D9.5 Evaluation and Socio-Economic Impact Assessment Report of iPRODUCE Social Manufacturing Framework

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Abstract	The deliverable 9.5 presents the activities and results of T9.6, which constitute 1) the qualitative Pilot Evaluation and 2) the quantitative Socio-Economic Assessment. D9.5 presents the overall summative evaluation/assessment of the iPRODUCE project, taking into account stakeholders', that is the MMC (makers, manufacturers, consumers) communities' – as beneficiaries and end-users – point of view. Methodologies and results of the data collections are presented as well as conclusions drawn with regard to the extent of the overall success of the project, its activities, and the technical tools (OpIS) developed in the course of it.

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1. Executive Summary

This deliverable reports the activities and results of Task 9.6 – “Pilots Evaluation and Socio-Economic Assessment”. These can be divided into two parts, the Pilot Evaluation (interviews or open-ended questionnaires) and the Socio-Economic Assessment (surveys), which constitute an overall summative evaluation/assessment of the iPRODUCE project. Participants were the beneficiaries of the project as makers, manufacturer representatives, and consumers (MMC communities). The Pilot Evaluation took place at two time points – before the implementation of the OpIS tools and after it, that is at the end of the project. The Socio-Economic Assessment took place over half a year at different time points due to stakeholders’ availability. The iPRODUCE cMDFs (pilots) provided the participants from the MMC communities that they established in the course of the project. Although several KPI measurements remained inconclusive, the results indicate that the project proved to be beneficial for many participants in terms of personal and organisational value. The major impacts were the extension of professional networks and the access to new technology (especially 3D printing) and MakerSpace thinking mentality for manufacturers. Several of the OpIS tools developed in the course of the project still had usability issues at the time of evaluation, some of which were improved in the aftermath. In some cases, the need for tutorials became clear. Nevertheless, many tools were rated as novel and interesting as well as useful for enhancing collaboration and co-creation. We conclude that overall, iPRODUCE did positively impact makers, manufacturers, and consumers in various ways. The cMDFs represent a feasible concept for social manufacturing.

Section 2 presents the scope and background of the data collections. This includes an overview of the horizontal project KPIs covered by T9.6 and captured/measured by the Pilot Evaluation and the Socio-Economic Assessment.

Section 3 describes the methodology in detail. This includes the mentioned major two data collection types along with a preceding survey for the purpose of KPI measurement. The procedure and structure of the activities are outlined as well as the EU Survey tool used and the acquisition of participants.

Section 4 presents the results of the Pilot Evaluation. This includes the capturing of several of the project KPIs.

Section 5 presents the results of the Socio-Economic Assessment survey, including the measurement of several KPIs.

Section 6 summarises the results of the presented activities and draws conclusions in the light of the goals of the project.

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List of Abbreviations

3D = 3 Dimensions

AR/VR = Augmented Reality / Virtual Reality

BPNSFS = Basic Psychological Need Satisfaction and Frustration Scale

CDO = Chief Digital Officer

cMDF = Collaborative Manufacturing Demonstration Facility

D = Deliverable

DIY = Do It Yourself

DoA = Description of Action

EU = European Union

FIT = Fraunhofer Institute for Applied Information Technology

GDP = Generative Design Platform

GDPR = General Data Protection Regulation

HCD = Human-Centred Design

KPI = Key Performance Indicator

M = Month(s)

meCUE = modular evaluation of key Components of User Experience

MMC = Makers, Manufacturers, Consumers

n = number in a sample

NPS = Net Promoter Score

OpIS = Open Innovation Space

p = page

SDT = Self-Determination Theory

SME = Small and Medium-sized Enterprise

SMF = Social Manufacturing Framework

T = Task

TAM = Technology Acceptance Model

TTM = Time To Market

UEQ = User Experience Questionnaire

UX = User Experience

WP = Work Package

2. Introduction

The project iPRODUCE seeks to establish so-called *collaborative Manufacturing Demonstration Facilitie*s (cMDFs) as pilot projects defining a *social manufacturing framework* (SMF) in their respective communities. Thereby, makers, manufacturers, and consumers (MMC) collaborate and co-create combining their various competencies and stakeholder networks. This SMF is supported by the Open Innovation Space (OpIS), a platform consisting of several collaboration and co-creation tools. In order to determine the success of those pilots and the feasibility of the SMF in iPRODUCE, a summative evaluation and assessment methodology is required, which is the aim of this deliverable D9.5. The following sections outline the purpose and scope of this study focussing on the KPIs and methodology; the later sections describe the results and conclusion.

2.1. Purpose

Whereas the project evaluation and assessment approaches are manifold, this deliverable focuses on the *summative* evaluation of the iPRODUCE project. The activities of Task T9.6 are centred around a number of general Key Performance Indicators (KPIs), both in terms of individual project participants' attitudes as well as organisational goals. However, the evaluation and assessment go beyond the predefined KPIs, capturing a variety of results. In the end, the central question is: *Did iPRODUCE achieve what it set out to do?* This question cannot be answered based solely on this deliverable; but *a* response is attempted to be made based on the hereby captured beneficiaries' point of view. The purpose of D9.5 is to determine whether the pilot cMDFs were successful in that they provided major benefits to the MMC communities that they attempted to establish via the iPRODUCE SMF. In this way, both the acceptance of the technical solutions (the OpIS platform) as well as the impacts of non-technical activities within the SMF such as training activities and workshops are hereby of interest. In line with human-centred design (HCD), the focus is on the MMC community members as end-users and beneficiaries. Their feedback is crucial in order to ensure feasibility and proof of concept, thereby ensuring that iPRODUCE is just the beginning of a new framework that will bring together MakerSpaces with companies and consumers everywhere.

2.2. Content, context and scope of this deliverable

D9.5 captures the efforts taken in T9.6 – "Pilots Evaluation and Socio-Economic Assessment". This task is basically concerned with the *evaluation* (To what extent did iPRODUCE reach its set goals?) and the *assessment* (How did the iPRODUCE activities and technologies perform?). In line with its title, it consists of two major parts: the *Pilot Evaluation* as a quantitative data collection and the *Socio-Economic Assessment* as a quantitative measure. However, strictly speaking, both parts were concerned with evaluation (e.g. of global KPIs) and with assessment [e.g. of the *User Experience* (UX) of the OpIS tools]. Both study parts were majorly defined in D9.2 – *Evaluation Methodology, Plan and Metrics 2*. Hereby, the Pilot Evaluation was conducted in the form of two rounds of structured interviews or alternatively, open-ended questionnaires. The Socio-Economic Assessment was conducted as a survey / rating questionnaire.

2.2.1. iPRODUCE Horizontal KPIs

Before the beginning of the iPRODUCE project, a number of "horizontal" (meaning across the project) KPIs were defined in order to capture the various goals of the project. They were distributed over the

different project tasks. The following Table 1 depicts the KPIs allotted to T9.6, how they were measured, and where they are included in this deliverable. Among the KPIs, the main distinction that determines the means of evaluation is whether a KPI captures participants' perceptions/attitudes or whether it is rather an organisational KPI. *Perception-focused* KPIs are subjective and attitudinal and thus require a certain number of indications in order to equalise error and bias. *Organisation-focused* KPIs on the other side are objective and can thus be determined by evaluating the achievement of entities within the project. KPIs 14, 15, 36, and 37, included in the surveys and focused on the perception of makers, manufacturers, and consumers, whereas KPIs 16, 23, and 30 focus on organisational aspects and thus retrieved in the Pilot Evaluation interviews/questionnaires with manufacturer representatives.

Table 1. Horizontal KPIs in T9.6

Horizontal KPIs covered in T9.6			
T9.6 KPI	**Type**	**Measurement**	**Included in**
KPI-14: Improvement in the perceived ability of manufacturing SMEs to apply open innovation methods: >20% increase	Perception-focused, relative	Short KPI Survey, Socio-Economic Assessment (survey)	Section 5.2.1
KPI-15: Improvement in makers' and consumers' perceived readiness to participate in collaborative manufacturing: >20%	Perception-focused, relative	Short KPI Survey, Socio-Economic Assessment (survey)	Section 5.2.1
KPI-16: Effectiveness and quality of collaborative manufacturing outputs: >80% Overall Labour Effectiveness (measured as: Workers' Availability & Performance and Product Quality)	Organisation-focused	Pilot Evaluation (interviews/ questionnaire)	Section 4.2.2.2
KPI-23: Improvement in the time to market of products: > 20% (reported by participating SMEs)	Organisation-focused	Pilot Evaluation (interviews/ questionnaire)	Section 4.2.2.2
KPI-30: Reduction in the development cost for new products: >20% (reported by participating SMEs)	Organisation-focused	Pilot Evaluation (interviews/ questionnaire)	Section 4.2.2.2
KPI-36: Consumers' satisfaction with regard to the co-manufactured products: > 90%	Perception-focused, absolute	Socio-Economic Assessment (survey)	Section 5.2.3
KPI-37: Consumers' willingness to support the manufactured products (loyalty): > 70% (among the communities' and pilot participants)	Perception-focused, absolute	Socio-Economic Assessment (survey)	Section 5.2.3

2.2.2. Theoretical background

For a comprehensive overview of social manufacturing and the maker movement, please see D2.1. Many of the hereby applied indicators and questions refer to the concepts of *social manufacturing*, the utilisation of "the power of communities in order to design and produce physical goods" and *maker movement*, "an innovative form of manufacturing production that combines cutting-edge technologies, such as 3D printing and laser cutting, with arts and crafts activities" (D2.1; Chapizanis et al., 2020, p. 2).

For a more detailed description of the theoretical background in terms of UX, see D9.2. This section provides a short overview. As outlined in D9.2, in terms of the usability/UX evaluation, the current study focuses on the *satisfaction* of the interactive systems, namely the tools of the OpIS platform. In contrast to the effectiveness and efficiency components of usability, satisfaction is concerned with the UX and the extent to which the UX meets the users' needs and expectations. It can be assumed that users at least do not expect to compromise their basic psychological needs, that is their autonomy, competence, and relatedness, according to *self-determination theory* (SDT, Edward L. Deci & Ryan, 1985; Ryan & Deci, 2017). Any technology that is supposed to be established as a long-term tool to support the users' work must not thwart any of their basic psychological needs, otherwise it can be considered detrimental to the users' motivation to use (short-term) and well-being (long-term). Optimally, any technology that aims to be engaging should not only *not* frustrate basic psychological needs but even support and thus satisfy them (Peters et al., 2018). Since the OpIS platform is however a tool, with the aim to support specific professional tasks, the focus should first and foremost lie on harm (negative UX) prevention before ensuring positive UX.

Besides need satisfaction and frustration, UX can also be considered under other aspects: It is common to distinguish between pragmatic/instrumental (e.g. perspicuity, efficiency, dependability) and hedonic aspects (e.g. stimulation, novelty), whereby the pragmatic aspects provide the baseline ensuring high usability. What is more, interactive technology should minimise negative emotions (by enhancing pragmatic quality) and maximising positive emotions (by enhancing hedonic quality). All those impressions come together in the overall attitude or rating of the product (quality), which can be called attractiveness, appeal, or satisfaction. On a related note, the *Technology Acceptance Model* (TAM; Davis, 1985) argues that perceived usefulness and perceived ease of use are the major factors for technology acceptance. Besides satisfaction and acceptance, another construct of a technology's success is the likelihood to recommend (also called Net Promoter Score – NPS). The above theories were applied to the Socio-Economic Assessment survey as constructs for measuring the UX (as the entirety of the users' experiences with a technology) of the OpIS platform (see 3.2 Measures).

3. Methodology

The following section is concerned with the methods applied to the Pilot Evaluation and Socio-Economic Assessment.

3.1. Procedure

3.1.1. Data Collection

There were two main phases of data collection: The first took place at the end of 2021, that is Months M22-M24, the second one from the end of 2022 (M35) up until the end of the project in spring 2023 (M41). The first phase consisted of a short KPI survey (in M21 and M22) as well as the first round of structured qualitative interviews; the second phase consisted of the main quantitative survey and second round of qualitative interviews. An overview of the activities in T9.6 is depicted in Figure 1.

3.1.1.1. Short KPI Survey

The short survey at an early stage of the project was conducted in order to address two of the horizontal KPIs that focused on a relative increase of a value (KPI-14, KPI-15), thus requiring at least two measurements, one before and one after the implementation of the OpIS tools in the cMDFs. The survey was created in an efficient manner via Google Forms. It was available for members of the cMDFs (makers and manufacturers) in English.

3.1.1.2. Pilot Evaluation Interviews

The qualitative Pilot Evaluation consisted of two rounds of structured interviews / open questionnaires, the first in November (M23) and December 2021 (M24), the second in April 2023 (M40). Thus, the first round took place *before* the implementation of the OpIS tools, the second one *afterwards*. The aim of the first round was to gather insights about the goals of the project participants, which should then be revisited in the second interview round. Moreover, the interviews served to define the evaluation criteria of the project, which could be translated into quantitative, measurable survey questions for the Socio-Economic Assessment. Since the Pilot Evaluation was qualitative, it was *not* meant to capture any average attitudes of the respondents but rather present qualitative, more in-depth examples of participating makers' and manufacturers' experiences with the project.

It was the responsibility of each cMDF coordinator to either carry out the interview themselves with other cMDF members (required if the participant does not understand English) or distribute the questions in the form of a qualitative questionnaire to members of the cMDF for them to answer the questions and fill out the online form by themselves (if they know English).

3.1.1.3. Socio-Economic Assessment Survey

Other than the Pilot Evaluation, the quantitative Socio-Economic Assessment survey did not include two strict rounds; it was however carried out over a longer space of time due to participant availability: In the course of iPRODUCE, several stakeholders took part only once or twice, at very specific times, which limited their availability as survey participants. Moreover, the integration of the OpIS tools happened over the course of the latter half of the project, which involved several rounds of testing, often by different stakeholders. Since it concerned the rating of various aspects of the project (both technical and non-technical), the survey round took place during the implementation and integration of the OpIS tools, one

year after the first interviews (M35) up until M41. It included various rating questions based on specific KPIs and other, less specific project goals, including the acceptance of the OpIS tools. In this way, the questions from the Short KPI Survey were also included. *EU Survey* (see below) served as the online survey tool. It took 10 to 20 minutes to complete, depending on whether the respondent had used the OpIS platform or not. Note that the OpIS tools were further improved, based on feedback from T9.2, during and after the Socio-Economic Assessment took place. The UX-related results therefore might not fully reflect the most up-to-date version's UX.

All items and text passages of the survey were translated from English into the specific languages of the iPRODUCE cMDFs: German, Italian, Greek, and Spanish. The translators were organisers of the respective cMDFs, who were later also responsible for distributing the survey among the cMDF members.

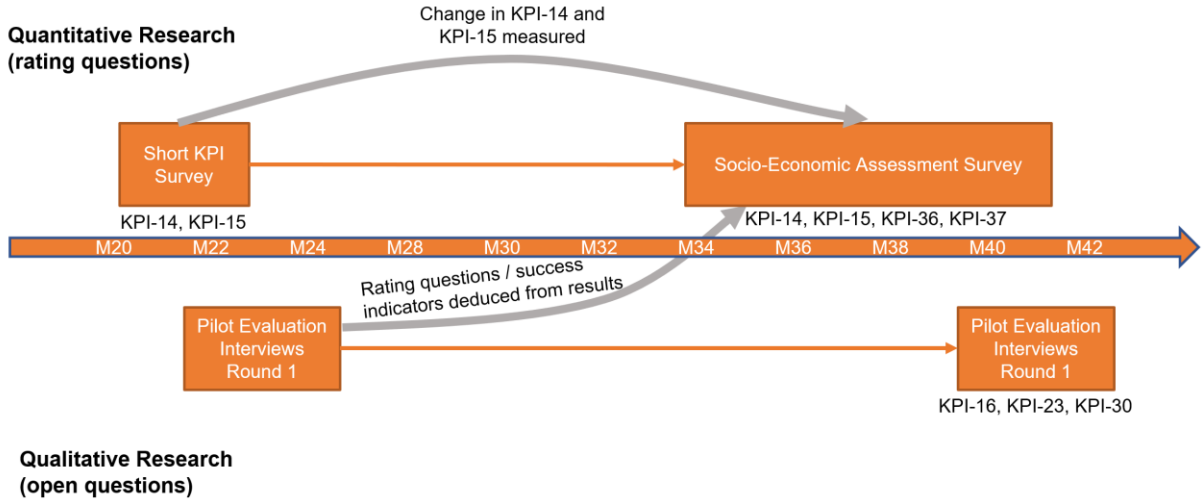

Figure 1. Task 9.6 Roadmap

3.1.2. Survey tool

The European Union (EU) Survey tool, employed for the Socio-Economic Assessment survey, is an online platform developed by the European Union that provides a user-friendly interface for creating and customising surveys to meet specific research needs, while capturing data from individuals and organisations. The tool offers a variety of question types, such as multiple-choice, open-ended, and rating scales, to ensure that research requirements are being met. The tool is specifically designed to comply with the *General Data Protection Regulation* (GDPR), which regulates the collection, use, and storage of personal data within the EU. It provides features, such as data encryption, secure data storage, and user consent management, to ensure that organisations can collect and manage data in compliance with EU privacy laws. With its robust functionality, flexibility, and GDPR-compliant features, the tool is a valuable resource for researchers and organisations seeking to better understand opinions, attitudes, and behaviours of the under-examination audience. It is a tool widely adopted in scientific publications as a reliable means for collecting survey data.

3.2. Measures

3.2.1. Pilot Evaluation Interview

The evaluation criteria/themes for the Pilot Evaluation were outlined in D9.2 (Tables 2 and 3). The open questions thereby defined were further refined later on, based on previous interviews and the defined aims of T9.6. There was a separate questionnaire for makers and for manufacturers, respectively. Several of the interview's open questions focused on gleaning specific success criteria for the later Socio-Economic Assessment, most of all the themes, pilot value, social impact, maker skills, and success.

In the maker version, there were 12 themes with one main question and one or two sub-questions each. The main themes were, in terms of the project in general: goals (what is pursued through iPRODUCE?), process (activities, methods, services, tools), expectations regarding pilot value (benefits, digitisation), and expectations regarding social impact (digitalisation of local communities and business); in terms of the OpIS tools and use cases: iPRODUCE platform value (expected benefits/values), motivation (why use it), general feeling (emotional reaction), competence (impact on capabilities and efficiency), autonomy (impact on control and choice), and relatedness (impact on connecting and community relations); and in general: maker skills (impact on skills), and success (measures/factors).

The manufacturer version also consisted of 12 themes, which were mainly focussed on the collaboration with MakerSpaces: role & tasks (business and connection to iPRODUCE), goals (what is pursued through iPRODUCE?), process (prototyping, services, meetings, reviews), production (impact), customer relations (impact), employee relations (impact), business relations (impact, also on supply chain), public relations (impact), digitalisation (impact), innovation (impact), sustainability (impact), and success (measures/factors).

Overall, the questions in the first round aimed at iPRODUCE participants' *expectations* for the project and what is important for them to make the project a successful one (for an overview of the open-ended questions, see annex). In contrast to the first round, the second round focused on the experiences with the iPRODUCE project and thus the evaluation of the cMDFs/pilots. Thus, the themes remained the same, whereas the questions were framed slightly differently, that is towards the past rather than the future of the project.

Whereas most KPIs were included in the survey as measurable attitudinal constructs, KPI-16 (Effectiveness and quality of collaborative manufacturing outputs: >80% Overall Labour Effectiveness) as well as KPI-23 (Improvement in the time to market of products: > 20%) and KPI-30 (Reduction in the development cost for new products: >20%) were included in the second round of the Pilot Evaluation.

KPI-16 was framed via three questions: "Compared to classical manufacturing, to what extent are your company's workers willing to contribute to collaborative manufacturing?", "Compared to classical manufacturing, to what extent would your workers' performance differ in collaborative manufacturing? ", and "Compared to classical manufacturing, to what extent would your company's product quality differ in collaborative manufacturing?" Note that the last two questions were framed hypothetically since collaborative manufacturing as such was most likely at the point of evaluation not fully established in the participating manufacturers' work. iPRODUCE was meant to serve as a pilot project introducing this way of thinking to the manufacturers in question.

