, manufacturing and marketing.

Innovation consultants are expected to be keen in joining the MANU-SQUARE ecosystem for the following main reasons:

- identification of innovation projects requiring support
- support in value-chain design
- support in best suppliers identification for creating a sustainable value network
- exploiting end-users opinions for product-service early assessment

End-users/Prospective consumers: these are end users of the developed solutions that have a non-direct connection with the activities carried out through the platform, but can access it to provide valuable insights about product/services provided. For-free they can access to a wide database of innovative products and ideas; smart searching functionalities; easy contact with innovators; capability to influence the shape and functions of products they will use in the future.

Potential financiers: "lack" or "no" access to financial resources is one of the most widely cited reasons for failure of innovation projects, especially ones promoted by start-ups. Developing a direct link with crowdfunding platforms and external investors is expected to mitigate this concern especially for the "innovators" target group. In exchange, financiers can find in the platform organized, ontology-based repository of multi-sectorial innovative projects with different maturity levels, also directly assessed from end-users.

Software developers: they transform a static (or just autonomously-developed) platform into a living solution

constantly enriched with new functionalities and services and integrated with other software tools in compliance with the Single Digital Market vision. In the platform they can get direct access to a wide range of potential customers for their software solutions (especially pre-existing manufacturers selling unused capacity and materials)

B. Platform architecture

The MANU-SQUARE platform exploits several integrated technologies to provide the services described in the previous sections. The software architecture underlying the MANU-SQUARE Marketplace Platform (MMP), shown in Figure 4, is meant to support the consistent and secure flow of information that, beginning with the data gathering in the companies' shop-floor, allows to aggregate real-time information to achieve a constantly updated snapshot of the ecosystem status thus fostering the provision of high value-added services to its members. The MMP functioning is strictly relying on the role of the Blockchain-based Platform for Supply Chain (BPSC) that has a twofold aim: on the one hand, it manages the processes and related transactions at any node of the supply chains generated within the ecosystem while, on the other hand, it connects the IoT devices within the single company node to support automatic data gathering. The MMP acts as the core managing system of the whole solution and, with its components provides functions at three different levels: data management, service provision and external integration. At data management level it has two main functions: (i) it exposes interfaces for data connection with the BPSC through the Ecosystem Live Data Services thus feeding the semantic representation of the ecosystem in the inputting direction while dictating actions such as user-driven supply chain configuration in the outputting direction; (ii) it keeps the various data repository (Live Data, Factory Data, Supply Chain Data, Innovative Ideas, etc.) updated through the Ecosystem Data Manager taking also care of the persistency of the data models. At service level it leverages on a set of modules that, by reasoning on the semantic representation of the data models, provide complementary services for the platform users (both human and other software modules). These service providing modules act cooperatively making a cross usage of the functionalities that each module offers to provide higher added-value services. The main service-providing modules are:

- Matching Service, the module stands at the core of the demand-supply matching within the MANU-SQUARE marketplace. It uses non-aprioristic relations offered by the semantic nature of the data models to identify and rank all the possible and most fruitful connections between companies' needs and offer.
- Unified Flow Ecosystem Orchestrator, an optimiser that abandons the one-to-one approach followed by the Matching Service to adopt an ecosystem-level perspective meant to enhance efficiency in the use of the resources (materials, energy, wastes, etc.) flowing between the ecosystem members.
- Sustainability Assessment Layer, a tool that calculates LCI and LCIA to measure the environmental sustainability of the processes and flows taking place in the ecosystem with the aim to complement the ranking system offered by the

Matching Service with a particular lens that monitors sustainability impacts.

- Open Innovation Co-Design Idea Management Tool, a platform for creative user interaction where new projects can be posted and followed to incentivise other actors' involvement in the development of the idea in an open innovation approach.
- User Profiler and Reputation Mechanism, the management tool of all the users (companies but also physical persons like the Innovation Manager) that allows the characterisation of demand, supply, know-how, competences and all the other information needed by the other modules to carry out their reasoning.

