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# Using digital platforms for value chain sustainability – Cases from the Digitala Stambanan project

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**Abstract**

Transforming firms towards sustainability is an imperative posed by urgent environmental concerns and governmental regulations, requiring the redesign of traditionally linear and non-transparent value chains. Digital platforms can support the twin transition to digitalization and sustainability, converting the abstract into the tangible (i.e., data flows, information, and knowledge), and providing an industrial testbed to collaborate and challenge the willingness to share data, co-create and deliver value through sustainability-oriented digital services.

This study presents a research collaboration with industrial actors in the context of Swedish manufacturing, aiming to showcase the potential of platforms in Swedish value chains. Awareness of the digital maturity as-is status from the individual actors within a value chain, and purposeful development strategies can lead to improved digital performance, an increased sense of collaboration and sustainable behaviour.

Through a case study approach, this article illustrates the potential of digital platforms by presenting three manufacturing value chains where prioritised industrial challenges are addressed through the capabilities of such platforms: (1) a CO2 visualisation platform that allows transparency, communication and data-sharing between the stakeholders of the value chain and aims to connect different industrial partners and aims to reduce sustainability impact through collaborative efforts; (2) a collaborative root-cause analysis digital platform that allows virtual commissioning of sustainability experts, and technical support; (3) the re-development of a productivity-centred digital service into a sustainability-informing solution that provides relevant production data for SMEs, who are customers of the machine tool sector.

The preliminary findings include: (1) digital maturity of individual firms in a value chain impacts the feasibility of platform development, (2) increased digital maturity allows companies to shift their focus towards sustainability priorities; most companies are often too concerned with productivity, visibility, and flexibility challenges, leaving the sustainability imperative as a nice-to-have, (3) the lack of focus on sustainability can be caused by unclear understanding of how consumer-perceived value can be captured.



*Keywords:* digital platforms; digital maturity; manufacturing; value chains; resilience; root-cause analysis; servitization; sustainability.

## 1. Introduction

Manufacturing firms are facing global imperatives that suggest an urgent need for digital and sustainable transformations to comply with market needs. Increasingly, new concepts appear in manufacturing discussions such as "twin transition" where green and digital transformations are parallel concepts. With such simultaneous agendas, firms are transforming towards digitalization along with the search of new value creation, and the enabling of business models. These


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allow value capture from outside the firm and not depend only on internal growth [1].

Digital technologies are showing more potential than ever, leading to a new wave of optimism regarding the feasibility of achieving sustainability goals from a triple-bottom-line perspective [2]. Specifically, research that explores how "digital platforms" can support the twin transition from conceptual and empirical cases and potentially deliver sustainable value is still at an infancy stage.

### *1.1. Knowledge gap and study aim*

Documented research [3, 4] is increasingly generating ideas for the implementation of the concept of digital platforms in real industrial scenarios, as along with other principles of industry 4.0, they facilitate enterprise systems integration and collaboration across the value chain, self-adaptation of production systems, and agile response to customer demands. Due to the potential of digital technologies to advance manufacturing, the interest in digital platforms and the urgency for sustainability-oriented solutions is growing. However, there is still a lack of understanding of how digital platforms can be used and implemented to create value.

Moreover, the implementation processes of digital solutions are perceived as huge transitions, but test beds and demonstrators can incentivize their adoption by showcasing the potential and exploring scalability in industrial contexts. The current study is part of a larger Swedish innovation project where the potential of digital platforms for value creation has been explored for three manufacturing value chains.

The assumption of this research study is that there is unexplored intrinsic value in positioning value chains on digital platforms. Also, that this strategy can lead to the achievement of individual and tangible goals such as increased quality, resilience, improved sustainability performance, visibility along with intangible benefits such as improved collaboration strategies, openness towards data sharing and so on.

Moreover, this study found that the terminology describing digital platforms is widely spread. For instance, concepts such as cloud-based platforms, internet platforms, manufacturing platforms, create linguistic dispersion and complicates homogeneity around their conceptualization. Also, the functionalities documented in literature are varied, as many published articles refer to digital platforms under the lenses of e-commerce instead of aiming to provide value and supply chain transparency and data sharing. Further, there is a lack of documented case studies in manufacturing contexts and with similar arrangements that can lead to transferable results.