However, only proof-of-concept validations (Use Cases in which prototypes have been developed) have been carried out in the project, so market or production-related KPIs can only be evaluated/validated by

means of estimates or perceptions. Therefore, KPI-23 and KPI-30, *instead* of the regular Pilot Evaluation, separate (interview) questions for the participating SMEs were developed to account for all facets of the related indicators. For KPI-16, extra interviews were conducted *in addition* to the regular Pilot Evaluation interviews/questionnaires:

KPI-16. *Effectiveness and quality of collaborative manufacturing outputs: >80% Overall Labour Effectiveness (measured as: Workers' Availability & Performance and Product Quality)*

- Collaborative manufacturing is about sharing information. How would you rate your internal information flow (production to design, to marketing, to quality, etc.)? To what extent would a collaborative manufacturing approach increase this flow?
- Collaborative manufacturing is about sharing information. How would you rate your external-internal information flow (market/users/external designers to production/marketing/ engineering). How many meetings or information exchanges do you have on average at the launch of a new product/range? To what extent would a collaborative manufacturing approach increase this flow?

KPI-23. *Improvement in the time to market of products: > 20% (reported by participating SMEs)*

- Justify the eventual improvement in time to market due to the iPRODUCE approach (user involvement, co-creation, collaborative prototyping, etc.).
- Are re-designs at the shopfloor stage a recurrent situation? How much of your initial design is modified due to manufacturing constraints?
- Do you have a prototype-and-test strategy, or put products in the market directly?
- Could you give us some indications on the motivations for a new product (Seasonal? Proposal from designer? Own ideas? Market needs detected?)? Would you estimate the time till the "product on the market" moment in each of the cases?

KPI-30. *Reduction in the development cost for new products: >20% (as reported by participating SMEs)*

- Is co-creation, co-development, and user involvement (iPRODUCE approach) reducing development costs, under your point of view? (you may answer yes, no, or maybe)
- Do you have the perception that more development costs may result in a higher market penetration or higher market value for your product/service?
- Is co-creation, co-development, and user involvement increasing market value, under your point of view? (you may answer yes, no, or maybe)
- Where would you put development costs? (tell us which are "good" development costs, and which are not)
- Are re-designs at the shopfloor stage a recurrent situation? How much of your initial design is modified due to manufacturing constraints?
- Do you have a prototype-and-test strategy, or put products in the market directly?
- When developing a new product, do you think of just one model or in a whole new range, which may have uneven success?

3.2.2. Socio-Economic Assessment Survey (& Short KPI Survey)

The basis for the Socio-Economic Assessment survey questions was manifold: They were based on the horizontal KPIs, on the Pilot Evaluation interviews, and on the T2.1 Survey (D2.1 and D2.2). As a standard (i.e. if nothing else is indicated below), most rating items employed a classic, fully labelled and numbered, bipolar 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree).

However, results (see Section 5) for individual items or item scales are presented on a transformed scale ranging from 0 to 4 for better interpretability. The first part of the survey focussed on non-OpIS aspects, whereas the second part was concerned with the OpIS tools. A screening question excluded participants from the second part if they ticked “I did not use any OpIS tools”. The third part consisted of several general questions about the project.

KPI-15 (focused on makers and consumers), KPI-14 (focused on manufacturers), and KPI-36 and KPI-37 (focused on consumers) required rating items for measurement. For each of these attitudinal constructs, a number of rating items were developed via brainstorming and based on previous interviews carried out by T9.6 leader Fraunhofer FIT. Before having to rate the statement, the respondents received a short explanation of the terms in question.

At the beginning of the questionnaire, an introductory text outlined the objectives of iPRODUCE and the purpose of the survey. Depending on the person and whether they assess OpIS tools or not, the survey took 10 to 20 minutes to complete.

Starting with the questionnaire, participants were asked to select the associated **cMDF** and their **role** as either *maker*, *representative of manufacturing SME*, or *consumer / representative of general public*. That selection determined the measures/scales that they encountered during the survey (see below). Moreover, they had to select the **frequency** with which they were involved in iPRODUCE activities among six levels, from “One time so far” to “Once a week or more”. An open question served to capture the specific activities and work the participants were involved in during iPRODUCE. The succeeding creation of an individual participant code served the potential mapping of responses of the Short KPI Survey and the latter Socio-Economic Assessment survey.

Demographics items captured age, gender, country of residence, highest level of education, previous experience in the fields of engineering or computer and information science (yes/no), occupational status, income level, and population of living area, similar to the T2.1 Survey (D2.1 and D2.2).

Collaborative Manufacturing Readiness (makers & consumers) at the beginning of the first part of the Socio-Economic Assessment was previously included in the Short KPI Survey. The first was an introductory *frequency* item: “I participate in collaborative manufacturing activities (i.e., social manufacturing together with or supported by other people).”, employing a fully labelled, 5-point item-specific scale ranging from 1 (Never) to 5 (Very frequently (almost daily or daily)). The construct was introduced with a *willingness* Likert item: “I would like to be more involved in collaborative manufacturing activities”. The main part consisted of an endpoint-labelled 5-item Likert scale capturing the core construct, *perceived readiness to participate in collaborative manufacturing* (KPI-15). An exemplary item is “I possess a community network that actively supports collaborative manufacturing activities”. The other items focused on technical and organisational means, manufacturing know-how, and know-how of collaboration methods. The internal consistency (*Cronbach’s Alpha* as an indicator of reliability) of the constructed scale was $\alpha = .79$.

Similarly, **Open Innovation Ability** (manufacturers) was developed for and initially applied in the Short KPI Survey as a relative value. An introductory item was employed to gauge *application in the past* via yes / no / I don’t know selection: “Did your company apply open innovation methods in the past?”. Four items captured the core construct “Improvement in the perceived ability of manufacturing SMEs to apply open innovation methods” (KPI-14), each employing endpoint-labelled, 5-point item-specific scales. The items were centred on the company’s willingness, frequency, employee skills and readiness with regard to open innovation methods, e.g. “According to your perception, how willing is your company's management/lead to apply open innovation methods?” with the response options ranging from 1 (Not

willing at all) to 5 (Very willing). Cronbach's Alpha for this scale was .82. The last question asked whether the company plans to apply open innovation methods in the future – again via yes / no / I don't know selection.

Perceived Value Creation (Personal) (all) focused on the personal benefits the iPRODUCE participant could potentially achieve via iPRODUCE. Therefore, the items were taken from the *Drivers* of the iPRODUCE Task 2.1 Survey (reported in D2.1 and D2.2). The items were introduced by "Participating in iPRODUCE helped me to…" followed by 11 possible benefits, e.g. "… access tools or mentorship". The last item was originally not included in T2.1 but added for this survey: "… helped me to become more innovative".

Perceived Value Creation (Organisational) (makers & manufacturers) was also adapted from the Drivers in T2.1. For makers, the items were introduced with "In my experience, participating in iPRODUCE helped my MakerSpace/FabLab to…", whereas for manufacturers, the introduction to the statements was "In my experience, working together with a MakerSpace/FabLab helped my company to…". There were nine rating items, e.g. "… reduce the cost of developing products and services".

Satisfaction and Loyalty Regarding Co-Manufactured Products (consumers) captured KPI-36 and KPI-37. A screening question consisted of two items: "I co-manufactured products in the course of the iPRODUCE project" and "I did not co-manufacture any products in the course of the iPRODUCE project". The two constructs *satisfaction with regard to the co-manufactured products* and *willingness to support the manufactured products* were captured via two items each, e.g. "I am satisfied with the products that I have co-manufactured in the course of the iPRODUCE project so far" and "I am loyal to the products that I have (co-)manufactured in the course of the iPRODUCE project so far".

Digitalisation & Digitisation Regarding Production and Deployment of Digital Tools (all) was developed based on the Pilot Evaluation results and divided into two parts: The first part, concerning organisational digitalisation/digitisation, was deployed for makers and manufacturers. The introductory sentence was "In my experience, my MakerSpace/FabLab helped companies..." and "In my experience, the collaboration with the MakerSpace/FabLab has helped my company…", respectively. This was followed by seven statements, e.g. "... to access 3D printing technology". The second part was about individual digitalisation, which was included in both the maker and the consumer questionnaire. The items were introduced with "In my experience, my MakerSpace/FabLab helped consumers / private individuals..." and "In my experience, working with/in the MakerSpace/FabLab has helped me personally…", respectively. An exemplary item was: "...to discover new open-source software." Both scales included a "in any other aspect" option.

Training Material and Activity Satisfaction (all) did not employ a dedicated scale but rather individual items. The first radio button choice was between "I participated in any training activity in the course of the iPRODUCE project" and "I did not participate in any training activity in the course of the iPRODUCE project", followed by "I received and used training material in the course of the iPRODUCE project" and "I did not receive and use any training material in the course of the iPRODUCE project". The main questions were "The training activities during the iPRODUCE project were helpful for me" and "The training material offered by the iPRODUCE project was helpful for me", both followed by an open question: "Please specify in which training activities you participated and explain your rating" and "Please specify which training material you used".

At the beginning of the second part, makers, manufacturer representatives, and consumers were asked to provide information about the **tools in use**. The survey collected responses on the following OpIS tools: *Marketplace*, *Generative Design Platform*, *AR/VR Toolkit*, *IPR Authoring Tool*, and *Mobile App for*

Social Media Enabled Consumers' & Makers' Feedback. There were not enough respondents, respectively, to evaluate the *Agile Data Analytics Tool*, *Training Support Tool* (as part of Digital FabLab Kit), and the *Process Automation Tool* (as part of Digital FabLab Kit). The first item captured the frequency of use ("Please indicate the frequency with which you use each OpIS tool.") for each tool, using a fully-labelled and numbered 5-point frequency scale ranging from 1 (Never) to 5 (Always). The next item captured recently used and regularly used tools, respectively with the phrasing "I have used the following OpIS tools relatively recently and have a vivid memory of using them:" and "The following OpIS tools are already established as a part of my typical work:".

The iPRODUCE Marketplace as the central tool of the OpIS platform was assessed via several standardised and partially adapted UX (including usability) scales. A screening question selected those participants who had used the tool.

General **User Experience** of the Marketplace was measured via selected scales from the *modular evaluation of key Components of User Experience* (*meCUE) 2.0* questionnaire (Minge & Thüring, 2018), namely *instrumental quality* (3 items for usability, e.g. "The tool is easy to use."; 3 items for usefulness, e.g. "The functions of the tool are exactly right for my goals."), *user emotions* (6 items for positive, e.g. "The tool exhilarates me."; 6 for negative emotions, e.g. "The tool annoys me."), and *overall evaluation* (1 item: "How do you experience the tool as a whole?"). The item scale consisted of 7 labelled points, ranging from 1 (Strongly disagree) to 6 (Strongly agree). The overall evaluation item employed an endpoint-labelled 11-point scale ranging from -5 (as bad) to 5 (as good). The internal consistency of the usability subscale was $\alpha = .93$; for usefulness $\alpha = .82$; for positive emotions $\alpha = .83$; for negative emotions $\alpha = .89$.

Basic Psychological Need Satisfaction and Frustration during the use of the Marketplace was measured with an adapted version of the *Basic Psychological Need Satisfaction and Frustration Scale* (BPNSFS; Chen et al., 2015). For each of the three needs autonomy, competence, and relatedness, there were four satisfaction and four frustration items, resulting in a total of 24 items. The introductory clause was "While using the iPRODUCE Marketplace, …", followed by the items, e.g. "… I felt a sense of choice and freedom in the things I undertook." for satisfaction (here: autonomy) and "… I had serious doubts about whether I could do things well." for frustration (here: competence). The questionnaire employed an endpoint-labelled 5-point Likert-type scale ranging from 1 (Not true at all) to 5 (Completely true). For the scales of autonomy satisfaction, autonomy frustration, competence frustration, and relatedness satisfaction, one item each was deleted in order to improve the reliability/consistency (Cronbach's Alpha) of the scale, respectively. Cronbach's Alpha was .77 for autonomy satisfaction, .78 for autonomy frustration, .78 for competence satisfaction, .82 for competence frustration, 86. For relatedness satisfaction, and .82 for relatedness frustration.

The **Product Quality** as a UX measure was assessed for *all* OpIS tools via the short version of the *User Experience Questionnaire* (UEQ; Schrepp et al., 2017), which employs a 7-point semantic differential. In this way, seven pairs of opposite adjectives describing the Marketplace could be rated via a slider, e.g. from "obtrusive (1)" to "supportive (7)".

Usefulness of all OpIS tools was measured via the respective item of the two-item questionnaire *UMUX-Lite* (Lewis & Sauro, 2021): "The tool meets my needs." The other construct of the UMUX-Lite, ease of use, was already captured by the items of the meCUE and UEQ. Perceived usefulness and ease of use are the two major components of the TAM (Davis, 1985).

Likelihood to Recommend the respective OpIS tool was measured via the typical NPS item, e.g. “How likely are you to recommend the iPRODUCE Marketplace to a friend or colleague?”, employing a 11-point scale from 0 – Not at all likely to 10 – Extremely likely.

The scales of Product Quality, Usefulness, and Likelihood to Recommend were applied for all other OpIS tools if the participants selected the respective option for each tool, as they were asked to evaluate the other tools that they are using regularly or have used recently.

Finally, **Perceived Feasibility** of the iPRODUCE concept as the third survey part was captured by two constructs. The *likelihood to participate again* (“I would participate again in social manufacturing activities (comparable to iPRODUCE).”) was rated via a 11-point scale from 0 – Not at all likely to 10 – Extremely likely. General *feasibility* was measured with the item “The cMDF (like in iPRODUCE) is a feasible concept for enhancing the collaboration of Makers, Manufacturers, and Consumers.” and an endpoint-labelled 5-point Likert scale.

3.3. Sampling

The cMDFs were responsible for distributing the data collection forms. In the case of the Pilot Evaluation, cMDF coordinators had the choice whether they carry out the structured interview with participants of their cMDF and thus, write down the notes themselves, or whether they distribute the open questionnaires containing the same questions to their cMDF’s members. The former method entailed translating the questions during the interview; the latter required participants to read and write English. The links to the survey were also sent to the cMDF coordinators for distribution among the cMDF stakeholders. The reason for focussing on the cMDF coordinators as a means of gathering responses was their familiarity with the MMC communities.

For the first round of Pilot Evaluation interviews, in total, there were 15 responses, nine of those from makers, six from representatives of manufacturing companies. Consumers were not interviewed, since no cMDF reported to actively and long-term involve representatives of the general public, not associated with a MakerSpace or company. The second round of the Pilot Evaluation yielded 14 responses, seven from makers and seven from manufacturers, respectively.

The first Short KPI Survey had 27 participants, thereof 14 makers, 10 manufacturer representatives, and 3 consumers.

47 people took part in the Socio-Economic Assessment survey. Of those, 25 considered themselves as makers (part of a MakerSpace/FabLab); 11 represented manufacturers, and 11 were consumers (i.e., none of the other two roles). However, it can be assumed that several people who could be categorised as consumers selected makers (see limitations in Section 6.3). The distinction was emphasised for later survey participations.

Due to the aforementioned differing availability and participation of the stakeholders (Section 3.1.1), participants were largely different between the Short KPI Survey and the later Socio-Economic Assessment survey. In this way, it was *not* possible to track the changes in attitudes of participants over time, as was originally planned if participants had remained the same (see limitations in Section 6.3).

3.4. Data Analysis

Content analysis was utilised to glean insights from the Pilot Evaluation texts. In this way, common terms and themes were revealed. In the first interview round, those provided indications for rating items for the

Socio-Economic Assessment survey. The Socio-Economic Assessment survey was descriptively analysed via *Microsoft Excel* and *IBM SPSS Statistics*.

4. Pilot Evaluation Results

The results of the Pilot Evaluation were gathered (in the form of interview notes or open questionnaire responses) and their contents extracted and evaluated by two researchers. Since this evaluation was qualitative and participation limited, clear statements can only be made regarding the *existence* of aspects, not regarding their prevalence or strength.

4.1. Results Round 1

As described in the methodology section (3.2.1), the themes of the Pilot Evaluation were defined in T9.1 (D9.2) and further refined in T9.6 based on previous interviews and the task description. Round 1 of the Pilot Evaluation took place in an advanced but still relatively early stage of the iPRODUCE project when the OpIS tools were envisioned, introduced, and partially developed but not completed or integrated yet.

4.1.1. Makers

The reported **goals** that cMDFs hope to achieve by their participation in iPRODUCE are manifold: A major aim of makers contributing to project work is naturally the networking and community building and improving collaboration with SMEs and other regional partners. This goes along with the idea that such collaboration would possibly bring the makers' way of working and thinking (especially in terms of idea generation) closer to SMEs. Makers also mentioned that whole new and different target groups could be involved in collaborative manufacturing, such as students, artists, freelancers, etc. Another goal according to the interview results is the acquisition of new machinery and generally less (machinery) maintenance. The project work could also potentially allow makers' experimenting with or creating new mechanical components/parts. Also pursued by makers is the digitalisation of training through iPRODUCE and other direct personal benefits such as improving their individual prototyping skills and acquiring better training.

Among the collaborative **activities** that respondents reported were workshops, training activities, and personal work. Also mentioned were the involvement of collaborators like students and companies. It was mentioned as well that remote cMDF meetings prevailed over hands-on face-to-face meetings due to Covid-19 restrictions.

The personal **expectations** for the project in terms of **value** were linked to the cMDF goals. Again, it was hoped to gain new contacts and clients (also online) and in this way, also to share experiences and work. Besides, participating in an EU project such as iPRODUCE could possibly also increase a MakerSpace's visibility and perceived professionalism. The iPRODUCE framework would also help with demonstrating openness to business collaborations for such new potential SME partners, enabling future industrial-scale projects. Better workflow and results/products were expected via the professional collaborators and new tools developed within the iPRODUCE project. In the same vein, makers hoped for many benefits from the OpIS platform. In the end, the iPRODUCE tools and activities would expectedly increase time for the development and potential improvement of the MakerSpace maintenance work due to the elimination of repetitive maintenance tasks of the machinery and hardware. In other words, digitalisation of manufacturing and prototyping should lead to better management and thus, better workflows and less required time.

In terms of **expectations for social impacts** of the project on the local community, easier access to tools and skills of the MakerSpace as well as the acquisition of feedback from (other) makers and time and money savings for prototyping, testing, and validating were mentioned. On the one side,

MakerSpaces could promote awareness of digital fabrication as a superior method, on the other side, they would impart the maker mentality to the outside community.

With regard to the **OpIS tools**, both expected value and conditions for being actually valuable and useful were mentioned. The open-source character of the OpIS tools would support the emancipation of makers away from corporate, especially US, software. The software would also enable digital fabrication, which can be much closer to people than regular fabrication. Makers could assumedly learn about projects and applications, make new networking contacts, and enhance their co-creation skills through the platform. Nevertheless, the respondents clearly stated that the tools need to be established first in order to make a proper judgement. Moreover, success of the OpIS tools heavily depends also on their usability, speed, performance, and design.

When asked what **motivates** them to engage with the OpIS tools, maker participants mentioned many of the previous aspects, e.g. the efficiency/usability and effectiveness/usefulness of the tools. The latter refers to using the OpIS platform as a means to getting in touch and collaborating with professionals or customers, advancing project work, and bringing structure into the otherwise rather chaotic MakerSpace environment.

The **feelings** towards the OpIS platform, which had been advertised at this point, were largely very positive. Respondents saw many of the benefits, which were also mentioned before. Overall, the platform was hoped to improve the daily work as a maker. However, some also mentioned sceptical feelings with regard to the potential increased maintenance and machine downtime and also questionable compatibility with other tools in their MakerSpace.

In terms of their own **competence and capabilities**, the makers had rather positive expectations if any. This is naturally bound to its usability. A concern was that the platform might quickly become out of date and not be used anymore if not properly developed.

Regarding **autonomy and control** over one's choices and data on the platform, participants' responses were mixed. According to some, it needs to be clear who is the host and who used which data. This would go hand in hand with a clear and guaranteed data security policy especially for copyrighted works and intellectual-property-related data. However, another opinion was that information sharing is part of the MakerSpace culture. One concern was on compatibility, meaning that the OpIS platform might not be compatible with personal data files and thus does not give makers the freedom to choose a product or project of their own.

Expectations for **relatedness and connecting** were positive overall. People expected to get to know other makers and similar institutions. However, it was also mentioned that this is not the priority, since there are many other tools for that purpose on the market.

Many kinds of **(maker) skills** that the project could improve as a whole were mentioned by respondents, like market research, new ways of making and managing, machine use (CNC machines, 3D printers), co-creation, mechanical engineering and mechatronics. Although the majority would be the improvement of already acquired skills, also some new skills could probably be learned in the course of the project.