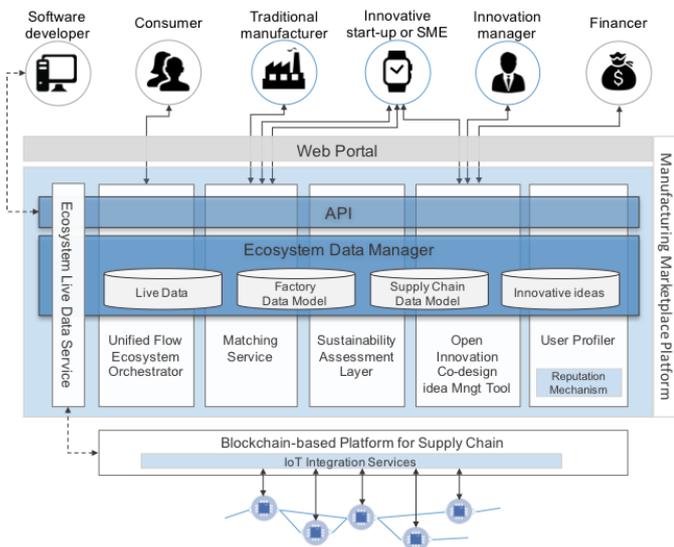


Figure 4: MANU-SQUARE platform architecture

C. MANU-SQUARE market uptake: platform business model and commercialization roadmap

In a nutshell, MANU-SQUARE proposes a multi-sided business model pattern that can be deployed in different shapes in accordance to the target user. This requires:

- fusion of physical and digital industries leading to a **platform-enabled marketplace** of manufacturing services;
- integration of cross-sectorial technologies and competences to leverage on full **open innovation** potential;
- enabling of **chained platforms** to foster secure creation and handling of reconfigurable value networks.

In order to fulfil the abovementioned requirements MANU-SQUARE is a **multi-sided** platform pursuing the goal that both sellers and buyers are placed in a common space thereby facilitating contact between two sides that would otherwise be unlikely to interact. As opposed to the conventional "pipeline" business model where the supplier of a product or a service generates value, a large part of the value derived by users of this platform is created by other users. The effects that one user of a good or service has on their value to other users are the so-called "network effects". The platform operator facilitates

transactions by actually reducing transaction costs: that's the real value MANU-SQUARE business model relies on. In fact, the platform operator provides a *convenient* way of matching the two sides of an interaction (e.g. search or recommendation function), a virtual space to interact, a code of conduct, instruments that increase trust (reputation, identity checks), methods of secure transaction, etc. to which both sides agree. In their simplest shape, online platforms do not intervene in the transaction (still guaranteeing its correct execution), except by asking for a fee from one or multiple sides of the transaction in order to make profit. This kind of platforms does not take control over the object of the transaction, nor on the transaction price. Considering preliminary investigations performed, the heterogeneous variety of requirements MANU-SQUARE wants to address requires a more complex approach. For this reason the platform needs to adopt a hybrid business model, choosing to act as a platform operator mediating between different market participants in one area of activity and as something like a reseller, or a vertically integrated firm, in another. There is also a spectrum of business models that fall somewhere between these two categories depending on the extent of control they exert over transaction parameters and direct contact between users. In Figure 5, business model canvas templates revised from Osterwalder and Pigneur (also including Social & Environmental costs and benefits) have been filled in representing the initial vision on project exploitation

MANU-SQUARE envisages a **spin-off** approach managing the concept implementation and exploiting its business model. The spin-off will act as a Platform Owner offering as **Value** the "Sustainable demand-supply matching of manufacturing-related product-services and knowledge" *through* an online platform (the **Key resource**) to a wide set of **Customer segments**, including (1) traditional manufacturers offering or seeking for production capacity, by-products, materials, technologies, etc.; (2) innovative companies (either start-ups or existing companies opening new business lines) searching for partners supporting their idea transformation into a concrete solution; (3) innovation managers looking for new opportunities to match innovation supply and demand. All these users will pay a fee in accordance to completed transactions and this is the most relevant **Revenue stream** envisaged for the spin-off. Both users (listed in customer segments) and complementors (mentioned in the **Key partners** box, together with the more traditional providers of IT and ICT services) are to be recruited outside the platform using conventional (fairs, workshops, etc.) and less conventional (e.g. by using other social networks) networking **Channels**, thus the major **Cost** entries refer to **Key activities** such as dissemination and marketing, aimed at acquiring and also maintaining (through durable **Customer relationships**) these entities, namely representing the real value of this kind of multi-sided platforms. The platform is also a relevant enabler for generating **Environmental and social benefits** as a result of its value proposition deployment: sustainability indicators guide the selection of new suppliers in the assisted matchmaking activity and in value network design, moreover new jobs and ventures are created bringing together innovation demand and supply.