Therefore, this article's aim is to identify the role of digital platforms in Swedish manufacturing value chains. To achieve the aim, the objectives of this study are twofold: (1) identify the types of digital platforms that can support sustainability in manufacturing value chains, and (2) identify the challenges connected to the use of digital platforms in manufacturing value chains and the potential opportunities they could provide for value co-creation in the twin transition process.

## 2. Theoretical background

### *2.1. Digital platforms in manufacturing value chains*

The concept of platforms has been explored in literature for a few decades now [5], while the potential of digital platforms in today's digital era has only now acquired increased relevance and interest from different industrial sectors. IT solutions could build and scale up platforms in a simple and cost-efficient manner, showcasing its potential to capture, analyse and exchange data in a transparent way.

Digital platforms aim to establish connections. They represent a technological foundation that can create a large impact in manufacturing value chains, as they enable direct communication and interactions between different groups of actors [6]. The technology supports the transition towards dynamic formations and operations of value chains that can overcome barriers and challenges by offering tools and making services available to a wide range of firms [3]. Value chains that make use of digital platforms can increase their ability to matchmake needs of customers and suppliers at global scale, and across multiple industrial sectors [8].

Digital platforms that connect suppliers with their customers and vice-versa, are characterized by indirect network effects, since the attractiveness and future success of the platform is influenced by the critical mass of actors on each side [7]. However, Veisedal [4] suggests that platforms experience the "chicken and the egg" phenomenon, a challenge where "no one joins until everyone joins". This makes room for further exploration of the potential of this technology and improve the arguments used to onboard firms into the platforms.

Digital platforms can function as mechanisms to transform competition and value creation processes in entire value chains. In their work, [1] describe this scenario by presenting two concepts: conventional "pipeline" value chains, and "platform" value chains. Deciding whether a value chain is purely pipeline or solely platform-based is not simple as these strategies are not mutually exclusive, but there are three strategic shifts that guide firms to rethink their value creation processes:

- Resource control to resource orchestration
- Internal optimization to external interaction
- Shifting from customer value to ecosystem value

The constantly changing global geopolitical situation can also benefit from digital platforms, particularly from an economic perspective and make value chains resilient to such challenges. Such platforms expand traditional marketplaces' geographic reach and drive the sharing economy concept, which enables resource sharing and the leveraging of excess capacity. Metcalfe's law [9] brings light to the important distinction between an individual's value from a network and the network, as a whole. In this context, community value is the summation of the individual values of the members in the community. This concept brings forth the unexplored value of unconventional market strategies and the business proposition of network growth, until an optimal number of participants is achieved [10]. When that point is achieved, the cost of value-delivery using platforms has a downward tendency, and other digital technologies such as blockchain can further serve as an independent facilitator of transactions by making transactions economically viable.

### 2.2. Typologies of digital platforms in literature

Several categorizations of digital platforms can be found in literature to understand the different ways in which digital platforms can contribute to increased value in manufacturing companies, according to the functionalities they provide. Table 1 exemplifies some of the most frequent distinctions in literature.

Table 1. Major typologies of digital platforms [5,11]

| Dimension | Major platform types |
|---|---|
| Market sides | Integrator; Product; Multi-sided |
| Interaction mode | Collaborative; Competitive |
| Governance mode | Open; Closed |
| Ownership structure | Property-based; Open-source |
| Affiliation | Registration; Subscription; Transaction; Investment |
| Participation | B2C; B2B; P2P; C2C |

Further, there are many different opportunities provided by digital platforms. Some examples identified by [12] include production capacity matching, know-how capabilities matching; by-product matching; sustainability assessment; ecosystem optimization; suppliers' assessment; certifications, innovation and trust management; communication support, among others.

## 3. Methodology

The objective of this research study is to understand the potential of the use of digital platforms to maximize value capture and value delivery through a value chain.

This article presents the preliminary results of an empirical study conducted through three case studies, composed of three manufacturing value chains in three different domains: steel manufacturing, automotive sector and machining industry. The work conducted within each value chain is organized in three different work packages (WP) in the project as seen in Fig. 1.