When asked what would make the project a **successful** one, participating makers provided many different responses. The main point however were successful projects and even products as a result of that. Also mentioned were new contacts and clients, especially in the long run, and also new members in their MakerSpace. Finally, an increase in the efficiency in prototyping seems to be another factor for success.

4.1.2. Manufacturers

The participating manufacturer representatives expressed their primary **goals** in contributing to the iPRODUCE cMDF activities by faster prototyping and networking with specialised MakerSpaces and potential new industry partners or customers. Considering that three of the five participating manufacturers are active cMDF members, this is somewhat natural. Manufacturers also seek opportunities for local manufacturing of consumer products and research equipment and to “break the barrier between maker and industrial SME”.

When asked to describe the **process** of the collaboration with a MakerSpace/FabLab, all participating manufacturer representatives stated that their focus is on learning. Manufacturers aim for fast feedback on their prototypes and help in finding (the right) domain experts in order to get answers to solve their specific manufacturing problem.

In terms of expectations for **production**, collaborating with a MakerSpace would assumedly result in faster production of functional prototypes and thus reduced *time to market* (TTM). One manufacturer also mentioned the fact that the MakerSpace is a place to observe the methods other manufacturers use for their rapid prototyping activities and thus allows for indirect learning.

Other expected outcomes in terms of **customer relations** were that the collaboration with makers would help the manufacturer to increase the number of product choices for its customers, increase the number of ideas, and serve as additional inspiration, simply from the fact to be surrounded by makers. Another proposed outcome was a deeper customer understanding and that the collaboration with makers might improve the UX in the manufactured product.

Regarding **expectations for employee relations**, all interview partners expected that collaborating with MakerSpaces would significantly improve employee skills, especially in “high-edge technologies”. One respondent even expected the MakerSpace to be a place for hiring new employees, thus being an “employee recruiting opportunity” for the manufacturer.

When asked for **expectations for business relations**, most participants clearly expected to improve those by collaborating with makers. They mentioned that the networking would allow them finding new, cheaper, or more reliable suppliers and broaden their business network in general.

In terms of **public relations**, the representatives of manufacturers generally expected a positive effect. The chance of using the collaboration activities for a marketing campaign was mentioned as well as that the collaboration with a MakerSpace may increase visibility towards public bodies and customers, and the fact that the MakerSpace often offers the (room) facility for holding in-person meetings and presentations, which especially for small companies / founders is of high value. One also stated that the collaboration with makers would improve the public perception of an SME, as it may be perceived as “more open”.

The **potential impact on digitalisation** as expected by interview respondents highlighted that the collaboration with Makers may help manufacturers to discover open-source tools, use and learn about digital machines and software, and implement/apply remote working habits.

Regarding **innovation**, participating manufacturer representatives also expected to create new revenue channels with stakeholders of the MakerSpace and to improve their innovation processes, like one who, thanks to the collaboration, discovered the new methodology of "frugal innovation[1]".

When asked for expected business impact on manufacturing **sustainability**, it was mentioned that material transportation for multiple MakerSpace members at the same time may be interesting as well as the reuse of others scraps and thus overall less material consumed. It was also stated that the help of makers may reduce mistakes when using machinery for prototyping and thus reduce trash.

Finally, asked what would make the iPRODUCE project and the contribution to collaborative cMDF activities **a success**, manufacturer representatives mentioned the time reduction for our R&D process and the manufacturing process itself, one successful collaborative R&D-project (or success story), one innovative product created, having learned something new and essential to the business, and having established a new/stronger stakeholder relationship.

Additional interview with external manufacturer

In addition to the interviews with manufacturers involved in iPRODUCE, an interview with a German manufacturer *outside* of iPRODUCE, which is however involved in collaborations with a local MakerSpace, was conducted. Thus, the interview focuses more specifically on the company itself and how it benefited from the contact to a MakerSpace. The interview served to provide a deeper understanding of the nature of MakerSpace–manufacturer collaborations in general to derive better fitting indices for the ensuing Socio-Economic Assessment surveys. The summary of the interview is presented in the following.

The SME of the interviewee is active in four fields of Business: 1) wholesale of electronic supplies and devices, 2) wholesale of home/garden products, 3) logistics, and 4) switchgear construction. Their business model is mainly based on acting as a middleman for electronic products sales. Those are most often produced in Asia, and the SME serves as a local dealer delivering on demand to its customers small businesses and private customers.

Observing the market development and evolving technologies like 3D printing challenge the current business model. The Chief Digital Officer (CDO) of the SME decided to undergo a risk analysis, concerning 3D printing technology. He sought professional support in understanding what 3D printing is and what impact the technology may bring to the market (and to the SME's business model within the next years. By hearsay, he was pointed to a MakerSpace nearby his facility. He organised several meetings and sent two employees to training activities to test and learn 3D printing. By identifying a business case, the technology is now applied within the SME: It is printing and selling spare parts for its private label for garden furniture.

The CDO also decided to join the steering committee of the MakerSpace as a volunteer activity when he was asked to. During the interview he pointed out that MakerSpaces should be available for anybody for free. Just like a public library they should be considered a public learning space.

[1] Frugal innovations refer to a simplified and application-oriented innovations for tapping new, price-sensitive market segments, often in emerging markets. They can be summarised in three premises. (1) More for less: the product should have a high benefit for the end customer that is proportionate to the price. (2) Asset-light: capital-efficient solutions, that is needs that were traditionally satisfied by products are now met by services (e.g. Airbnb). (3) Good enough: The product should only cover target group-specific and application-oriented functions but fulfil them at a medium to high level (Weyrauch & Herstatt, 2017).

The CDO mentioned one dedicated benefit, which is that the MakerSpace serves as a playground for testing. It relieves the SME from costly purchases of machinery and provides quick answers/ideas from experts that would have caused hours of desk research for the SME novice otherwise.

4.1.3. Summary of Round 1

Summarising the results of the interviews with both makers and manufacturers, networking and visibility regarding the collaboration was a goal targeted by both makers and manufacturing companies at the beginning of the project. By participating in iPRODUCE, makers intended to develop their prototyping skills, acquire new machinery and hardware for their facility. They aimed to optimise the MakerSpace's processes, address a larger number of target groups and thus become more inclusive as an organisation. Compared to this, manufacturers and SMEs were more interested in learning and skill development. They value especially quickly learning and understanding 3D printing technology in short time and for little money.

The OpIS platform promised collaborative features that are of high value to both makers and manufacturers (especially collaborative 3D design). By way of illustration, one maker mentioned: "A platform financed by the EU and published open-source results in emancipation of makers from corporate, especially US software."

4.2. Results Round 2

Round 2 of the Pilot Evaluation took place towards the end of iPRODUCE, *after* the OpIS platform had been introduced and tested. However, at that time, the tools were *not* fully integrated into the daily work of the participating MakerSpaces and manufacturers yet.

In the following, the iPRODUCE *Hackathon* (D6.6) is mentioned several times. The main objective of the iPRODUCE hackathon was to contribute to the validation of the iPRODUCE value proposition, particularly the OpIS platform and the respective tools. The main challenge of the iPRODUCE Hackathon was for teams/individuals to develop a product idea creating their own user journey and using as many of the OpIS tools as possible to develop their product. Individuals/teams were invited to develop any type of idea/solution, focusing on any type of sector. The Hackathon took place on two days between the 20th and 22nd of April 2023, that is at the late stage of the iPRODUCE project. In this way, the Hackathon served as one of the main use cases of the OpIS platform in the project.

4.2.1. Makers

Overall, participating makers reported to have achieved within their cMDF the **goals** that they hoped to achieve in the course of the iPRODUCE project. They utilised the OpIS platform to find partners and test products before launching them to the market. It was also reported to have promoted the OpIS platform to the maximum extent with various stakeholders, which had been one of the goals. Other participants enabled experimentation and ideation for students, supporting creative thinking and pursuit of passions. Both the conducting of and participating in the iPRODUCE Hackathons were also mentioned. One participant mentioned a concrete product that they achieved to develop in the course of the Hackathon.

The reported **activities** at the end of the project mirrored the results from the first round. Besides project meetings, workshops, and training activities, especially the testing and use of the OpIS tools and the Hackathon were mentioned.

The **value** that iPRODUCE and the pilots (cMDFs) imparted was manifold. On the one hand, makers (and MakerSpaces) were able to find collaborators and create NDA contracts via the Matchmaking and the IPR Authoring Tool. Moreover, the project enabled meeting local communities and expanding the connections among makers, manufacturers, and consumers. Although not all tools were used intensively beyond the occasion of the Hackathon, participants did see potential for entrepreneurs to use the OpIS tools. The project also highlighted the difficulty of creating and maintaining product ownership in collaborative efforts. Makers reported that they discovered some new tools and methods, including the OpIS platform but also design thinking and co-creation approaches. The project helped to identify the necessary competencies for co-creating prototypes and foster new synergies among stakeholders. What is more, the OpIS platform enabled the learning of (new) technology (e.g. 3D printing) without the need for a supervisor, which can significantly reduce the resources used, in general.

In terms of **social impact**, the participation in the project and the use of the OpIS platform allowed makers and small companies to find collaborators, expand their community, and reduce costs, especially for “small” makers, fostering an ecosystem for creativity and collaboration. However, the capabilities of the OpIS platform for co-creation were considered too low by one participant. The experience of working with groups on the same idea in the same place was reported to be positive, leading to new solutions that could potentially reach the market. Moreover, the communication efforts of iPRODUCE made participants aware of the project's results and opportunities for co-creation of new products.

The reported **value of the OpIS tools** was mixed, with some participants reporting great and other low value. Some also had only little occasion to actually use the platform (e.g. during the Hackathon). For instance, the AR/VR toolkit was used to visualise the project, and the IPR Authoring tool was used to create a contract. Moreover, the tools were reported to enable the navigation through the user’s journey and getting in touch with other users and stakeholders from different fields. This allowed some participants to gather the necessary competencies for the development of their product and also to have a platform to store and share project details and comments.

The **motivations** to use the platform were mainly to connect with the organisers of iPRODUCE and of the Hackathon. Besides, it was mentioned that by testing the OpIS tools, one can stay up to date with the newest developments of tools for the MakerSpace communities.

Overall, the **feelings** for the OpIS tools were positive rather than negative, but the need for improvement of the platform became clear. Some participants found the tools to be great for creators and matchmaking with customers as well as for the co-design of products. However, some participants found some of the tools frustrating to use, not intuitive, and needing to be improved before being ready for professional use. The UX was considered poor by some, and some tools were not fully operational according to the participating makers.

Regarding the users’ **competence** with the tools, the responses were mixed. Some makers found the tools easy to use – given that they have previous experience with digital tools. Others did not feel competent at all in their use, which highlights the requirement of good tutorials. It was also mentioned that the user flow between the tools is hard to follow. Overall, the tools did not seem to have improved the efficiency of the responding makers; however, as mentioned before, the Pilot Evaluation is not meant to be representative in this way but rather to showcase individual experiences.

No major thwarting of user **autonomy** due to the OpIS tools was reported as makers feel in control of their actions with the tool. It was however reported that the user flow can feel restrictive at times, even though the functionalities are overall satisfactory.

When asked for **relatedness** with other users of the OpIS platform, the responses were again mixed. Whereas some makers reported that they could easily expand their network via the platform, others were not able to communicate or connect with other people – partially due to a lack of tutorials.

So far, the OpIS platform did not seem to have enabled any new **maker skills**. This was mostly due to the fact that makers were not able to fully exploit all the platform's potentials yet. However, in the responses there were mentions of improved creativity and knowledge of some tools and technology (e.g. digital twins).

In terms of project **success**, the main aspect in the responses was the expansion of the community, be it other makers or clients. Makers who participated in the Hackathon reported the successful development of a product.

4.2.2. Manufacturers

4.2.2.1. Overall results

The manufacturer participants achieved various **goals** in iPRODUCE, including finding alternative solutions to existing problems, making new contacts, improving manufacturing processes, enhancing the design of existing products, accessing diverse skills and knowledge from makers and designers, speeding up product development cycles, and reducing costs and risks associated with traditional manufacturing methods. Moreover, participants enhanced their networks, especially getting in contact with the respective cMDF communities. The development of several products was reported, which were, through iPRODUCE, socially manufactured, including various stakeholders.

In terms of the collaboration **process**, manufacturers reported a variety of activities, from prototyping and training to tools testing and hackathons. Several manufacturer participants described the collaboration with the respective cMDFs/MakerSpaces to have been very pleasant and proactive.

The **production** itself did not seem to be majorly affected through iPRODUCE, according to the responses. This was largely due to the fact that the manufacturer–maker collaborations were not fully established yet but remained individual occasions. However, participants recognised the great capacity of such collaborations to enhance product quality (through makers' feedback) and to lower costs (through accessing specialised equipment and expertise). Manufacturer representatives stated that they have enhanced their contacts, which could lead to such production enhancements in the future.

The results were similar in terms of **customer relations** as participants reported increased contacts and a better understanding of the customers' needs. There was recognition of the possibility to establish a collaborative and customer-centric approach to product development, which consequently can lead to increased customer engagement and greater customer satisfaction.

Also for **employee relations**, the results were rather vague with little concrete outcomes but rather recognised potential and opportunity for beyond the project lifetime: Manufacturers in this way increased their contacts with talented students who could be prospective employees. It was also mentioned that working together with makers is always an enriching experience for the manufacturer and the employees, fostering a collaborative and creative work environment for more innovation, personal development, and social impact.

When asked for **business relations** due to iPRODUCE, responses were mixed, with some manufacturer representatives reporting new suppliers and business contacts that they work together with now and others reporting nothing related to this.

Public relations were improved by good public coverage of iPRODUCE events, according to the participants. This increases the visibility and recognition in the local community.

According to this data collection, no aspects of increased **digitalisation** of the manufacturers were reported. Participants were already very digitalised. However, some recognised partial improvements of some aspects (e.g. communication and document sharing).

Similarly, in terms of **innovation**, there were no concrete outcomes, according to the participants. Nevertheless, new ideas were developed and potentially pursued prospectively. In any case, new ways of co-creation and relating to stakeholders were recognised and will be applied in the future. Collaborating with new partners has thus widened some manufacturers' horizon regarding technologies and market trends in social manufacturing.

No effects regarding **sustainability** were reported. Only the potential for manufacturers to learn about new sustainable materials and environment-friendly production methods was recognised.

Finally, the reports of potential **success** of the iPRODUCE project for participating manufacturers were largely positive with a few negative aspects. The enlargement of the stakeholder network (MakerSpaces, companies, students) was considered a success and will positively impact the participating manufacturers in the future. Some OpIS tool features could be used successfully, benefitting the companies' collaborative manufacturing; other tools did not work as expected. Also a success were deemed the manifold activities and learnings that iPRODUCE enabled, such as prototyping and exploring new design concepts and digital manufacturing technologies. In this way, new opportunities for innovation could be identified, which could lead to a higher quality of products.

4.2.2.2. KPI-specific results

KPI-16 (> 80% overall **labour effectiveness**) was included in the regular Pilot Evaluation questions, that is directed at manufacturer stakeholders of iPRODUCE. In addition, the questions for KPI-16 as well as *KPI-23* (> 20% reduced **time to market**) and *KPI-30* (> 20% reduced **development costs**) were sent to / asked representatives of AIDPLEX and LAGRAMA, the only two manufacturing companies, which are part of the iPRODUCE consortium.

KPI-16 was framed via three questions in the regular Pilot Evaluation. In terms of **workers' availability**, the manufacturers' employees were generally reported to be rather open to contribute to collaborative manufacturing (as compared to classical manufacturing). Many workers were reported to be interested in investigating new ways and tools to facilitate collaborative manufacturing and communication. However, it was also mentioned that whether collaborative manufacturing is pursued is not a matter of the employees' willingness but of the companies' management. Overall, **workers' performance** was not expected to be higher in collaborative than in classical manufacturing according to the participating manufacturer representatives. However, it was highlighted that there exists no data yet to make a clear statement on that. It was suggested that the workload would be better distributed and facilitated. Moreover, in some cases, workers may need to acquire new skills or knowledge to fully participate in collaborative manufacturing processes, which may take some time and training. Similarly, participants were – for the most part – unable to estimate the relative effect of collaborative manufacturing on **product quality** due to a lack of data at that time. It was however pointed out that the different backgrounds and expertises could possibly enhance product quality. What is more, working with makers and designers who have expertise in cutting-edge technologies and innovative design could lead to higher product quality and a better fulfilment of the customers' needs. Especially potential design flaws or manufacturing issues could possibly be identified earlier in the development process. However, one

participant claimed their product quality to be improved due to the project. Thus, overall, KPI-16 could not be measured directly; rather, some iPRODUCE manufacturers were able to make educated guesses, whereas others were not.

In the following, the feedback from AIDPLEX (Greek cMDF) and LAGRAMA (Spanish cMDF) on KPI-16 (in addition to what is presented above), KPI-23 and KPI-30 is reported.

KPI-16. *Effectiveness and quality of collaborative manufacturing outputs: >80% Overall Labour Effectiveness (measured as: Workers' Availability & Performance and Product Quality)*

Internal information flow is considered satisfactory among the different departments of the companies. The culture of collaboration and sharing – as well as the distributed responsibilities – is considered as an added benefit of a specifically collaborative approach. However, they are generally less enthusiastic about collaborative approaches leading to an efficiency rise for the internal compared to the external information flow.

The integration of *external* information (external collaborations, user view, market info, etc.) is considered as "a difficulty" or "sometimes difficult to keep up with". Apparently, SMEs see a clearer impact in the internal–external information flow, but this does not usually translate into increase of productivity. Nevertheless, an increase of the communication may have the additional effect of clearer user or market insights.

KPI-23. *Improvement in the time to market of products: > 20% (reported by participating SMEs)*

Although the number of use cases related to market-ready products is not negligible (a total of 5 UC "market ready" prototypes from the Spanish and Greek cMDFs), they are too heterogeneous to derive a KPI from. Instead, a perceived indicator was built based on:

- The existence of the improvement when applying iPRODUCE.
- The consideration of re-work efforts due to manufacturing, usability, and market information not adequately included in the early stages of design and development.

According to the companies, the improvement exists because of "focused efforts on essential features and reduced time wasted on irrelevant aspects", and "improving the communication speed among all actors". Processes were more concurrent and "streamlined development cycles by removing bottlenecks and accelerating consensus-building". Since in the current situation "it is common to redesign products before launching them for sale" and "Iterative prototyping and testing played a vital role", including as much information as possible in the first steps of the prototyping stage is key to reduce iterations".

Given the fact that the actual TTM for most of the "commercial" products of the companies ranges from a quarter to a year, no big influence is detected in time to market for such a range of products. However, for special or on-demand elements, we are talking of weeks of a few months and in this case the improvement in TTM can be clear.

The perception on the improvement in TTM is clear from the companies, in all their commercial offering, but is judged as relevant in the cases of bespoke, on-demand, or special products.

KPI-30. *Reduction in the development cost for new products: >20% (as reported by participating SMEs)*

Proof of concept / market-ready prototypes have been developed in iPRODUCE, although final production processes have not been specified during the project. Again, the sample of products is small and heterogeneous, such as in KPI-23, and prototyping stages do not allow us to account for production

adaptation and market placement (they often use bespoke materials, pre-assembled elements, usually do not consider iterations, etc.). The indicator was evaluated in terms of:

- The existence of the cut in development costs when applying iPRODUCE.
- The relative importance of development costs vs. market value.
- The nature of the development costs and the induced costs due to production issues and/or market-induced redesign.
- The increase of market value when applying the iPRODUCE approach, either because of more unitary-value or less low-value products

The perception of improvement on development costs is not shared by the participant SMEs, although they reckon the collaborative approach may decrease them; the relevance they give to this decrease ranges from not significant to important. They neither share the idea of development costs increasing or decreasing as a sign of market value. However, they do perceive the increase of market value due to iPRODUCE-like approaches: “Investing in user-centred design activities, including UX/UI design and usability testing, ensures intuitive and user-friendly products that align with user expectations”.

Thus, the KPI value cannot be confirmed by the SMEs, but instead they focus on the market value increase both in commercial ranges and on one-part batch production.