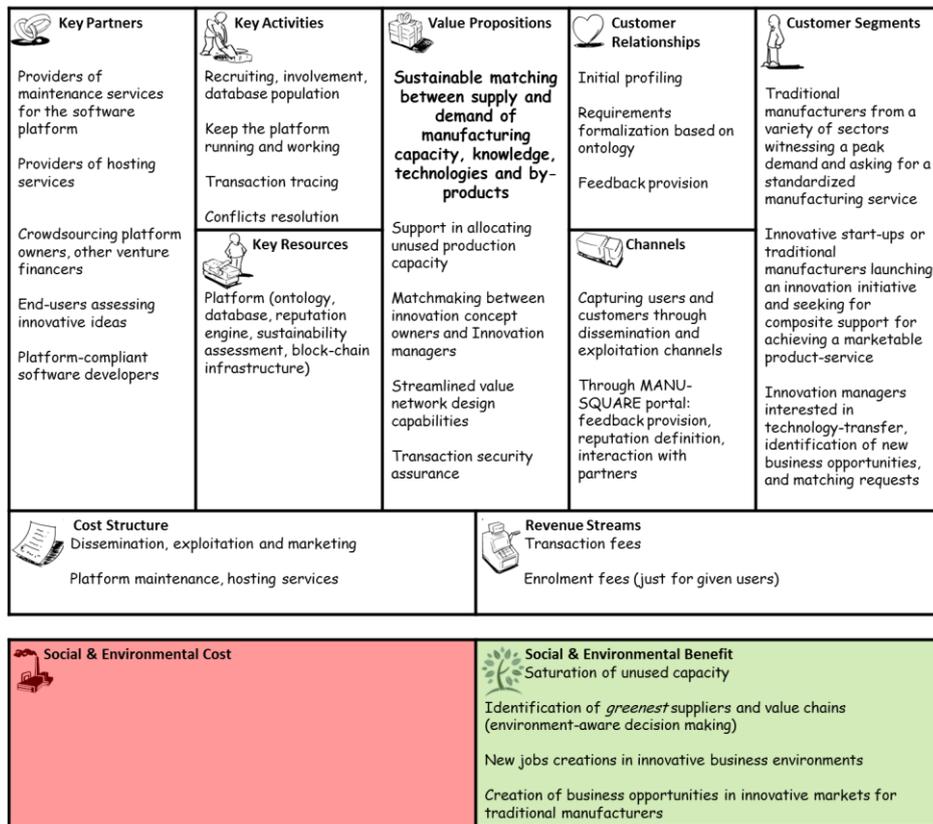


Figure 5: MANU-SQAURE platform business model

V. CONCLUSIONS AND NEXT STEPS

In this conceptual paper the key technological and business elements of the MANU-SQUARE multi-sided platform for the sharing of unused company potential have been discussed. Starting from the idea of dematerialising production resources and, in parallel, of embracing servitisation, it has been shown how the European industrial ecosystem could benefit from the current wave of sharing economy by offering, through the MANU-SQUARE platform, manufacturing capacity as a service. The main stakeholders involved in the platform-enabled transactions have been identified eliciting also their needs and the way they interact with the platform. Understanding the advantages that the platform can offer to each of them, what functions they are seeking and what they are willing to pay for is key to the development of a successful business model of which a preliminary version is constructed in this paper.

Adoption discriminants have also been topic of investigation with a particular focus on building a mutual trust environment where providers of unused potential, such as traditional manufacturers and innovative companies can cooperate in the conception of innovative ideas and in the development of the resulting product-services. Guidance of qualified experts, the innovation managers, as well as interaction with customers in the design and development

process is sought putting into practice an open innovation approach that aggregates around the platform, individuals and companies capable to contaminate the new ideas with their expertise and know-how.

The translation of this concept into a working prototype of the platform will be the main target of the next steps in this research that will have to better define and populate with functional modules the initial platform architecture presented in this work. At the same time lab-scale experiments will be carried out within the embryonic stage of the industrial ecosystem around the platform to demonstrate the validity of the concept in cross-domain value networks (an experiment linking the silk and the cosmetics sectors is already underway).

Achieving an adequate level of support to the transaction of manufacturing services and a critical mass to sustain the ecosystem is a remarkable challenge that this research will have to overcome. Yet it is definitely relevant that Europe grasps the potential residing in this paradigm shift and put backs into the loop the otherwise wasted capacity that its industry currently present.

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VII. REFERENCES

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