The companies shown in Fig. 1 are coded from A to H to maintain anonymity of data, further details of which are provided in Table 1.

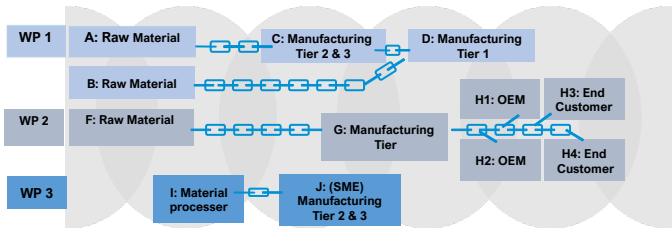


Fig. 1. Project structure and study design

Table 1. Company description

| Value Chain | Company | Description | No. Employees |
|---|---|---|---|
| VC1 | A | Hot and cold -rolled steel processing | 1700 |
| | B | Manufacturing of fasteners and c-parts | 1200 |
| | C | Steel assembly and manufacturing of motor vehicle parts | 78 |
| | D | Digital end-to-end traceability solutions | 9 |
| VC2 | E | Porcelain factory founded | 1300 |
| | F | Automotive component manufacturers | 150 |
| | G | Engine manufacturer | 3000 |
| VC3 | H | Tool manufacturing and solution provider | 8000 |
| | I | Medium company that manufactures valves | 171 |

Each of the value chains which compose the three case studies have been studied following similar case study method [13] with the following steps: (1) conduct workshops with the involved stakeholders to define objectives, (2) define demonstrator opportunities, (3) define requirements for platform implementations, (4) regular meetings for progress follow ups and (5) participate in joint project meetings for dissemination of results and challenges.

## 4. Findings from the empirical cases

### 4.1. Description of platform development in the three value chains

Each work package followed a case study approach based on the established project objectives and is described in the following sections. Table 2 categorizes the platforms that are developed or are under development in the project for the three value chains, according to the typology described in Section 2.2.

Table 2. Platform categorisation for the three value chains (Adapted from [5,11,12])

| Dimension | Platform type | VC1 | VC2 | VC3 |
|---|---|---|---|---|
| Market sides | Integrator | | X | |
| | Product | | | X |
| | Multisided | X | | |
| Interaction mode | Collaborative | X | X | X |
| | Competitive | | | |
| Governance mode | Open | | | |
| | Closed | X | X | X |
| Ownership structure | Property | | X | X |
| | Open source | X | | |
| Affiliation | Registration | | X | |
| | Subscription | | | X |
| | Transaction | X | X | |
| | Hybrid | X | | |
| Participation | B2B | X | X | X |
| | B2C | | | X |

| | | | | |
|---|---|---|---|---|
| Functionality | Production capacity | X | | X |
| | Know-how matching | X | X | |
| | Trust management | X | X | |
| | Certifications | X | | |
| | Sustainability assessment | X | | |

### 4.1.1. Value chain 1

In the first value chain in WP1, a demonstrator was developed to visualize CO2 emissions from the different production activities of the entire value chain and based on multi-sided digital platforms. The digital platform provided opportunities for the sharing of data and information flows, along with communication and collaboration amongst the value chain partners, thus enhancing the resilience and sustainability of the value chain.

The stakeholders of this value chain meet bi-weekly to discuss: (1) the progress of the current state analysis based on the Industry 4.0 maturity index assessment, (2) the development of the demonstrator, and (3) plan for workshops for value chain objectives in the other focus areas. The focus of the value chain was categorized into four areas: understanding customer requirements, delivery assurance, product data and green conversion. Accordingly, it was decided to develop a first version of the demonstrator for the focus area 'green conversion'.

The market side type for the demonstrator developed was a 'multi-sided' platform [14,15] where two or more distinct sides (in this case, the three companies in the value chain) directly interact on the platform to co-create value. The platform is largely collaborative, as the partners are willing to share data so that there is a transparent system where data regarding quality, delivery, and customers' concrete requirements can always be visible and available across the entire value chain. This standardized application or system can enable the sharing of product data certificates (along with correct part numbers), without which, production is blocked. The value the companies intend to create is of a hybrid type [3], which means that their strategies combine transaction aspects (exchange of information) as well as innovation (where the platform facilitates special services, in this case the traceability of the value chain).