4.2.3. Summary of Round 2

Overall, the qualitative data from makers and manufacturer representatives showed evidence that iPRODUCE was indeed a success for participating MakerSpaces and manufacturers. It appears from the responses that the expectation to make promising new contacts in the course of the project was fulfilled. Makers could learn new methods of co-creation and manufacturing, whereas manufacturers could use the expertise and resources of the MakerSpaces to innovate and co-create. The introduction of the OpIS tools was a success only in parts, which was mainly due to the delayed development within the project lifetime. Towards the end of the iPRODUCE project, several tools, including the Marketplace, were still partially complicated to use due to usability problems (D9.3; Núñez & Gigante, 2023), which raised the need for tutorials and training activities. Nevertheless, and most importantly, the OpIS tools introduced new ways of collaborating and manufacturing to MakerSpaces and manufacturing companies, which can be exploited prospectively. Until then, no direct impact on the general production can be determined. So far, iPRODUCE established a vision and showed stakeholders a way of social manufacturing – it is for them and consecutive projects to bring this vision along with its methods, tools, and activities to fruition.

The KPIs covered by the Pilot Evaluation could not be measured directly – mostly since iPRODUCE did not cover the stage of production with a collaborative manufacturing approach. Whereas the potential to improve the effectiveness and quality of collaborative manufacturing outputs (KPI-16) as well as the time to market of products (KPI-23) was recognised by participating SMEs, a reduction in development costs for new products (KPI-30) seems less likely as a result of social/collaborative manufacturing like done in iPRODUCE.

5. Socio-Economic Assessment Results

The results of the Socio-Economic Assessment survey were analysed via Microsoft Excel and IBM SPSS Statistics. The results of the Short KPI Survey are presented alongside the pertaining results from the main survey.

5.1. Sample

Of the 25 participating makers, four were female and 17 were male (two preferred not to answer). Five of the 11 manufacturer representatives were female and six male. Of the 11 participating consumers, four were female and seven male. In total, there were 13 females and 32 males. 12 participants (26%) were between 20 and 29 years old, 18 (36%) were between 30 and 39; six (13%) were between 40 and 49, and 11 (23%) were between 50 and 59. 43% of participants were from Spain, 26% from Italy, 15% from France, 11% from Germany, and 6% from Greece. These numbers do not necessarily reflect the size of the respective cMDFs.

66% of respondents had a Master's degree or equivalent; 19% a Bachelor's degree, 11% a Doctorate, and 4% up to a High school diploma. 83% reported to have previous experience in the fields of engineering or computer and information science. Of the survey people, 26% were students, 15% were self-employed, and the majority (55%) was regularly employed. Of the 11 manufacturer representatives, one was the company owner, two were entrepreneurs, two were in a leading/management position, and six were regular employees. Figure 2 shows the project participation rate of the respondents, detailing the number of responses per response option.

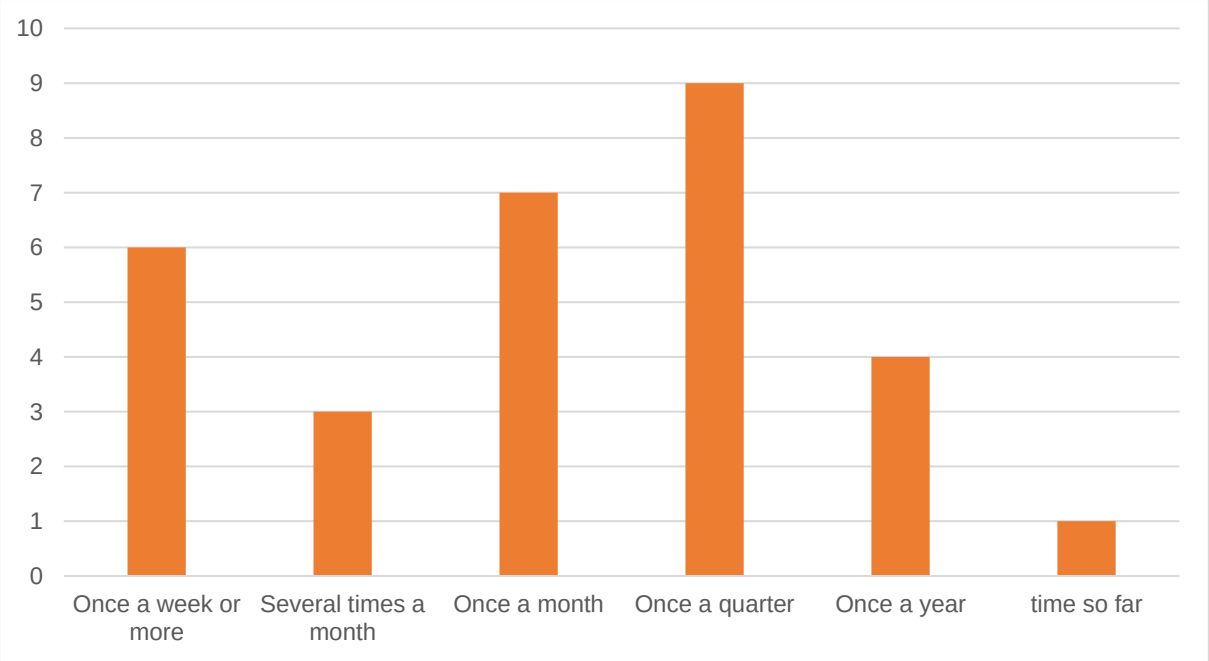

Figure 2. Project Participation Rate as Number of Responses (*n* = 47)

5.2. Detailed Results

In the following, scales consisting of several items are presented with their means, which were transformed to values from 0 to 100 (percent). Note that this is only an *estimate* based on the available

and limited sample. For each average scale value, the 95% confidence interval is given for all scale values in order to provide a plausible range for the "true" population mean (population = all potential users). Individual items, which cannot be combined with other items to a scale representing a construct are usually presented with the *top-2-box scores* (the proportion of participants who selected *4 – agree* or *5 – strongly agree* on a 5-point Likert scale). In the case of some items, – despite it being ordinal data – the average values (transformed to range from 0 to 4 instead of 1 to 5 for better interpretability) are reported as well, as is common in applied statistics.

5.2.1. Collaborative Manufacturing & Open Innovation Methods

KPI-15 specified a larger than 20% improvement in *makers' and consumers' perceived readiness to participate in collaborative manufacturing*, and **KPI-14** a 20% improvement in the *perceived ability of manufacturing SMEs to apply open innovation methods*. It was not possible to track iPRODUCE participants' change in attitude over time (see Sections 3.1.1 and 3.3). That means *different* makers, manufacturers, and consumers participated in the Short KPI Survey (Time 1) and later in the Socio-Economic Assessment (Time 2). It *is* possible to compare the values of both groups/timepoints, but this does *not* allow for any statements about (intra-individual) change over time and thus, **no measurement of KPI-14 and KPI-15** as specified. Nevertheless, both values (Time 1 and Time 2) are reported in the following. Note that due to the small sample size, no factor analysis to confirm the factor structure of the developed scales was possible.

At Time 1 (n = 17), the average scale value of the perceived readiness to participate in collaborative manufacturing (KPI-15; measured by five items) was 66.2 (i.e. about 66% of the maximum score). Based on the 95% confidence interval, we can be 95% confident that the mean population score is between 54.7 and 77.7. At Time 2 (n = 36), the average transformed score was 60.6. With 95% confidence, the population mean is between 53.3 and 67.9. Thus, the sample value at Time 2 was lower than at Time 1 (decreased by 8%, or by 5.6 percentage points), contrary to the hypothesis but with a substantial overlap of the confidence intervals. Accordingly, there was no significant (at α = .05) difference. Hence, that difference is more likely to be due to chance than a real difference between participants in Time 1 and Time 2. Besides the readiness construct, the *current participation* in collaborative manufacturing at Time 1 (measured by one item) was rated 2.29 out of 4 (57%). 43% agreed with the statement (top-2-box score). At Time 2, the average was 1.61 out of 4 (40%); 19% agreed. The *willingness to participate* was rated 3.14 (79%) at Time 1 (86% agreed with the statement), compared to 2.78 (70%) at Time 2 (67% agreed).

The perceived ability of manufacturing SMEs to apply open innovation methods (KPI-14; measured by four items) was 67.5 out of 100 at Time 1 (n = 10). We can be 95% confident that the population mean is between 53.1 and 81.9. At Time 2 (n = 11), the score was 64.2. The 95% confidence interval was between 51.7 and 76.7. Therefore, although there was a decrease (5% or 3 percentage points), from Time 1 to Time 2 contrary to expectations (increased by 8%), that difference was not significant. Moreover, 80% of companies reported applying open innovation methods in the past at Time 1, compared to 55% at Time 2. 90% of respondents reported that their company plans to apply open innovation methods in the future at Time 1; at Time 2, it was 73%.

5.2.2. Perceived Value Creation

The items regarding individually perceived **personal value creation** were framed by the statement "Participating in iPRODUCE helped me to:", followed by the item stem (see below).

51% (24 out of 47) of participants (makers, manufacturer representatives, and consumers) agreed (scores 4 and 5 on a 5-point scale) with the statement that iPRODUCE helped them to access tools and/or mentorship. 36% agreed that they acquired new technical skills. 38% said they could provide a valuable service to their community due to the project. 74% agreed that they could share knowledge and skills with others. 47% improved their employability skills, according to the results. 79% extended their network in the course of iPRODUCE. 81% were enabled to meet individuals with common interest due to iPRODUCE. 11% gained financial rewards. 23% gained perceived peer recognition / acknowledgement as an inventor. 47% achieved moral satisfaction from seeing their idea turn into a product; and 55% became more innovative in general. This reflects the results from the analysis in T2.1 (D2.1), in which it appeared "…that (i) meeting people with common interests, (ii) acquiring new technical skills, (iii) exchanging knowledge and (iv) extending network consist important drivers towards participating in a social manufacturing project" (p. 23), showing that project participation enabled the fulfilment of the drivers/needs. Table 2 shows the top-2-box scores for each individual participant group.

Table 2. Personal Value Creation Results

Personal Value Creation			
Participating in iPRODUCE helped me to:	**Makers Top-2-Box Score (*n* = 25)**	**Manufacturers Top-2-Box Score (*n* = 11)**	**Consumers Top-2-Box Score (*n* = 11)**
access tools and/or mentorship	48%	27%	82%
acquire new technical skills	40%	27%	36%
provide a valuable service to my community	44%	36%	27%
share knowledge and skills with others	76%	55%	91%
improve my employability skills	52%	18%	64%
extend my network	76%	73%	91%
meet individuals with common interests	80%	73%	91%
gain financial rewards	20%	0%	0%
gain peer-recognition/acknowledgement as an inventor	28%	18%	18%
achieve moral satisfaction from seeing my idea turn into product	52%	27%	55%
become more innovative	60%	27%	73%

The items regarding **makers' organisational value creation** were framed by the statement "In my experience, participating in iPRODUCE helped my MakerSpace/FabLab to:", followed by the item stem (see below).

Two out of 25 makers (8%) agreed (top-2-box scores) with the statement that iPRODUCE helped their MakerSpace to reduce the cost of developing products and services. 56% of makers were of the opinion that their MakerSpace could develop more personalised products due to the project. 48% experienced an enhanced co-creation culture within their MakerSpace. The MakerSpaces of 52% of the respondents could identify new commercial opportunities. 64% reported that their MakerSpace could better share its vision with the public due to iPRODUCE. 52% agreed that the testing of new product design was facilitated. 32% reported increased MakerSpace efficiency and 20% an optimisation of resources. Finally, 40% of participating makers agreed that due to iPRODUCE, their MakerSpace became more aware of sustainability issues.

In contrast, the items regarding **manufacturers' organisational value creation** were framed by the statement "In my experience, working together with a MakerSpace/FabLab helped my company to:", followed by the item stem (see below).

4 out of 11 (36%) of the manufacturer representatives agreed with the statement that their company's working together with a MakerSpace helped them reduce the cost of developing products and services, which appears like a more optimistic result than from the Pilot Evaluation (see Section 4.2.2.2). Also 36% of company representatives reported to have developed more personalised products. 64% enhanced the co-creation culture in the manufacturing company; and also 64% reported to have identified new commercial opportunities. 36% agreed with the statement that the company could better share its vision with customers through iPRODUCE. 55% could better test new product designs and evaluate the product before reaching the market. 27% agreed that their companies increased in efficiency (e.g. to meet rapid demand changes). 36% could better optimise their resources; and also 36% reported that their company became more aware of sustainability issues. Table 3 contrasts the organisational value creation for makers and manufacturers in the form of top-2-box scores (proportion of "agree" and "strongly agree" ratings).

Table 3. Organisational Value Creation Results

Organisational Value Creation		
In my experience, working together with a MakerSpace/FabLab helped my company to:	**Makers Top-2-Box Score (*n* = 25)**	**Manufacturers Top-2-Box Score (*n* = 11)**
reduce the cost of developing products and services	8%	36%
develop more personalised products	56%	36%
enhance its co-creation culture	48%	64%
identify new commercial opportunities	52%	64%
share its vision with the public / customers	64%	36%
test new product designs	52%	55%
increase efficiency	32%	27%
optimise resources	20%	36%
become more self-aware of sustainability issues	40%	36%

5.2.3. Satisfaction and Loyalty Regarding Co-Manufactured Products

KPI-36 specified *consumers' satisfaction with regard to the co-manufactured products* to be larger than 90%. Four of the participating consumers indicated that they had co-manufactured products in the course of the iPRODUCE project. All of them were fully satisfied with those products (strongly agree). Thus, the average value was 4 (100%: maximum score). Two of them strongly agreed and two agreed with the statement that those products were of good quality. The average was thus 3.5 out of 4 (88% of maximum). Thus, although the number of participants was small, **this KPI was met with 94%** of the maximum score across two items, based on the limited data available.

KPI-37 was specified as *consumers' willingness to support the manufactured products (loyalty)*, which was supposed to exceed 70%. Two of the four consumers agreed (top-2-box score) with the statement that they wish to support the ongoing development of those products. The average score was 2.5 out of 4 (63%). Three of them agreed that they are loyal to their co-manufactured products with an average score of 3 out of 4 (75%). Thus, according to the limited available data and the specific operationalisation, **this KPI was barely not met with 69%** of the maximum average score across two items.

5.2.4. Digitalisation & Digitisation Regarding Production and Deployment of Digital Tools

The items regarding **digitalisation of businesses/manufacturers** were framed by the statement "In my experience, my MakerSpace/FabLab helped companies to:" for the makers' perspective and "In my experience, the collaboration with the MakerSpace/FabLab has helped my company to:" for the manufacturers' perspective – followed by the item stem, respectively (see below).

36% of participating makers agreed (top-2-box score) that their MakerSpace helped companies to translate analogous into digital processes. 11% of manufacturers agreed with that statement. 48% of makers reported digitalisation of product fabrication, whereas 11% of manufacturers confirmed this. 64% of makers were of the opinion that their MakerSpace helped companies to discover open-source software; 22% of manufacturers reported self-same help from MakerSpaces. 76% of makers agreed that manufacturers received access to 3D printing technology from the maker–manufacturers collaboration, which was confirmed by 56% of manufacturer representatives. Access to other technology was reported by 68% of participating makers and 33% of participating manufacturers. Finally, makers agreed to 56% that they helped companies to better apply remote collaboration tools, which was *not* confirmed by manufacturers (0%).

Table 4 contrasts the results for the digitalisation of manufacturers items for the perspectives of makers and manufacturers. Overall, the differences between items (i.e. benefits) is largely the same for makers and manufacturers. However, makers rated the items much higher (i.e. agreed to a much larger extent to the statements) than manufacturer representatives. The most notable difference is between the scores for better applying remote collaboration tools, which manufacturers did not ascribe to MakerSpaces.

Table 4. Digitalisation of Manufacturers Results

Digitalisation of Manufacturers		
In my experience, my MakerSpace/FabLab helped companies to / In my experience, the collaboration with the MakerSpace/FabLab has helped my company to:	**Maker Perspective Top-2-Box Score (*n* = 25)**	**Manufacturer Perspective Top-2-Box Score (*n* = 9)**
translate analogous processes into digital ones	36%	11%
digitalise product fabrication	48%	11%
discover new open-source software	64%	22%
access 3D printing technology	76%	56%
access digital machines (other than 3D printing technology)	68%	33%
better apply remote collaboration tools	56%	0%

The items regarding **digitalisation of consumers** (from the makers' perspective) were framed by the statement "In my experience, my MakerSpace/FabLab helped consumers/individuals to:" for the makers' perspective and "In my experience, working with/in the MakerSpace/FabLab has helped me personally to:", followed by the item stem, respectively (see below).

64% of participating makers agreed that their MakerSpace helped consumers to discover new open-source software. 73% of consumers agreed on having received this digitalisation benefit. 72% of makers believed they helped consumers in terms of accessing 3D printing technology. This was only confirmed by 27% of participating consumers. 76% of makers were of the opinion that their MakerSpaces helped consumers to access other digital machines (besides 3D printing). 45% of consumers were of the same opinion. Finally, 44% of makers reported to have helped consumers better apply remote collaboration tools. This was agreed with by 91% of the participating consumers.

Table 5. Digitalisation of Consumers Results

Digitalisation of Consumers		
In my experience, my MakerSpace/FabLab helped consumers/individuals to: / In my experience, working with/in the MakerSpace/FabLab has helped me personally to:	**Maker Perspective Top-2-Box Score (*n* = 25)**	**Consumer Perspective Top-2-Box Score (*n* = 11)**
discover new open-source software	64%	73%
access 3D printing technology	72%	27%
access digital machines (other than 3D printing technology)	76%	45%
better apply remote collaboration tools	44%	91%

Table 5 contrasts the results for the digitalisation of consumers items for the perspectives of makers and consumers. There are some differences between how items (i.e. benefits) were rated, especially for accessing 3D printing technology and better applying remote collaboration tools. The latter contrasts (and could explain) the results of the manufacturer digitalisation, whereby manufacturers did not ascribe any improvement to their collaboration with makers/MakerSpaces.

5.2.5. Training Material and Activity Satisfaction

18 out of 47 participants indicated that they had participated in a **training activity** in the course of iPRODUCE. The item "The training activities during the iPRODUCE project were helpful for me." was rated with 2.56 out of 4 (64% of maximum score). 10 (56%) of respondents agreed to the item statement (top-2-box score). As examples for training activities, the participants typically mentioned consultation workshops in which the OpIS tools were tested.

19 out of 47 participants indicated that they had received and used **training material**. The item "The training activities during the iPRODUCE project were helpful for me." was rated with 2.56 out of 4 (64% of maximum score). 10 (56%) of respondents agreed to the statement (top-2-box score). The helpfulness of the material was rated 2.84 out of 4 (71%). In terms of the top-2-box score, 83% agreed to the statement. As examples, OpIS platform manuals, environmental guides, and educational material was mentioned.

5.2.6. OpIS Platform User Experience

Out of 47 survey participants, 28 indicated that they used OpIS tools. Of those, *all* indicated that they use the Marketplace, that is at least "rarely". OpIS platform users use the other tools to a varying degree. Figure 3 shows the OpIS platform users' mean **frequency** of use measured from 0 – never to 4 – always.

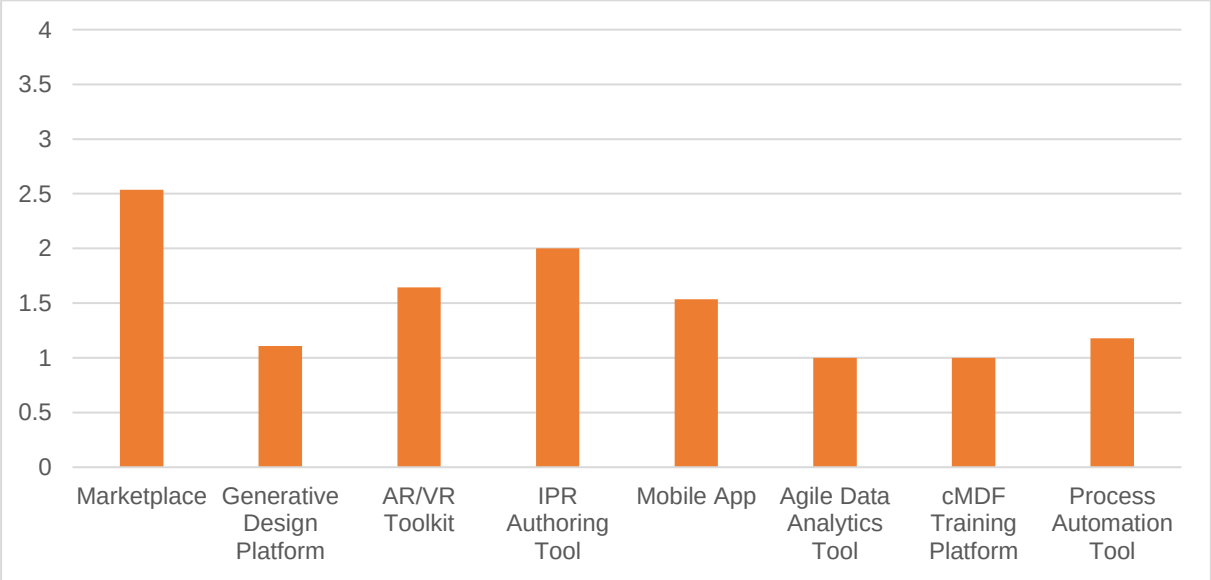

Figure 3. Relative Frequency of OpIS Tool Use by OpIS Users (*n* = 28)

Different than the non-OpIS aspects, the UX of the OpIS tools was measured via standardised questionnaires. Therefore, for the most part, no individual item results (in the form of top-2-box scores or averages) but instead, average scale scores, transformed to range from 0 to 100 are reported (see also Figure 3). Notably, although more people have tested the OpIS tools in the course of the project,

only the MMC communities as end-users participated in this survey, which limits the number of responses in the case of some tools.

5.2.6.1. Marketplace

22 people rated the Marketplace's UX. Of those 22, six indicated they use it "rarely", three "sometimes", six "often", and seven "always". Therefore, the respondents can be considered suitable to judge the tool. The meCUE provides a variety of UX measures, including usability. **Usefulness** was rated on average 40.9 (out of 100). We can be 95% confident that the population mean is between 33.2 and 48.6. **Usability** reached a score of 36.1. The population mean is between 26.4 and 45.9 with 95% confidence. The mean score of **positive emotions** was 29.3. According to the calculated 95% confidence interval, the plausible range of the population mean is between 21.6 and 36.9. The mean of **negative emotions** in this sample was 49.8. We can be 95% confident that the population mean is between 39.7 and 59.8. Finally, the global **evaluation** value was exactly 0 (at a possible range between -3 and 3).

The BPNSFS was completed by 20 participants: The sample mean value of **autonomy satisfaction** was 49.5 (out of 100). Based on the 95% confidence interval, we can be 95% confident the population mean value is between 40.2 and 58.8. The mean of **autonomy frustration** was 49.5. With 95% confidence, the population mean is between 37.2 and 61.9. Thus, certain users experienced a sense of freedom, choice, and self-determination while using the Marketplace, whereas others felt restricted or controlled in their tasks. The average **competence satisfaction** was 50.7. We can be 95% confident the population mean value is between 40.6 and 60.7. The mean **competence frustration** of the sample was 41.2. The population mean is between 28.4 and 54 with 95% confidence. According to this, competency experiences differed between users who handled the tool well and felt effective and others who struggled with it, resulting in feelings of incompetence. **Relatedness satisfaction** was rated 57.8. We can be 95% confident that the population mean is between 46.8 and 68.8. The **relatedness frustration** mean was 36.8. With 95% confidence, the population mean is between 27.2 and 46.4. Hence, the users felt rather included and connected to the other users (team members, customers, etc.) than excluded/disconnected.

Altogether, the UX of the Marketplace was judged neither good nor very bad. For a tool like the Marketplace, the prevention of negative UX takes priority over the promotion of positive UX. Nevertheless, the Marketplace shows room for improvement in terms of perceived usefulness and usability as well as negative emotions like frustration.

Figure 4 shows the different UX scale values in comparison – all interpolated to a maximum of 100 and a minimum of 0. Orange bars indicate UX values, for which *high* values are desirable. Red indicates *low* desirable values. The error bars indicate the 95% confidence intervals around the sample mean. For the autonomy and competence needs, the values of satisfaction and frustration are in approximately the same range. In contrast, the confidence intervals of positive and negative emotions and of relatedness satisfaction and frustration do not overlap respectively, indicating that the values of the two constructs are largely different from each other, respectively.

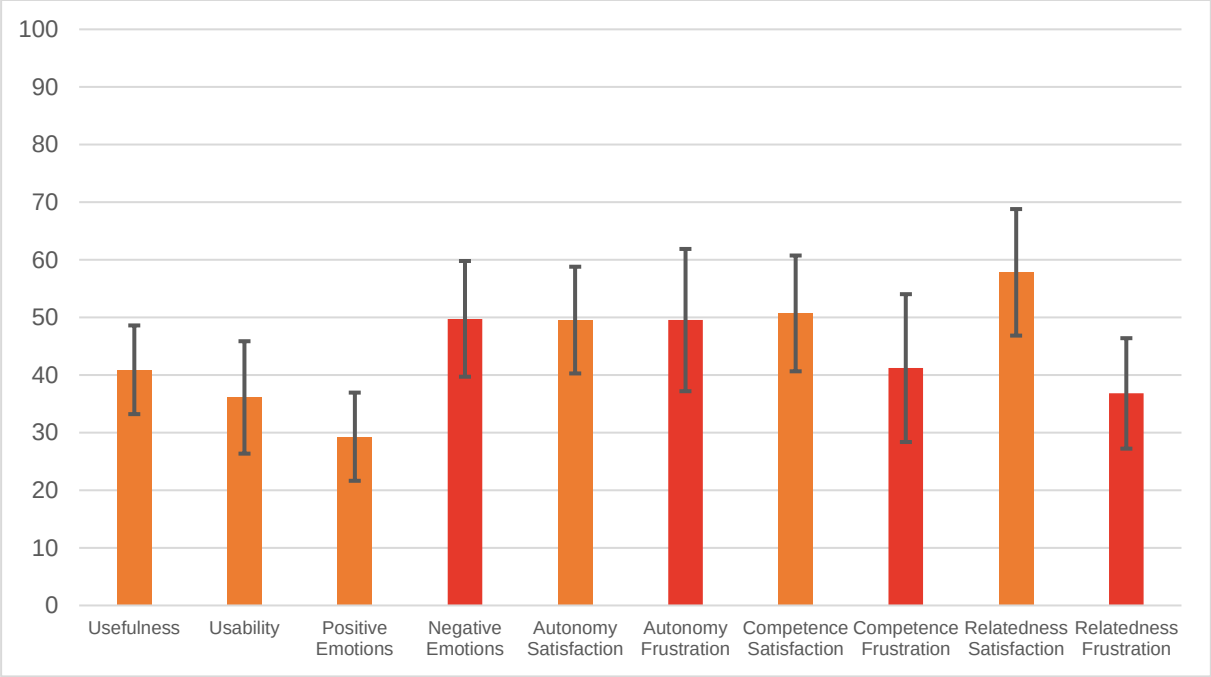

Figure 4. Marketplace User Experience Scale Values with 95% Confidence Intervals

The preceding scales were applied to the Marketplace assessment only. The following was the same for all OpIS tools, which is why some conceptual overlap with the Marketplace-exclusive items exists.

The UEQ (short version) for the Marketplace was completed by 20 users. The results of the **product quality** (as a UX measure) are depicted in Figure 5, presenting the semantic differential with eight pairs of opposite adjectives. The values are in the neutral to less desirable (left) range, with instrumental quality (first four items) being rather negative and hedonic quality (second four items) being rather neutral. This confirms the previous results and indicates some usability or performance issues and resulting frustrations despite experiences of novelty (hedonic quality).

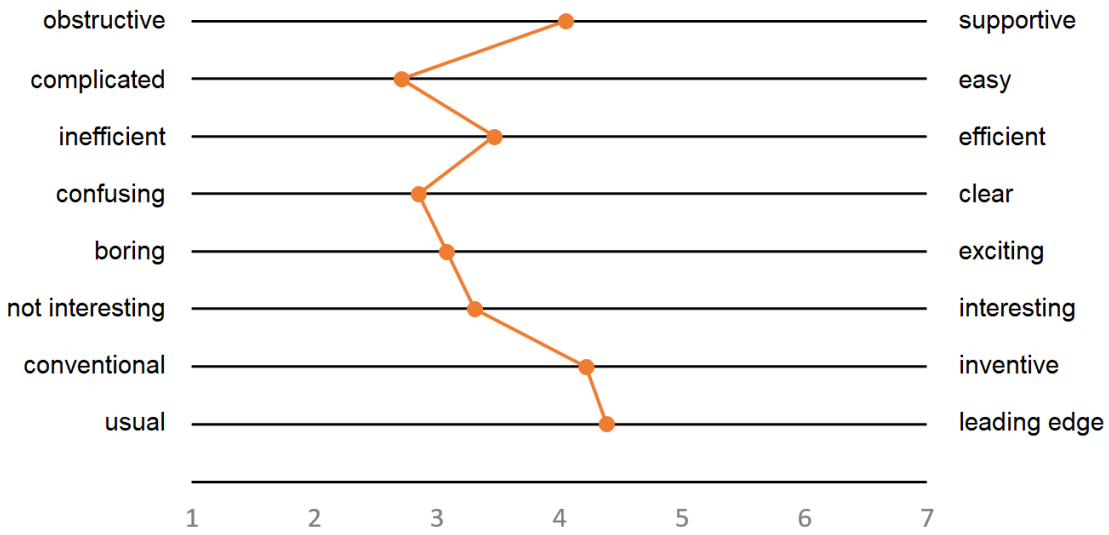

Figure 5. Semantic Differential (UEQ) of the Marketplace (*n* = 20)

The single **usefulness** item was rated 1.77 out of 4 (44% of the maximum score). 27% of participants agreed or strongly agreed with the statement, “The tool meets my needs”. This result is consistent with

the meCUE usefulness scale result. The average **likelihood to recommend** / NPS was 4.23 out of 10. Six out of 22 (27%) had a rating of 7 or above. Of those six, five had a rating of 7 (considered "passives") and one participant had a rating of 10 (considered a "promoter"). The rest (rating 6 or below) are considered "detractors", according to typical NPS interpretation. In this way, participants so far had a rather neutral to negative stance towards the Marketplace.

5.2.6.2. Generative Design Platform

The UEQ for the Generative Design Platform (GDP) was filled out by 5 participants. Of those, one used the GDP "never", two "rarely, one "sometimes", and one "often". The respondent indicating "never" as frequency of use was included nevertheless, since his or her responses seemed deliberate. Figure 6 shows the results, which are rather negative for the instrumental quality and neutral to positive for the hedonic quality of the tool, indicating a considerable novelty (inventive, leading edge) experience despite a rather low usability.

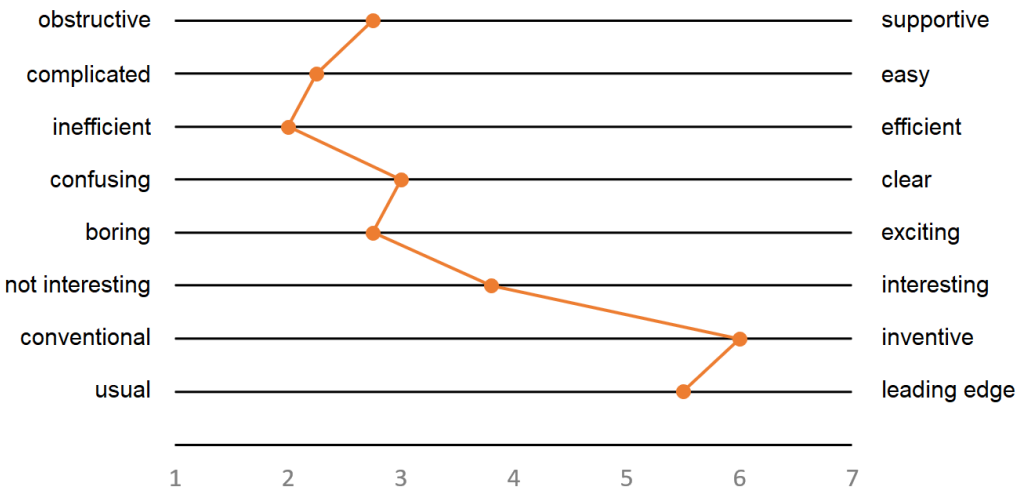

Figure 6. Semantic Differential (UEQ) of the Generative Design Platform (*n* = 5)

Usefulness was rated 1.8 out of 4 (45%) for the GDP. One out of five (20%) agreed to the statement that the GDP meets his or her needs. The likelihood to recommend was 2.2 out of 10, whereby no rating was above 6.

5.2.6.3. AR/VR Enabled Collaboration Tool

Nine participants as users filled out the UEQ for the AR/VR Enabled Collaboration Tool. Of those nine, two indicated as frequency of use "rarely", four "sometimes", one "often", and two "always". As depicted in Figure 7, the results are in the neutral to positive range with the hedonic quality being rather positive. In this way, the AR/VR toolkit appears to be usable and innovative to a certain extent, while providing a stimulating (exciting, interesting) UX.

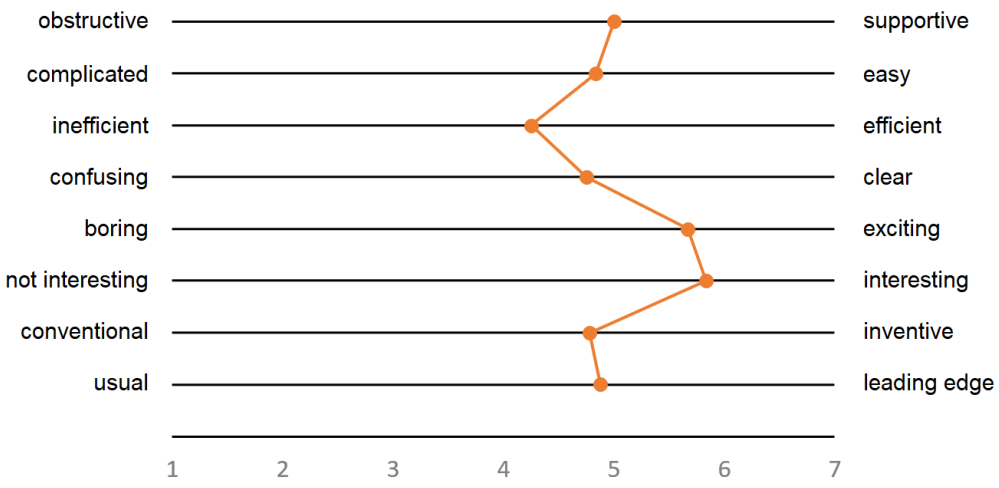

Figure 7. Semantic Differential (UEQ) of the AR/VR Toolkit (*n* = 9)

The usefulness was judged to be rather high with a rating of 2.44 out of 4 (61%). Two thirds of the respondents (67%) agreed with the statement that the AR/VR Toolkit meets their needs. The NPS was 6.22 out of 10 with one promoter (rating 9 or 10) and 5 passives (rating 7 or 8).

5.2.6.4. IPR Authoring Tool

The UEQ for the IPR Authoring Tool was filled out by 12 participants. Of those, five indicated their use frequency as “rarely”, two as “sometimes”, three as “often”, and two as “always”. Figure 8 shows the results, which are neutral to slightly positive. There seems to be room for improvement in terms of usability, whereas the tool provides experiences of stimulation and novelty in parts.

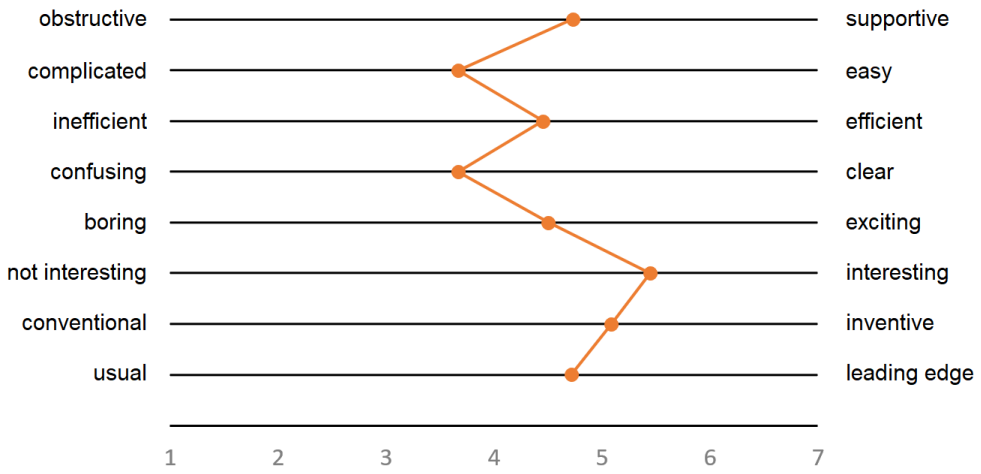

Figure 8. Semantic Differential (UEQ) of the IPR Authoring Tool (*n* = 12)

Usefulness ratings were high with an average of 2.58 out of 4 (65%). The top-2-box score was 67%. The NPS was 6 out of 10 with one promoter and 5 passives.

5.2.6.5. Mobile App for Social Media Enabled Consumers’ & Makers’ Feedback

Seven participants filled out the UEQ for the Mobile App. Of the seven, two indicated they use it “rarely”, three “sometimes”, and two “often”. The results are shown in Figure 9. The results are in the neutral to

slightly positive range for both instrumental and hedonic quality, indicating basic usability and stimulation/novelty.

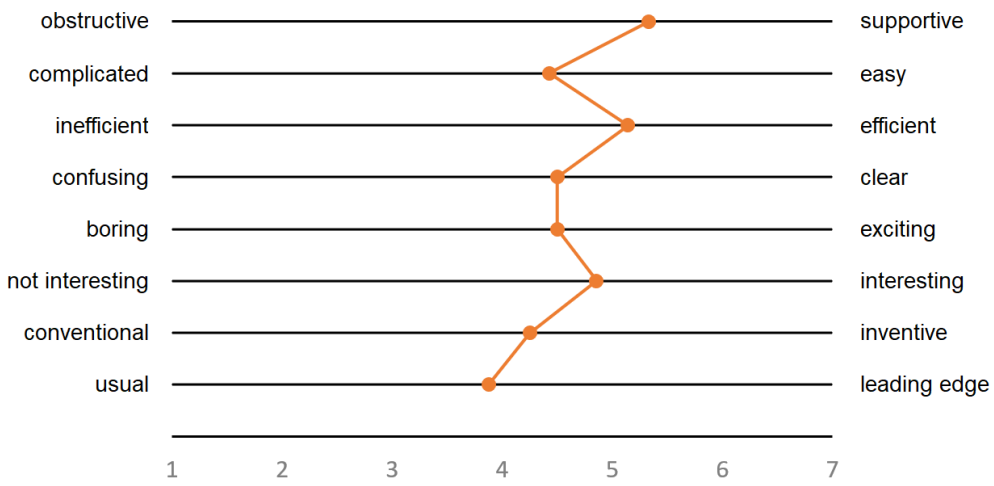

Figure 9. Semantic Differential (UEQ) of the Social Media Application (*n* = 7)

The tool's usefulness was rated 2.67 out of 4 (67%) by nine participants. 78% agreed that the tool meets their needs. The likelihood to recommend (NPS) was 5.89 out of 10 with one promoter and 4 passives (*n* = 9).

5.2.7. Process Success

Finally, the **likelihood to participate again in social manufacturing activities** comparable to iPRODUCE was rated 6.83 out of 10 (*n* = 47). Thereby 21% of the participants made a rating of 9 or 10; 53% a rating of 7 or more. When asked if they think that the cMDF is a feasible concept for enhancing the collaboration of makers, manufacturers, and consumers (**cMDF feasibility**), 66% of survey participants agreed (top-2-box score). The average item score was 2.91 out of 4 (73% of maximum score). Table 6 shows the feasibility results (top-2-box score indicating the extent of agreement) separately for each iPRODUCE stakeholder group.

Table 6. cMDF Feasibility Results

cMDF Feasibility			
	Makers Top-2-Box Score (*n* = 25)	**Manufacturers Top-2-Box Score (*n* = 11)**	**Consumers Top-2-Box Score (*n* = 11)**
The cMDF (like in iPRODUCE) is a feasible concept for enhancing the collaboration of Makers, Manufacturers, and Consumers.	64%	64%	73%

5.3. Summary of the Survey Results

The aim of the Socio-Economic Assessment was to assess the performance of the iPRODUCE product and the OpIS platform. For that purpose, the perceptions and attitudes of the three target groups makers,

manufacturers, and consumers, were measured. The results of the survey are in line with the Pilot Evaluation results (Section 4.2), indicating that in general, iPRODUCE proved to be beneficial or even a success for the project participants. The agreement ratios show the many different benefits and learnings that stakeholders experienced. The UX of the OpIS tools varied depending on the tool. Some tools were experienced as exciting and novel, whereas some of them at the time of assessment still had considerable usability issues that resulted in frustrations and negative UX in some users.