The demonstrator has a strong sustainability focus, as visualization of the carbon footprint of the entire value chain and the manufacture of 'green steel' are the primary objectives of the value chain. A second version of the demonstrator is currently being developed for different product types, use real-time data from machine-machine connectivity and generate a demonstrator in the form of a Discrete Event Simulation (DES) platform for Digital Twins under the focus area 'delivery assurance'.

### 4.1.2. Value chain 2

Value chain 2, which is organized under WP2, is currently focused on the requirements to design a collaborative platform demonstrator for quality traceability and root cause analysis that can be simultaneously used by different companies across the same value chain. To identify these requirements qualitative research activities have been conducted which include a series of workshops, focus groups, and interviews with the industrial partners.

Interestingly, manufacturing companies are already struggling to have complete visibility and understanding of their processes and to establish the relationship between cause and effect for production disturbances. At the value chain level, this problem exponentializes since the complexity increases when more customers and suppliers are considered within the scope. Therefore, the strategy of most manufacturing companies involves spending a high amount of energy primarily on mitigating the disturbances' consequences. In this scenario, often the root causes for disturbances in the value chain are not found and therefore cannot be tackled since the origin, risking facing them again in a short amount of time.

The identified requirements to build the collaborative platform demonstrator are divided into two groups. The first group of requirements is oriented to the development of a data collection protocol that includes the data requirements and data integration pipeline. The second group of requirements is oriented to building a dataset model to trace process, quality, product identification and time. The features of the platform are divided into two different modules: investigation and connecting with experts. In the investigation module, it is possible to start a new collaborative root cause analysis investigation with the participation of all actors in the value chain. In the expert module, it is possible to search for the experts in a specific area of knowledge in the monitored value chain, who might be relevant in specific root cause analysis investigations.

With such a platform, and with the improvement of the root cause analysis process, reoccurring disturbances at the level of the value chain are expected to be reduced. This might directly influence the energy consumption and raw material use among the involved manufacturing companies, resulting in a more sustainable value chain.

### 4.1.3. Value chain 3

The third value chain which is explored in WP3, is focused on the re-development of a productivity-centered digital service into a sustainability-informing solution that provides relevant production data. As stated in the section 3, it engages with a machine tool manufacturer who is trying to understand how they can better tailor their digital services to serve different types of clients, particularly SMEs.

The digital platform used in this work package follows a business model that has a subscription revenue format. It is also a product-oriented platform, which means that the service it offers supports the better usage of the product (machine tool). The digital platform and the service delivered provide direct access to data about machine and tool utilization, providing transparency and allowing the optimization of manufacturing processes. The visualization of data is provided through the configuration of dashboards and reports, by setting monitoring rules and provided feedback to create improvements in the data analysis after collecting information from the sensors.

In this value chain, the SMEs are customers of the machine tool sector, but the digital platform can be installed as well on most machine tools from other manufacturers, as long as they are, in average, 10 years old. Once installed, the use of this platform allows optimized production planning and a streamlined production through increased overall efficiency from a site management perspective, enables cost-efficiency in production processes, promotes collaboration within production stations and can support reducing costs and resource usage, and allows to capture operator knowledge by collecting their feedback and insights.

The governance structure of this platform can be considered closed, as its development is mainly under the control of the service provider, and creating significant variations require to be discussed with the customer before performing a full implementation. The connections between the factory and the platform take place in the cloud, in a secure, encrypted manner, but the customers can add their own guidelines to increase cybersecurity. Although for now, not many concerns have been raised regarding security between these two companies, the possibility of eventually sharing data with other members of the value chain will certainly open that discussion.

The development of the work in this value chain visualizes a future where understanding and insights about local processes can support improved sustainability performance. Such transition is foreseen to happen by reducing material and energy usage, increasing efficiency, having better understanding of how to select materials and machines, impacting procurement stages and potentially altering the value chain as its positioned today.