Due to the limited available sample, the KPIs could not or only with a limited number of respondents be measured. Based on that, consumers' satisfaction with (KPI-36) and loyalty towards (KPI-37) their co-manufactured products could largely be confirmed. No strict measurement of the improvement over time of manufacturers' ability to apply open innovation methods (KPI-14) and makers' and consumers' readiness to participate in collaborative manufacturing (KPI-15) was possible.

6. Summary and Conclusion

At the beginning of this document, we asked the question, *did iPRODUCE achieve what it set out to do?* This can surely *not* be answered by this deliverable alone; however, as a summative evaluation and assessment, the Evaluation and Socio-Economic Impact Assessment Report of iPRODUCE Social Manufacturing Framework contributes to providing a clearer picture of the project's impact on its participants, users, and stakeholders.

We thereby focused on the pilot projects within the larger iPRODUCE project, the so-called cMDFs as local multi-stakeholder ecosystems. Starting from the do-it-yourself (DIY) and maker movements, the cMDFs sought to establish iPRODUCE's novel social manufacturing framework (SMF). This concept unites hardware, physical and digital spaces as well as the expertises of makers, designers, and other actors (see Figure 10) to turn customers into prosumers and help manufacturers access innovation and commercial benefits through collaborating with MakerSpaces/FabLabs. Of central importance for this is, besides workshops and training activities, the OpIS, a platform developed in the course of iPRODUCE including a number of tools for collaboration and co-creation.

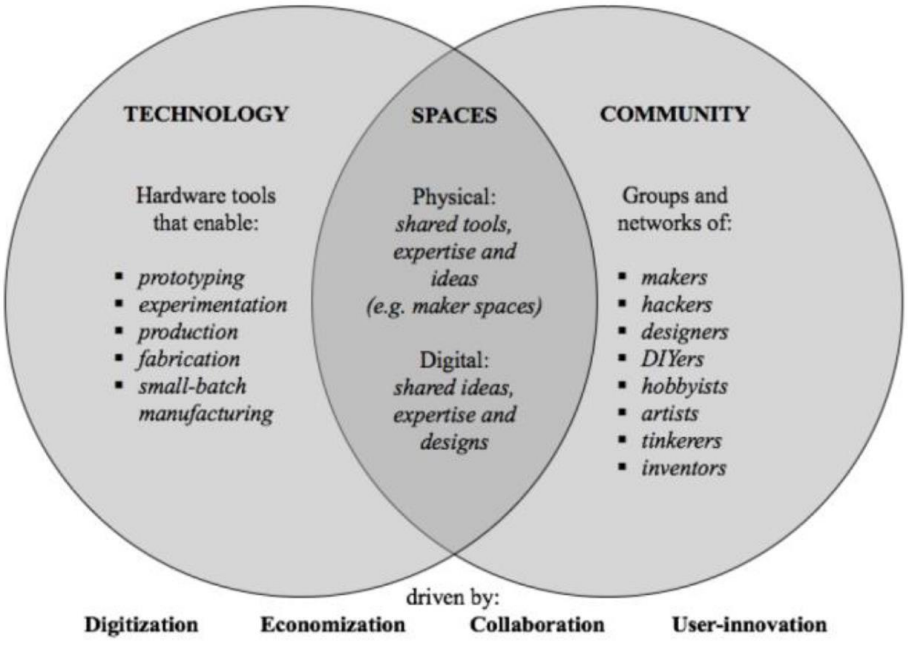

Figure 10 The three pillars of makers movement, brought together in iPRODUCE social manufacturing framework (iPRODUCE DoA)

In order to judge the quality and extent of the project's impact, two major research methodologies as defined in D9.2 were employed: The qualitative Pilot Evaluation included open-ended questionnaires or structured interviews with cMDF's/pilot's makers and manufacturers and focused in two rounds on their goals and achievements/benefits. The quantitative Socio-Economic Assessment survey was filled out by the maker, manufacturer, and consumer (MMC) communities of the cMDFs and included rating questions about value and benefits from project participation and OpIS tool use.

6.1. iPRODUCE KPIs

T9.6 covered a number of project KPIs, which were included in either of the two data collections. The extent of achievement of the KPIs covered by T9.6 is shown in Table 7, based on the results presented previously (see Section 5).

Table 7. Achievement of Horizontal KPIs in T9.6

Horizontal KPIs covered in T9.6	
T9.6 KPI	**Result**
KPI-14: Improvement in the perceived ability of manufacturing SMEs to apply open innovation methods: **>20%** increase	**No strict measurement** as intra-individual change over time possible; mean **decrease by 5%** (not significant)
KPI-15: Improvement in makers' and consumers' perceived readiness to participate in collaborative manufacturing: **>20%**	**No strict measurement** as intra-individual change over time possible; mean **decrease by 8%** (not significant)
KPI-16: Effectiveness and quality of collaborative manufacturing outputs: >80% Overall Labour Effectiveness (measured as: Workers' Availability & Performance and Product Quality)	**No data available** for deriving an indicator; recognised potential for increased workers' availability, product quality, and internal–external information flow.
KPI-23: Improvement in the time to market of products: **> 20%** (reported by participating SMEs)	**Sample products too heterogenous** to derive indicator; recognised potential for TTM improvement for bespoke, on-demand, or special products
KPI-30: Reduction in the development cost for new products: **>20%** (reported by participating SMEs)	**Sample products too heterogenous** to derive indicator; potential to reduce development costs not confirmed; potential for market value increase instead
KPI-36: Consumers' satisfaction with regard to the co-manufactured products: **> 90%**	KPI confirmed with **95%** of maximum satisfaction based on $n = 4$
KPI-37: Consumers' willingness to support the manufactured products (loyalty): **> 70%** (among the communities' and pilot participants)	KPI not (but almost) confirmed with **69%** of maximum loyalty based on $n = 4$

Due to the sample's limited availability, KPI-14 and KPI-15 could not be measured as intraindividual change. The comparison of the *independent* samples revealed an 5% mean decrease of the perceived ability of manufacturing SMEs to apply open innovation methods (KPI-14) and an 8% mean decrease of makers' and consumers' perceived readiness to participate in collaborative manufacturing (KPI-15), contrary to the hypothesis, respectively. Nevertheless, those differences cannot be considered significant. These KPIs therefore remain inconclusive. However, the intent to apply open innovation methods in the future and to participate in collaborative manufacturing was high in both times, respectively. Also the Pilot Evaluation pointed to new innovation approaches for manufacturers.

There was too little data on actual manufacturing outputs available to measure KPI-16. It was assumed that product quality and external–internal information flow could be improved due to collaborative

manufacturing. For KPI-23 and KPI-30, the sample products were too heterogeneous to derive an indicator. However, the potential to improve TTM (KPI-23) for bespoke, on-demand, or special products was recognised by participating SMEs, whereas little potential for a reduction in development costs was recognised.

Keeping in mind that the sample was rather small with four co-manufacturing consumers, KPI-36 and KPI-37 could largely be confirmed as consumers' substantial satisfaction with and loyalty towards their (co-)manufactured products in the course of iPRODUCE. This is in line with the idea of the SMF turning consumers into prosumers.

6.2. Overall Impact of iPRODUCE

Besides the predefined KPIs, the T9.6 data collections included a number of different indicators and measures, which were applied in order to understand iPRODUCE's impact on its stakeholders and beneficiaries. The results of the Socio-Economic Assessment and the Pilot Evaluation were largely in line, with the former providing insight into the general prevalence and the latter providing examples.

The biggest personal impacts/benefits of iPRODUCE were without a doubt the extending of networks, sharing of skills, and meeting likeminded individuals. Less relevant were aspects like distinguishing oneself as a maker or inventor or financial rewards. This result highlights the community and social aspect of the SMF established by iPRODUCE. Besides that, makers and consumers learned or improved their skills, became more innovative and gained satisfaction from turning ideas into products. Consumers benefited from accessing tools and/or mentorships from the maker community. The individual value creation for manufacturer representatives appeared to be lower than for makers and consumers, which seems plausible considering that most expected benefits would be for the manufacturing companies themselves rather than the individual working for the company. Indeed, the results indicate that manufacturers could enhance their co-creation and prototyping culture, identify new commercial opportunities, and test new product designs through collaborating with a MakerSpace. The same is true for MakerSpaces, but moreover, they developed more personalised products and shared their vision with the public. In this way, manufacturers benefited from the maker culture, whereas MakerSpaces in turn enhanced their perceived impact on the society, both commercial and private.

In the course of iPRODUCE, manufacturers drew from MakerSpaces' resources in terms of machines and expertise. According to the results, most of all this helped them to access 3D printing technology and to a lesser extent other digital machines. Other impacts on the digitalisation and digitisation of manufacturers remain inconclusive. It might be that the participating manufacturers were already rather digitised; however, they did lack access to certain machinery like 3D printers. Different from the manufacturers, the biggest digitalisation impact for consumers was not the access to 3D printing machines but other machines, open-source software and remote collaboration tools in the course of iPRODUCE. In this way, iPRODUCE by way of MakerSpaces digitised and digitalised both manufacturers and consumers in different ways.

The results revealed that the optimisation of the OpIS tools was a long process that required several rounds of iterations, also after the data collection at the very end of the project. Especially the acceptance of the Marketplace as the central OpIS tool was rather low at the time of evaluation due to its low usability and resulting frustrations. Nevertheless, users did mention useful aspects of the Marketplace, which enables teamwork and data exchange. In order to improve users' satisfaction with the tool, the Marketplace should be further improved based on the feedback from T9.2. The variety of OpIS tools was appreciated by iPRODUCE participants. Although some of the tools showed room for

improvement in terms of usability, many of them imparted stimulating or innovative experiences, which have the chance to increase adoption if all major usability problems are ameliorated with coming iterations. Thereby, the need for better training activities and manuals for the use of the tools also became clear. Notably, several participants mentioned the presentation and instructions for the OpIS platform as helpful training activities, which indicates that some uses simply did not have access to those, which could have improved their competencies with the digital tools. Altogether, the participants certainly recognised the potentials of the OpIS platform, and many could already use them to enhance their social manufacturing activities. Besides the Marketplace, the IPR Authoring Tool, the AR/VR Toolkit, and the Mobile App were the most established – and in some cases adopted – OpIS tools. Prospectively, efforts should be undertaken to introduce more users to the remaining OpIS tools in order for the platform to realise its full potential.

6.3. Limitations

There were several limitations of this summative evaluation/assessment study, which need to be taken into account when interpreting the data. The first big limitation was the availability of the surveyed stakeholders. Only two makers and two manufacturer representatives each provided data before *and* after the OpIS integration for KPI-14 and KPI-15 so that these KPIs could not be measured directly over time. Moreover, the late and extended integration process of the OpIS tools as well as limited stakeholder availability did not allow for two rounds of Socio-Economic Assessment measurement as originally planned. This resulted in an extended data collection, meaning that some participants filled out the survey a few months earlier than the others. Comparison of earlier and later data however did not reveal any substantial differences.

It is also likely that some stakeholders who participated in the course of cMDF activities, selected as their role “makers” (associated with a MakerSpace) instead of “consumers” (not directly associated with a MakerSpace or a manufacturer), before the instructions were later then clarified. This is possibly the reason for the low number of consumer participants indicating that they had co-manufactured products in the course of iPRODUCE. What is more, in order to not overburden survey participants, the rating of the other OpIS tools besides the Marketplace was voluntary. This resulted in less responses for those tools as would have been possible. It was hence not possible to evaluate all of the OpIS tools. It, however, might also reflect the prevalence of the respective OpIS tool use (see Section 5.2.6).

6.4. Conclusion

Despite usability issues of the OpIS platform and several unconfirmed KPIs, this study revealed, from an overall perspective, the positive and extensive impact of the iPRODUCE concept, activities, and tools on its stakeholders, the MMC communities of the project’s cMDFs. The majority of the crucial drivers of social manufacturing revealed in T2.1 were realised for stakeholders in the course of iPRODUCE. The main goals of the makers and manufacturers at the beginning of the project were fulfilled from their perspective, that is gaining recognition, extending their networks, and accessing tools, methods, and expertise. Many of iPRODUCE’s impacts could certainly not be measured within the project’s lifetime but will happen at a later stage due to the extended contacts and once the collaborative manufacturing has reached the commercialisation. Moreover, the results showed that consumers were successfully and involved in various activities to actively participate in social and collaborative manufacturing as prosumers.

According to our data, we can answer the question whether iPRODUCE and the pilot cMDFs achieved what it set out to do for the most part positively – from the beneficiaries’ point of view. Of course, this is

not the full picture of the extent of the project's achievements. For that matter, please refer to the other project deliverables, especially of WP9 – Validation, Demonstration & Evaluation of the iPRODUCE Social Manufacturing Space. Nevertheless, overall, stakeholders from the MMC communities appeared in their responses satisfied with the project and its outcomes. With this in mind, efforts should be undertaken to extend the project's SMF to other local MMC communities involving MakerSpaces, manufacturing SMEs, and the local public in many places. If the usability of the OpIS tools can be improved and all tools be integrated, they can provide a digital space that fully supports social/collaborative manufacturing, within and among communities.

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8. Annex

8.1. Pilot Evaluation – Templates for Interviewers

8.1.1. Round 1 – Makers

Interview with Representatives of MakerSpaces/FabLabs						
	Number	Theme	Main question	Sub-questions	Comments	Interviewee response text
Introduction	1.	Partner	Which MakerSpace/ FabLab /organization do you **represent**?		Term "MakerSpace" used from now on	
	2.	Goals	Which goals does your cMDF pursue through iPRODUCE?			
Pilot/cMDF	3.	Process	How does this process of participating in an iPRODUCE cMDF look like?	I.e., which activities do you engage in during the iPRODUCE project? E.g., methods, services, tools, meetings, reviews within your cMDF.		
	4.	Expectations / Pilot Value	According to your **expectations**, how will the iPRODUCE project affect your MakerSpace's practice/production?	As a MakerSpace, how does iPRODUCE help to **digitize** your practice? How do you and your MakerSpace **benefit** from **participating** in iPRODUCE?		
	5.	Expectations / Social Impact	According to your **expectations**, how will the iPRODUCE project affect your local community?	As a MakerSpace, how does iPRODUCE help to digitalize your community and local businesses? How does your local community benefit from you participating in iPRODUCE?		
OpIS Platform	6.	OpIS Tools	Which **tools** of the iPRODUCE platform are you planning to use?		Generative Design Platform AR/VR Toolkit Marketplace Training Support Tool Process Automation Tool Agile Data Analytics Tool Mobile App for Social Media IPR Authoring Tool	
	7.	Use Cases	How exactly / in which **use cases** are you planning to employ each iPRODUCE tool?	What benefits do you hope to achieve through that? Note: We are aware of the use case descriptions in D2.5 but would like to know of any changes to your plans.	Provide list of Use Cases by Interviewer	
	8.	iPRODUCE Platform Value	According to your expectations, what **value** would the iPRODUCE platform have?			
	9.	Motivation	What would **motivate** you to use the iPRODUCE platform and its digital tools?			
Personal Perception	10.	General Feeling	Speaking for you **personally**, as a maker, how do you **feel** about the introduction of a digital platform like the iPRODUCE platform and its digital tools in your MakerSpace?	Why do you feel this way?		
	11.	Competence	Do you have any expectations or concerns in terms of your **capabilities** of using the iPRODUCE platform?	How could it affect your **efficiency** as a maker?		
	12.	Autonomy	Do you have any expectations or concerns in terms of the **control** over your choices or your data on the iPRODUCE platform?	How could it affect your **freedom and choices** as a maker?		
	13.	Relatedness	Do you have any expectations or concerns in terms of **connecting with other people** through the iPRODUCE platform?	How could it affect your **community relations** with other makers/people?		
Perception of iPRODUCE Project	14.	Maker Skills	Speaking for you personally, how would the iPRODUCE project affect your **skills**?	**Which skills** do you hope to acquire? (via tools, trainings, etc.)		
	15.	Success	How would you measure/determine iPRODUCE's **success** in your MakerSpace?	**Which factors** indicate such success for you? Please relate back to your goals from above.		
	16.	End	Is there anything you want to add that has not been discussed yet?			

8.1.2. Round 1 – Manufacturers

Interview with Representatives of Manufacturers						
	Number	Theme	Main question	Sub-questions	Comments	Interviewee response text
Introduction	1.	Partner	Which organisation/ company do you **represent**?	I.e., which cMDF (collaborative Manufacturing Demonstration Facility) are you associated with?	· Spanish cMDF (AIDIMME, Lagrama, VLC Fablab) · German cMDF (ZENIT, Makerspace Bonn, Fraunhofer FIT) · French cMDF (Materalia, Excelcar, FabLab-Vosges) · Italian cMDF (Trentino Sviluppo, Energy@Work, FabLab-BITZ) · Danish cMDF (BetaFactory, CBS) · Greek cMDF (OKthess, AidPlex)	…
	2.	Role & Tasks	What is your connection with the iPRODUCE cMDF?	What is it that your organisation does? What is your organisation's role in the iPRODUCE project?		
	3.	Goals	Which **goals** does your organisation pursue through collaborating with MakerSpaces/ FabLabs?	What do you hope to achieve through social manufacturing within iPRODUCE?		
Expectations	4.	Process	How does this process of collaborating with a MakerSpace/FabLab look like?	I.e., which activities do you engage in through collaborating with a MakerSpace/FabLab? E.g., prototyping, services, tools, meetings, reviews.		
	5.	Expectations (Production)	According to your expectations, how does collaborating with a MakerSpace/FabLab affect your production?			
	6.	Expectations (Customer Relations)	According to your expectations, how does collaborating with a MakerSpace/FabLab affect your customer relations?			
	7.	Expectations (Employee Relations)	According to your expectations, how does collaborating with a MakerSpace/FabLab affect your employee relations?			
	8.	Expectations (Business Relations)	According to your expectations, how does collaborating with a MakerSpace/FabLab affect your business relations?	How does it affect your relations to partners within your supply chain?		
	9.	Expectations (Public Relations)	According to your expectations, how does collaborating with a MakerSpace/FabLab affect your public relations (PR)?			
perceived business impact	10.	Digitalisation	As a manufacturer, how does your collaboration with a MakerSpace/FabLab affect digitalisation within your organisation?			
	11.	Innovation	As a manufacturer, how does your collaboration with a MakerSpace/FabLab affect innovation within your organisation?			
	12.	Sustainability	As a manufacturer, how does your collaboration with a MakerSpace/FabLab affect sustainability within your organisation?			
	13.	Success	How would you measure/determine the success of your collaboration with a MakerSpace/FabLab?	Which factors indicate such success for you? Please relate back to your goals from above.		
	14.	End	Is there anything you want to add that has not been discussed yet?			

8.1.3. Round 2 – Makers

Interview with Representatives of MakerSpaces/FabLabs about the impact of project participation and digitalization on MakerSpaces and FabLabs						
This is the final evaluation interview / open questionnaire of the iPRODUCE project. Your help is much appreciated. The information will be kept confidential.						
	Number	Theme	Main question	Sub-questions	Comments	Interviewee response text
Introduction	1.	Partner	Which MakerSpace/ FabLab /organization do you **represent**?		Term "MakerSpace" used from now on	...
	2.	Goals	To what extent did your cMDF **achieve the goals** that it pursued through iPRODUCE?	What were those goals?		
Pilot/cMDF	3.	Process	How did this **process** of participating in an iPRODUCE cMDF look like?	I.e., which **activities** did you engage in during the iPRODUCE project? E.g., methods, services, tools, meetings, reviews within your cMDF		
	4.	Pilot Value	In your experience, how did participating in the iPRODUCE project affect your **MakerSpace's practice/production**?	As a MakerSpace, how did iPRODUCE help to **digitize** your practice? How did you and your MakerSpace **benefit** from participating in iPRODUCE?		
	5.	Social Impact	In your experience, how did participating in the iPRODUCE project affect your **local community**?	As a MakerSpace, how did iPRODUCE help to **digitalize** your community and local businesses? How did your local community **benefit** from you participating in iPRODUCE?		
OpIS Platform	6.	OpIS Tools	Which **tools** of the iPRODUCE **platform** did you use?		Generative Design Platform AR/VR Toolkit Marketplace Training Support Tool Process Automation Tool Agile Data Analytics Tool Mobile App for Social Media IBR Authoring Tool	
	7.	Use Cases	How exactly / in which **use cases** did you employ each iPRODUCE tool?	What **benefits** did you achieve through that?	Provide list of Use Cases by Interviewer	
	8.	iPRODUCE Platform Value	What **value** did the iPRODUCE platform have for you?			
	9.	Motivation	What **motivated** you to use the iPRODUCE platform and its digital tools?			
Personal Perception	10.	General Feeling	Speaking for you **personally**, as a maker, how did you **feel** about the iPRODUCE platform and its digital tools?	**Why** did you feel this way?		
	11.	Competence	How **competent** did you feel using the iPRODUCE platform?	How did it affect your **efficiency** as a maker?		
	12.	Autonomy	How **in control** over your choices or your data did you feel using the iPRODUCE platform?	How did it affect your **freedom and choices** as a maker?		
	13.	Relatedness	How **connected with other people** did you feel using the iPRODUCE platform?	How did it affect your **community relations** with other makers/people?		
Perception of iPRODUCE Project	14.	Maker Skills	Speaking for you personally, how did the iPRODUCE project affect your **skills as a maker**?	**Which skills** did you acquire? (via tools, trainings, etc.)		
	15.	Success	Overall, to what extent has iPRODUCE been a **success** for your MakerSpace?	**Which factors** indicated such a success (or failure) for you or your MakerSpace? Please relate back to your goals from above.		
	16.	End	Is there anything you want to add regarding your evaluation of the iPRODUCE project and your cMDF that has not been discussed yet?			

8.1.4. Round 2 – Manufacturers

Interview with Representatives of Manufacturers						
This is the final evaluation interview / open questionnaire of the iPRODUCE project. Your help is much appreciated. The information will be kept confidential.						
	Number	Theme	Main question	Sub-questions	Comments	Interviewee response text
Introduction	1.	Partner	Which **organisation/ company** do you represent?	I.e., which cMDF (collaborative manufacturing demonstration facility) are you associated with?	· Spanish cMDF (AIDIMME, Lagrama, VLC Fablab) · German cMDF (ZENIT, Makerspace Bonn, Fraunhofer FIT) · French cMDF (Materalia, Excelcar, FabLab-Vosges) · Italian cMDF (Trentino Sviluppo, Energy@Work, FabLab-BITZ) · Danish cMDF (BetaFactory, CBS) · Greek cMDF (OKthess, AidPlex)	…
	2.	Role & Tasks	What is your **connection** with the iPRODUCE **cMDF**?	What is it that your organisation does? What was your organisation's **role** in the iPRODUCE project?		
	3.	Goals	To what extent did your cMDF **achieve the goals** that it pursued through collaborating with a MakerSpace/FabLab via iPRODUCE?	What were those **goals**? What did you achieve through **social manufacturing** in the course of iPRODUCE?		
Company	4.	Process	How did this **process** of collaborating with a MakerSpace/FabLab look like?	I.e., which **activities** did you engage in through collaborating with a MakerSpace/FabLab? E.g., prototyping, services, tools, meetings, reviews,		
	5.	Production	In your experience, how did **collaborating** with a MakerSpace/FabLab affect your **production**?			
	6.	Customer Relations	In your experience, how did **collaborating** with a MakerSpace/FabLab affect your **customer relations**?			
	7.	Employee Relations	In your experience, how did **collaborating** with a MakerSpace/FabLab affect your **employee relations**?			
	8.	Business Relations	In your experience, how did **collaborating** with a MakerSpace/FabLab affect your **business relations**?	How did it affect your **relations to partners within your supply chain**?		
	9.	Public Relations	In your experience, how did **collaborating** with a MakerSpace/FabLab affect your **public relations (PR)**?			
Perceived business impact	10.	Digitalization	As a manufacturer, how did your **collaboration** with a MakerSpace/FabLab affect **digitalization** within your organisation?			
	11.	Innovation	As a manufacturer, how did your **collaboration** with a MakerSpace/FabLab affect **innovation** within your organisation?			
	12.	Sustainability	As a manufacturer, how did your **collaboration** with a MakerSpace/FabLab affect **sustainability** within your organisation?			
	13.	Overall Labour Effectiveness: Availability	Compared to classical manufacturing, to what extent are your company's workers **willing** to contribute to *collaborative manufacturing*?			
	14.	Overall Labour Effectiveness: Performance	Compared to classical manufacturing, to what extent would your workers' **performance** differ in *collaborative manufacturing*?			
	15.	Overall Labour Effectiveness: Product Quality	Compared to classical manufacturing, to what extent would your company's **product quality** differ in *collaborative manufacturing*?			
	16.	Success	Overall, to what extent has iPRODUCE been a **success** for your **organisation**?	**Which factors** indicated such a success (or failure) for you or your organisation? Please relate back to your **goals** from above.		
	17.	End	Is there anything you want to add that has not been discussed yet?			

8.2. Pilot Evaluation – Additional Questions for KPIs 16, 23, 30

KPI-16. *Effectiveness and quality of collaborative manufacturing outputs: >80% Overall Labour Effectiveness (measured as: Workers' Availability & Performance and Product Quality)*

- Collaborative manufacturing is about sharing information. How would you rate your internal information flow (production to design, to marketing, to quality, etc.)? To what extent would a collaborative manufacturing approach increase this flow?
- Collaborative manufacturing is about sharing information. How would you rate your external-internal information flow (market/users/external designers to production/marketing/ engineering)? How many meetings or information exchanges do you have on average at the launch of a new product/range? To what extent would a collaborative manufacturing approach increase this flow?

KPI-23. *Improvement in the time to market of products: > 20% (reported by participating SMEs)*

- Justify the eventual improvement in time to market due to the iPRODUCE approach (user involvement, co-creation, collaborative prototyping, etc.).
- Are re-designs at the shopfloor stage a recurrent situation? How much of your initial design is modified due to manufacturing constraints?
- Do you have a prototype-and-test strategy, or put products in the market directly?
- Could you give us some indications on the motivations for a new product (Seasonal? Proposal from designer? Own ideas? Market needs detected?)? Would you estimate the time till the "product on the market" moment in each of the cases?

KPI-30. *Reduction in the development cost for new products: >20% (as reported by participating SMEs)*

- Is co-creation, co-development, and user involvement (iPRODUCE approach) reducing development costs, under your point of view? (you may answer yes, no, or maybe)
- Do you have the perception that more development costs may result in a higher market penetration or higher market value for your product/service?
- Is co-creation, co-development, and user involvement increasing market value, under your point of view? (you may answer yes, no, or maybe)
- Where would you put development costs? (tell us which are "good" development costs, and which are not)
- Are re-designs at the shopfloor stage a recurrent situation? How much of your initial design is modified due to manufacturing constraints?
- Do you have a prototype-and-test strategy, or put products in the market directly?
- When developing a new product, do you think of just one model or in a whole new range, which may have uneven success?

8.3. Pilot Evaluation – Responses for KPIs 16, 23, 30

8.3.1. Dimitrios Moustakas (AIDPLEX)

- **Collaborative manufacturing is about sharing information. How would you rate your internal information flow (production to design, to marketing, to quality, etc.)? To what extent would a collaborative manufacturing approach increase this flow?**

The internal information flow within AIDPLEX involves the seamless sharing of information among different departments such as regulations, production, design, marketing, sales, quality, and engineering. The main channel of communication between those departments are emails, communication on Slack & Google Meets, and CRM for sales, regulations, and marketing. It is difficult to keep up with using all these different tools of different companies, which increases the training process of a new employee and adds an extra small percentage of the possible fault.

Collaborative manufacturing can significantly enhance the internal information flow by promoting a culture of collaboration and knowledge sharing. It encourages cross-functional teams to work together, even if the members of them are working remotely, share expertise, and contribute ideas throughout the product development process. This approach can lead to improved communication, reduced faults, faster decision-making, and increased efficiency in bringing products to market.

- **Collaborative manufacturing is about sharing information. How would you rate your external-internal information flow (market/users/external designers to production/marketing/engineering)? How many meetings or information exchanges do you have on average in the launch of a new product/range? To what extent would a collaborative manufacturing approach increase this flow?**

The number of meetings or information exchanges required in the launch of a new product can vary depending on the complexity of the project, the size of the organisation, and the level of collaboration involved. Generally, launching a new product typically involves multiple meetings (10 meetings in 3 months on average) and exchanges between different teams such as production, marketing, engineering, and design.

A collaborative manufacturing approach can enhance the external-internal information flow by involving external stakeholders more closely in the product development process. It can include methods such as crowdsourcing ideas from the Marketplace, gathering feedback from users with the Mobile App and AR/VR tool, and collaborating with external designers. By actively engaging external parties, organisations can tap into a wider pool of knowledge and experience, gain valuable insights, and ensure that the end product meets market needs more effectively.

- **Justify the eventual improvement in time to market due to the iPRODUCE approach (user involvement, co-creation, collaborative prototyping, etc.).**

The eventual improvement in time to market due to the iPRODUCE approach, encompassing user involvement, co-creation, and collaborative prototyping has been convincingly demonstrated. The involvement of users from the early stages of development has led to a thorough understanding of their needs, resulting in focused efforts on essential features and reduced time wasted on irrelevant aspects. The iterative feedback loops facilitated have enabled real-time user input, ensuring usability and satisfaction are addressed promptly. By actively involving users in the development process, uncertainties were mitigated, and product concepts were refined in alignment with user expectations. Collaborative prototyping further minimised risk by identifying and resolving potential issues early on, preventing significant setbacks. The iPRODUCE approach's collaborative decision-making process

streamlined development cycles by removing bottlenecks and accelerating consensus-building. Concurrent development activities enabled parallel work streams, reducing dependencies and accelerating product iterations, ultimately shortening the time to market.

- **Are re-designs at the shopfloor stage a recurrent situation? How much of your initial design is modified due to manufacturing constraints?**

The extent of modifications to the initial design varied depending on factors like product complexity and collaboration between design and manufacturing teams. Manufacturing constraints, such as material availability and cost considerations, necessitated adjustments for manufacturability. Iterative prototyping and testing played a vital role in identifying manufacturing challenges, leading to iterative redesigns. Continuous improvement was emphasised, with feedback from shopfloor personnel contributing to refining design and manufacturing processes, minimising future redesigns.

- **Do you have a prototype-and-test strategy, or put products in the market directly?**

As a medical device startup founder, our approach involves a well-defined prototype-and-test strategy before putting products in the market. Given the critical nature of medical devices and the regulatory requirements in the healthcare industry, thorough testing and validation are essential to ensure safety, efficacy, and compliance.

Our prototype-and-test strategy consists of several key steps to ensure the successful development and launch of our medical device. We begin with concept development, conducting extensive research and gathering feedback from healthcare professionals and potential users. Prototyping follows, using various methods to refine the device's design and functionality. Verification and validation processes ensure compliance with design specifications and functional requirements. User testing and feedback sessions allow us to enhance usability and user experience. We closely adhere to regulatory guidelines, conducting tests to meet the necessary standards. Iterative refinement based on feedback and validation results further improves the device. Clinical trials may be conducted for data on efficacy and safety. By following this strategy, we mitigate risks, build trust, and regulatory requirements for a successful product launch.

- **Could you give us some indications on the motivations for a new product (seasonal? Proposal from designer? Own ideas? Market needs detected?)? Would you estimate the time till the "product on the market" moment in each of the cases?**

AIDPLEX, a medical startup driven by innovation and the desire to improve patients' lives, acknowledges that the development timeline for new products can vary depending on different motivations. For seasonal products like face shields during the pandemic, the timeline can range from several weeks to a quarter of a year or more, considering complexity and supply chain considerations. When considering proposals from designers or other makers, the timeline depends on the readiness and complexity of the design, spanning from several weeks to a quarter of a year or more. For AIDPLEX's own ideas and innovations discovered through conversations with potential customers, the timeline can vary significantly, ranging from several months to multiple years. This variation is due to factors such as technological complexity, regulatory requirements, and production scalability, with various stages like concept development, prototyping, testing, refinement, and manufacturing involved in the process.

- **Is co-creation, co-development, and user involvement (iPRODUCE approach) reducing development costs, under your point of view? (you may answer yes, no, or maybe)**

Yes

- **Do you have the perception that more development costs may result in a higher market penetration or higher market value for your product/service?**

Yes

- **Is co-creation, co-development and user involvement increasing market value, under your point of view? (you may answer yes, no, or maybe)**

Yes

- **Where would you put development costs? (tell us which are "good" development costs, and which are not)**

Good development costs are essential for creating successful products. Thorough research and analysis provide valuable insights into user needs, market trends, and competition, supporting informed decision-making and reducing future costs. Investing in user-centred design activities, including UX/UI design and usability testing, ensures intuitive and user-friendly products that align with user expectations. The costs associated with prototyping and testing iterations are worthwhile investments, allowing for early validation, feedback incorporation, and issue resolution to optimise product features and quality. Compliance and regulatory expenses are crucial for industries like healthcare, ensuring product safety, quality, and legal compliance through certifications, compliance testing, and meeting regulatory requirements.

Not-So-Good development costs can be detrimental to the development process. Over-engineering, where resources are allocated to non-essential features, can be avoided by focusing on the core value proposition of the product. Poor planning and project management can lead to delays and cost overruns, emphasising the need for effective project management processes. Scope creep, the uncontrolled expansion of project scope, should be managed to prevent unnecessary expenses. Ineffective collaboration and communication among team members and stakeholders can result in misunderstandings and delays, highlighting the importance of investing in efficient communication tools and fostering collaboration.

- **Are re-designs at the shopfloor stage a recurrent situation? How much of your initial design is modified due to manufacturing constraints?**

Redesigns at the shopfloor stage can be a recurring situation in manufacturing, particularly for complex products or when encountering manufacturing constraints. The extent of redesigns depends on factors like product complexity, manufacturing processes, and collaboration between design and manufacturing teams. Key considerations include addressing manufacturing constraints such as material limitations and cost considerations through modifications to the initial design. The iterative process of product development allows for refinements based on real-world manufacturing feedback, optimising manufacturability, quality, and cost efficiency. Close collaboration between design and manufacturing teams minimises the need for significant redesigns by proactively addressing manufacturability challenges. By adopting design practices that consider manufacturing constraints early on, leveraging collaborative platforms like iPRODUCE, and utilising agile methodologies, extensive redesigns can be minimised, optimising the overall product development and manufacturing processes.

- **When developing a new product, do you think of just one model or in a whole new range, which may have uneven success?**

Developing a single model focuses resources and efforts on designing and bringing to market one specific product. This approach allows for a concentrated effort, enabling the team to focus on refining and perfecting a single concept. It can be particularly effective when the product addresses a specific

market need or targets a niche audience. By focusing on one model, the development team can allocate resources efficiently, streamline production, and build a strong brand around that particular product. However, the success of this approach is highly dependent on the market acceptance and demand for the single model.

8.3.2. Joan Grau (LAGRAMA)

- **Collaborative manufacturing is about sharing information. How would you rate your internal information flow (production to design, to marketing, to quality, etc.)? To what extent would a collaborative manufacturing approach increase this flow?**

As we work today, we have a flow system in place that includes the design team, with the technical team and the manufacturing team. In this way, information flows both ways to streamline the process of creating new products and making improvements to it.

Where we have more problems is when the information must leave our company and collaborate with suppliers. This is the case where we believe that a system like iPRODUCE could help improve the flow of information to be faster in the creation of new designs.

- **Collaborative manufacturing is about sharing information. How would you rate your external-internal information flow (market/users/external designers to production/marketing/engineering)? How many meetings or information exchanges do you have on average in the launch of a new product/range? To what extent would a collaborative manufacturing approach increase this flow?**

As I mentioned before, the main difficulty we encounter is the exchange of information between our suppliers. With a collaborative system that included this, it could significantly reduce the process time. Now we usually have one design meeting a month with the design team, the technical team works on a daily basis, and the production team works on the order of the technical team.

- **Justify the eventual improvement in time to market due to the iPRODUCE approach (user involvement, co-creation, collaborative prototyping, etc.).**

iPRODUCE improves the speed of communication between all actors from the beginning of a design to its final prototype, ready for production and sale. This is due to the creation of more direct communication channels that help to better organise work tasks.

- **Are re-designs at the shopfloor stage a recurrent situation? How much of your initial design is modified due to manufacturing constraints?**

Yes, during the prototyping process of a design, it is very common to encounter difficulties that need to be solved. Therefore, it is common to redesign products before launching them for sale.

- **Do you have a prototype-and-test strategy, or put products in the market directly?**

We never put a product directly on the market before making a prototype. Our process consists of making an initial freehand design, from there to a rendering, through assembly in Inventor, and then to manufacturing an actual prototype. This prototype is evaluated and, if necessary, redesigned.

- **Could you give us some indications on the motivations for a new product (seasonal? Proposal from designer? Own ideas? Market needs detected?)? Would you estimate the time till the "product on the market" moment in each of the cases?**

In our case, we have 4 product lines. Every year we renew 1 of them, so its useful life is 4 years. In these renovations, many of the previous designs are kept because they continue to sell well, so we eliminate the designs that do not sell and, through our designers, we look for new solutions to innovate

in the furniture market. From the time we start the design process until the product goes to market, an average of 1 year usually passes.

- **Is co-creation, co-development and user involvement (iPRODUCE approach) reducing development costs, under your point of view? (you may answer yes, no, or maybe)**

When the system is improved, I think it could mean an improvement in cost reduction, but today I think that there is not enough time to fully develop a system that achieves this. It is a slow road, but one that would be very interesting to travel. It is slow because there are many variables, and each industry works in a different way, but as I say, I believe that this objective should be pursued.

- **Do you have the perception that more development costs may result in a higher market penetration or higher market value for your product/service?**

No, not at all. If we talk about the quality of the materials, obviously it gives an added value, but a higher cost in production does not necessarily result in a better product.

- **Is co-creation, co-development and user involvement increasing market value, under your point of view? (you may answer yes, no, or maybe)**

Yes, for us as a company, they are related. In fact, for several years now, we have been approaching the company in this way, seeking to listen to all stakeholders in the design of new products.

- **Where would you put development costs? (Tell us which are "good" development costs and which are not)**

All parts of development are important, from freehand design to final prototype, such as listening to your customers or analysing trends.

- **Are re-designs at the shopfloor stage a recurrent situation? How much of your initial design is modified due to manufacturing constraints?**

Of course, yes, many of the designs are modified. It may be because of a design that we don't like or for some technical reason that we can't solve. I can't tell you how many of them are due to manufacturing constraints, because at the design stage we already try to take into account the limitations of our production systems.

- **Do you have a prototype-and-test strategy, or put products in the market directly?**

We never put a product directly on the market before making a prototype. Our process consists of making an initial freehand design, from there to a rendering, through assembly in Inventor, and then to manufacturing an actual prototype. This prototype is evaluated and, if necessary, redesigned.

- **When developing a new product, do you think of just one model or in a whole new range, which may have uneven success?**

It depends on what we are preparing to bring to market. We do both types of product development, both single pieces of furniture and product programs within the same line.

8.4. Socio-Economic Assessment Survey

Welcome Note

Welcome note

Dear participant, welcome to our survey.
This survey will take **10 to 20 minutes** to fill out. There are no right or wrong answers, as this is about your personal opinions regarding your experience with the iPRODUCE project. All data is anonymized, and your privacy is guaranteed.

Thank you for helping us gather relevant information.

What is the iPRODUCE project?

iPRODUCE is an EU-funded Horizon 2020 project which aims to promote collaborative manufacturing between makers, consumers and manufacturing Small Medium Enterprises (SMEs).

The objectives of iPRODUCE are threefold:
(1) bring Manufacturers, Makers and Consumer communities (MMCs) closer at the local level;
(2) engage these communities into joint co-creation challenges for the manufacturing of new consumer products and the introduction of novel engineering and production (eco) systems;
(3) provide practices, methods, and tools that both makers and manufacturing companies (specifically SMEs) are employing.
With this survey we aim at collecting information regarding people's, makers' and manufacturers' perceptions, opinions and needs regarding the maker movement, collaborative manufacturing and co-creation schemes between individual makers, consumers, and manufacturing enterprises.