#### *4.1.4. Challenges faced in the three value chains*

The value chains selected in this project had the initial hypothesis of how the different level of digital maturity can enable the participation in collaboration activities that focus on the use of platforms to develop insights on production efficiency, understanding the source of production disruptions, and providing visibility on sustainability performance.

However, the authors have identified that through this process, some similar challenges are seen. Some of them include the lack of understanding of processes of other value chain actors, with varying reactions. For instance, in the performed workshops some participants were positively surprised when seeing process maps from other partners and reacted with curiousity, showing that companies can benefit from understanding better the priorities, and agendas from other members of the value chain.

Further, it was noticed that transparency and communication strategies are not yet clear and there are few guidelines on how to establish dialogues with value chain partners to provide visibility of day-to-day operations visibility. This was evident mainly in WP1 and WP2, where, accordingly, there is still needed to have visualization of the emissions at production level from different partners, and there is also a need for a transparent system that can flag data deficiencies related to material and delivery. We argue that clear guidelines for information exchange are lacking, but this is also an opportunity to research activities.

Part of the outputs of this research project is that it has brought light to the enthusiasm from many companies towards embracing the potential of digitalization but has also highlighted that many do not have clarity of where to begin in their digital transformation journeys. Even after adopting certain technologies for platform implementation, many companies are still unsure about which investments should be prioritized.

Additionally, for many organizations, joining platforms and data sharing could be an innovative idea with unexplored potential. However, they often raise the point about how to protect themselves and express their privacy concerns towards data sharing.

Further, some additional challenges faced were consequences of the significant restructuration that has happened in many manufacturing firms in post-pandemic times. The redefinition of roles, opening of discussions about working from home, along with many other motives have incentivized the re-thinking of many employees as to which direction they want to take in their career. This has led to the constant reshaping of workforce, which has also highlighted issues as the lack of continuity in projects, implementations and need for constant reskilling to fit new job descriptions.

Lastly, one of the most recurring challenges lies in the fact that organizations are aware that sustainability is imperative to include in future agendas. However, there seems to be a lack of clarity about how digitalization can enable more sustainable operations and how to capture value from activities that support such priorities.

## 5. Discussion and conclusions

Today's manufacturing environments are seeing an increasing interest in digital platform implementation, and many companies are striving to increase their digital maturity. However, there is only a certain degree of success that can be achieved when companies grow independently and only at an internal scale.

Existing literature on platforms shows that there are many different structures and types of platforms that could be explored in manufacturing applications. However, not all the functionalities and configurations are exemplified in cases, showing a gap for potential case studies to increase the understanding of the applicability of such theoretical concepts and typologies in industrial scenarios.

The lack of visibility in todays' value chains and the reactions of the partners through the project bring up a realization of lack of dialogue among value chain partners. Some questions one could ask include: Why is this not done today? Before research projects connect value chain members and propose extended discussions around data visibility, transferability, and security, what are the right spaces for companies to have such interactions? This study contributed to filling these gaps by describing real manufacturing scenarios and the process of designing and implementing digital platforms to achieve stakeholders' objectives to capture sustainable value. The learnings and challenges contribute to the state-of-the-art, and provide knowledge that could in the future be transformed into guidelines and frameworks that support the design and implementation of digital platforms in manufacturing environments.

In this research project, those value chains whose Industry 4.0 maturity assessments were complete shared that the assessments were useful for receiving insights in different key areas where actions could be prioritized moving forward. Their

digital maturity assessments changed their perception on how they perceived their collaboration for instance, or the knowledge transferred between different functions within the organization as well as across the value chain. A pressing need to focus on converting tacit knowledge to explicit knowledge was also suggested. This shows that digital maturity and corresponding capabilities have a large role to play for platform implementation and use [7,8,14,15] to improve value capture, increase their resilience and positively impact sustainability.

Rethinking the concepts previously introduced, research needs to find new ways of supporting the transition from pipeline into platform-based value chains. Future research directions can benefit from looking into the potential of applying technologies such as AI, cloud, machine learning into the development of new tools, software and algorithms. Developing such technologies into value propositions that can be delivered through platforms could open the discussion for new and more sustainable ways of creating value and supporting companies to develop competitive advantage.

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