Purpose of the survey

The purpose of this survey is to understand your perceptions on and attitudes toward your participation in the iPRODUCE project and the iPRODUCE cMDFs. The survey is organized by Fraunhofer FIT. You are invited to participate because you are associated with the iPRODUCE project, either as maker (belonging to a MakerSpace/FabLab), or as a representative of a manufacturing company/SME/startup or as a consumer who is interested in social manufacturing.

cMDFs and role

* **Which cMDF of iPRODUCE are you associated with (i.e., you are part of the cMDF or you worked together with the cMDF)?**

- (●) cMDF SPAIN [AIDIMME, Lagrama, VLC Fablab]
- ( ) cMDF GERMANY [ZENIT, MakerSpace Bonn, Fraunhofer FIT]
- ( ) cMDF FRANCE [Materalia, Excelcar, FabLab-Vosges]
- ( ) cMDF ITALY [Trentino Sviluppo, Energy@Work, FabLab-BITZ]
- ( ) cMDF DENMARK [BetaFactory, CBS]
- ( ) cMDF GREECE [OKthess, AidPlex]

I am associated with the iPRODUCE project via the following organization/MakerSpace/FabLab:

* **What is your primary role/profession?**

Please select one answer from the following list. In case you assume multiple roles, you may repeat the questionnaire for the other role(s).
In case you assume none of the following roles, feel free to quit the survey.

- (●) Maker involved in a MakerSpace/FabLab
  (Maker = a person who regularly works on Do-it-Yourself projects within a FabLab/MakerSpace and considers him or herself a member of a FabLab/MakerSpace)
- ( ) Representative of a manufacturing SME or manufacturing startup company
  (Manufacturing SME = small- to middle-sized industry company that produces tangible products)
- ( ) Consumer / representative of general public
  (Consumer = a private individual who has at least once worked on a Do-it-Yourself project within a FabLab/MakerSpace)

* **How frequently do you contribute to iPRODUCE activities (i.e., workshops, training, collaborative manufacturing, etc.)?**

- (●) One time so far
- ( ) Once a year
- ( ) Once a quarter
- ( ) Once a month
- ( ) Several times a month
- ( ) Once a week or more

* **Please name the activities and work that you have done in iPRODUCE:**

This field is required.

Participant Code

* As there will be a follow-up survey at the end of the project, we would like to be able to identify each respondent in an anonymous but unambiguous way. This is why we ask you to create your individual participant code below, as indicated below:

- LAST letter of your family name (e.g. H for Smith)
- TWO digits of your day of birth (e.g. 04 for 4th of July)
- FIRST letter of the town you were born in (e.g. N for New York)
- LAST letter of your mother's first name (e.g. A for Clara)

In this example the participant code would be H04NA.

This field is required.

Demographics

* **What is your age?**
- (●) Under 20 years
- ( ) 20-29 years
- ( ) 30-39 years
- ( ) 40-49 years
- ( ) 50-59 years
- ( ) 60+ years

* **Your gender:**

Male

* **In which country do you live?**

- ( ) Denmark
- ( ) France
- ( ) Germany
- ( ) Greece
- ( ) Italy
- (●) Spain
- ( ) Other

* **What is the highest level of education you have attended?**
- (●) Less than a High School Diploma
- ( ) High School Diploma
- ( ) Bachelor's Degree or equivalent
- ( ) Master's Degree or equivalent
- ( ) Doctorate or equivalent

* **Do you have previous experience in the fields of engineering or computer and information science (either academic or professional experience)?**
- (●) Yes
- ( ) No

* **What is your occupational status?**

Unemployed

How would you classify the net household income of your family?
- ( ) Low income
- (●) Medium income
- ( ) High income

How would you describe the area you live in?
- ( ) Densely populated area (urban)
- ( ) Intermediate area (semi-urban)
- (●) Thinly populated area (rural)

Open Innovation

Please read carefully and select the answer that best suits to you:

.	1 (Never)	2 (Seldom: once or a few times per year)	3 (Sometimes: about once per month)	4 (Often: about once per week)	5 (Very frequently: almost daily or daily)
* I participate in collaborative manufacturing activities (i.e., social manufacturing together with or supported by other people). This field is required.	○	○	○	○	○

Please indicate your agreement with the following statements:

.	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
* I would like to be more involved in collaborative manufacturing activities.	○	○	○	○	○
* I possess a community network that actively supports collaborative manufacturing activities.	○	○	○	○	○
* I have access to all the necessary technical means (tools, machines, workspaces) to participate in collaborative manufacturing activities.	○	○	○	○	○
* I have access to all the necessary organisational means (events, community meetings, trainings) to participate in collaborative manufacturing activities.	○	○	○	○	○
* I possess all the necessary manufacturing know-how to participate in collaborative manufacturing activities.	○	○	○	○	○
* I possess all the necessary know-how on collaboration methods to participate in collaborative manufacturing activities.	○	○	○	○	○

Open Innovation

* **In your company, you are:**

- ○ the owner
- ○ in a leading position (management)
- ○ an employee in an executing position (e.g., designer, engineer, programmer)
- ○ an entrepreneur (startup)

An open innovation method refers to a product development method actively engaging stakeholders OUTSIDE of the manufacturing company. Activities like stakeholder ideation sessions, hackathons, crowdsourcing, use of MakerSpaces/FabLab, university collaborations or so called open innovation challenges are possible examples.

* **Did your company apply open innovation methods in the past?**

- ○ Yes
- ○ No
- ○ I don't know

Please read each of the following statements carefully and answer to the best of your knowledge.

.	1 (Not willing at all)	2	3	4	5 (Very willing)
*According to your perception, how willing is your company's management/lead to apply open innovation methods?	○	○	○	○	○

.	1 (Rarely or not at all)	2	3	4	5 (On a daily basis)
*According to your perception, how regularly does your company apply open innovation methods?	○	○	○	○	○

	1 (Very unskilled - not even basic knowledge)	2	3	4	5 (Very skilled - confident to apply in any context)
*According to your perception, how skilled are the employees of your company in applying open innovation methods?	○	○	○	○	○

Perceived Value Creation

Please indicate your agreement with the following statements:

Participating in iPRODUCE helped me to:	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
*access tools and/or mentorship	○	○	○	○	○
*acquire new technical skills	○	○	○	○	○
*provide a valuable service to my community	○	○	○	○	○
*share knowledge and skills with others	○	○	○	○	○
*improve my employability skills	○	○	○	○	○
*extend my network	○	○	○	○	○
*meet individuals with common interests	○	○	○	○	○
*gain financial rewards	○	○	○	○	○
*gain peer-recognition/acknowledgement as an inventor	○	○	○	○	○
*achieve moral satisfaction from seeing my idea turn into product	○	○	○	○	○
*become more innovative	○	○	○	○	○

Co-manufacturing

Please indicate your agreement with the following statements:

In my experience, participating in iPRODUCE helped my MakerSpace/FabLab to:	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
reduce the cost of developing products and services	○	○	○	○	○
develop more personalized products	○	○	○	○	○
enhance its co-creation culture	○	○	○	○	○
identify new commercial opportunities	○	○	○	○	○
share its vision with the public	○	○	○	○	○
test new product designs	○	○	○	○	○
increase efficiency	○	○	○	○	○
optimize resources	○	○	○	○	○
become more self-aware of sustainability issues	○	○	○	○	○
other	◉	○	○	○	○

Please specify other aspects (if applicable):

Co-manufacturing

Please indicate your agreement with the following statements:

In my experience, working together with a MakerSpace/FabLab helped my company to:	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
reduce the cost of developing products and services	○	○	○	○	○
develop more personalized products	○	○	○	○	○
enhance its co-creation culture	○	○	○	○	○
identify new commercial opportunities	○	○	○	○	○
share its vision with customers	○	○	○	○	○
test new product designs and evaluate the product before reaching the market	○	○	○	○	○
increase efficiency (e.g., meet rapid demand changes)	○	○	○	○	○
optimize resources	○	○	○	○	○
become more self-aware of sustainability issues	○	○	○	○	○
other	◉	○	○	○	○

Please specify other aspects (if applicable):

Co-manufacturing

Please select which applies:

- ◉ I co-manufactured products in the course of the iPRODUCE project.
- ○ I did **not** co-manufacture any products in the course of the iPRODUCE project.

Please indicate your agreement with the following statements:

	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
I am satisfied with the products that I have co-manufactured in the course of the iPRODUCE project so far.	○	○	○	○	○
The products that I have co-manufactured in the course of the iPRODUCE project so far are of good quality.	○	○	○	○	○
I wish to support the ongoing development of the products that I have co-manufactured in the course of the iPRODUCE project so far.	○	○	○	○	○
I am loyal to the products that I have co-manufactured in the course of the iPRODUCE project so far.	○	○	○	○	○

Digitalization

Please indicate your agreement with the following statements:

In my experience, my MakerSpace/FabLab helped companies to:	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
translate analoguous processes into digital ones	○	○	○	○	○
digitalize product fabrication	○	○	○	○	○
discover new open-source software	○	○	○	○	○
access 3D printing technology	○	○	○	○	○
access digital machines (other than 3D printing technology)	○	○	○	○	○
better apply remote collaboration tools	○	○	○	○	○
in any other aspect	◉	○	○	○	○

Please specify what other aspects:

Please indicate your agreement with the following statements:

In my experience, my MakerSpace/FabLab helped consumers/individuals to:	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
discover new open-source software	○	○	○	○	○
access 3D printing technology	○	○	○	○	○
access digital machines (other than 3D printing technology)	○	○	○	○	○
better apply remote collaboration tools	○	○	○	○	○
in any other aspect	◉	○	○	○	○

Please specify what other aspects:

Digitalization

Please indicate your agreement with the following statements:

In my experience, the collaboration with the MakerSpace/FabLab has helped my company to:	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
translate analoguous processes into digital ones	○	○	○	○	○
digitalize product fabrication	○	○	○	○	○
discover new open-source software	○	○	○	○	○
access 3D printing technology	○	○	○	○	○
access digital machines (other than 3D printing technology)	○	○	○	○	○
better apply remote working tools	○	○	○	○	○
in any other aspect	○	○	○	○	○

Digitalization

Please indicate your agreement with the following statements:

In my experience, working with/in the MakerSpace/FabLab has helped me personally to:	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
discover new open-source software	○	○	○	○	○
access 3D printing technology	○	○	○	○	○
access digital machines (other than 3D printing technology)	○	○	○	○	○
better apply remote collaboration tools	○	○	○	○	○
in any other aspect	○	○	○	○	○

Training material and activities

Please select which applies:

- (●) I participated in a training activity in the course of the iPRODUCE project.
- ( ) I did not participate in any training activity in the course of the iPRODUCE project.

Please indicate your agreement with the following statements:

	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
* The training activities during the iPRODUCE project were helpful for me.	○	○	○	○	○

* **Please specify in which training activities you participated and explain your rating:**

Please select which applies:

- (●) I received and used training material in the course of the iPRODUCE project.
- ( ) I did not receive and use any training material in the course of the iPRODUCE project.

Please indicate your agreement with the following statements:

	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
* The training material offered by the iPRODUCE project was helpful for me.	○	○	○	○	○

* **Please specify which training material you received and explain your rating:**

Tools in use

Please select which applies:

- (●) I did use OpIS tools.
- ( ) I did **NOT** use any OpIS tools.

Please indicate the frequency with which you use each OpIS tool.

	1 (Never)	2 (Rarely)	3 (Sometimes)	4 (Often)	5 (Always)
* Generative Design Platform	●	○	○	○	○
* AR/VR Toolkit	●	○	○	○	○
* Marketplace	●	○	○	○	○
* Data Analytics & Visualization Suite	●	○	○	○	○
* IPR Authoring Tool	●	○	○	○	○
* cMDF Training Platform (Training View & Training Flow)	●	○	○	○	○
* Process Automation Tool	●	○	○	○	○
* Mobile Application for Social Media	●	○	○	○	○
Other	○	●	○	○	○

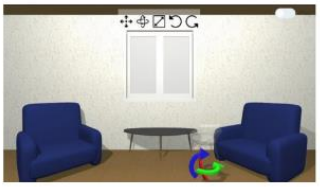
* **Please specify which other tool:**

iPRODUCE Tools Screenshots

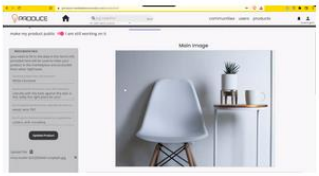
1. Generative Design Platform

2. AR Tool

2. VR Tool



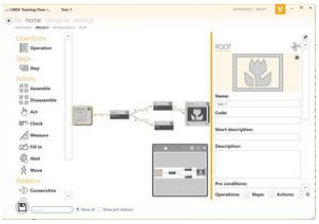
3. Marketplace



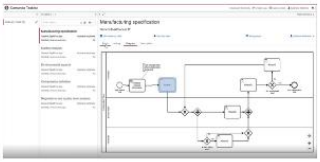
4. Data Analytics and Visualization Suite

5. IPR Authoring Tool

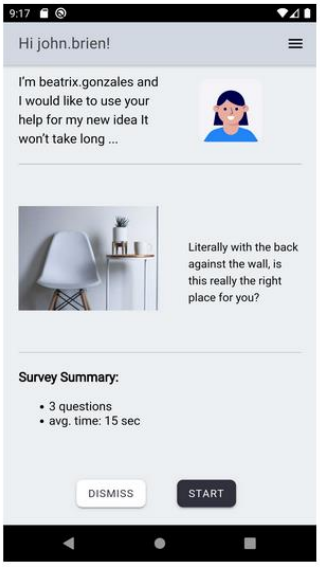
6. cMDF Training Platform



7. Process Automation Tool



8. Mobile Application for Social Media



I have used the following OpIS tools relatively recently and have a vivid memory of using them:
Please select all that apply.

- ☐ Generative Design Platform
- ☐ AR/VR Toolkit
- ☐ Marketplace
- ☐ Data Analytics & Visualization Suite
- ☐ IPR Authoring Tool
- ☐ cMDF Training Platform (Training View & Training Flow)
- ☐ Process Automation Tool
- ☐ Mobile Application for Social Media
- ☐ Other

The following OpIS tools are already established as a part of my typical work:
Please select all that apply.

- ☐ Generative Design Platform
- ☐ AR/VR Toolkit
- ☐ Marketplace
- ☐ Data Analytics & Visualization Suite
- ☐ IPR Authoring Tool
- ☐ cMDF Training Platform (Training View & Training Flow)
- ☐ Process Automation Tool
- ☐ Mobile Application for Social Media
- ☐ Other

User experience

The next two questionnaire parts will be about the OpIS platform. The first questionnaire part focuses solely on the Marketplace as the central part of the OpIS platform.

There are a number of statements that you can use to judge your experience. You can choose from 1 (Not true at all) to 5 (Completely true) to indicate the degree to which the statement is true for you.

Decide spontaneously and without long contemplation to convey your first impression. Please judge each statement even if you feel that it does not completely match your experience.

There are no right or wrong answers – all that counts is your personal opinion!

* Have you either **used** the iPRODUCE Marketplace **recently** or are **you using it regularly**?

- ○ Yes
- ○ No

While using the **iPRODUCE Marketplace**, …	1 (Not true at all)	2	3	4	5 (Completely true)
… I felt a sense of choice and freedom in the things I undertook.	○	○	○	○	○
…. most of the things I did felt like "I have to".	○	○	○	○	○
…. I felt that I belonged to the group of users.	○	○	○	○	○
…. I felt excluded from the other users.	○	○	○	○	○
…. I felt confident that I could do things well.	○	○	○	○	○
…. I had serious doubts about whether I could do things well.	○	○	○	○	○
…. I felt that my decisions reflected what I really wanted.	○	○	○	○	○
…. I felt forced to do many things I would not choose to do.	○	○	○	○	○
…. I felt connected with the other users.	○	○	○	○	○
… I felt that the other users are cold and distant towards me.	○	○	○	○	○
… I felt capable at what I did.	○	○	○	○	○
… I felt disappointed with many of my performances.	○	○	○	○	○
…. I felt my choices expressed who I really am.	○	○	○	○	○
…. I felt pressured to do too many things.	○	○	○	○	○
…. I felt close and connected to the other users.	○	○	○	○	○
…. I had the impression that the other users disliked me.	○	○	○	○	○
…. I felt competent to achieve my goals.	○	○	○	○	○
…. I felt insecure about my abilities.	○	○	○	○	○
…. I felt I was doing what really interests me.	○	○	○	○	○
…. my activities felt like a chain of obligations.	○	○	○	○	○
…. I experienced a good bond with the other users.	○	○	○	○	○
…. I felt the relationships with the other users were superficial.	○	○	○	○	○
…. I felt I could successfully complete difficult tasks.	○	○	○	○	○
…. I felt like a failure because of the mistakes I made.	○	○	○	○	○

The following questions serve to assess how you experience the iPRODUCE Marketplace.

There are a number of statements that you can use to judge your experience. You can choose from 1 (Strongly disagree) to 7 (Strongly agree) to indicate the degree to which you agree with the statement.

Decide spontaneously and without long contemplation to convey your first impression. Please judge each statement even if you feel that it does not completely match your experience. There are no right or wrong answers – all that counts is your personal opinion!

Please recall your past experiences with the iPRODUCE Marketplace:

	1 (Strongly disagree)	2 (Disagree)	3 (Somewhat disagree)	4 (Neither agree nor disagree)	5 (Somewhat agree)	6 (Agree)	7 (Strongly agree)
* The tool is easy to use.	○	○	○	○	○	○	○
* The functions of the tool are exactly right for my goals.	○	○	○	○	○	○	○
* It is quickly apparent how to use the tool.	○	○	○	○	○	○	○
* I consider the tool extremely useful.	○	○	○	○	○	○	○
* The operating procedures of the tool are simple to understand.	○	○	○	○	○	○	○
* With the help of this tool I will achieve my goals.	○	○	○	○	○	○	○
* The tool exhilarates me.	○	○	○	○	○	○	○
* The tool makes me tired.	○	○	○	○	○	○	○
* The tool annoys me.	○	○	○	○	○	○	○
* The tool relaxes me.	○	○	○	○	○	○	○
* When using this tool I feel exhausted.	○	○	○	○	○	○	○
* The tool makes me feel happy.	○	○	○	○	○	○	○
* The tool frustrates me.	○	○	○	○	○	○	○
* The tool makes me feel euphoric.	○	○	○	○	○	○	○
* The tool makes me feel passive.	○	○	○	○	○	○	○
* The tool calms me.	○	○	○	○	○	○	○
* When using this tool, I feel cheerful.	○	○	○	○	○	○	○
* The tool angers me.	○	○	○	○	○	○	○

	-5 (as bad)	-4	-3	-2	-1	0	1	2	3	4	5 (as good)
* How do you experience the tool as a whole?	○	○	○	○	○	○	○	○	○	○	○

For your direct assessment of the iPRODUCE Marketplace, please fill out the following questionnaire part.

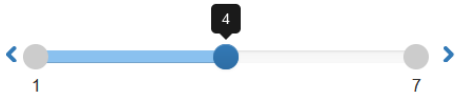
This part of the questionnaire consists of pairs of contrasting attributes that may apply to the tool. The numerical range between the attributes represent gradations between the opposites. You can express your agreement with the attributes by moving the slider to indicate your impression.

Please decide spontaneously. Don't think too long about your decision to make sure that you convey your original impression.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

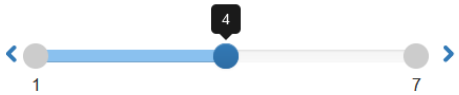
Move the slider or accept the initial position.

obstructive — supportive



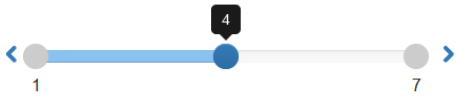
Move the slider or accept the initial position.

complicated — easy



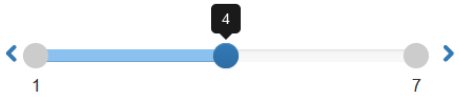
Move the slider or accept the initial position.

inefficient — efficient

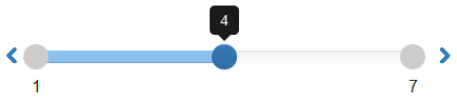


Move the slider or accept the initial position.

confusing — clear

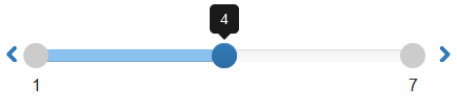


boring exciting



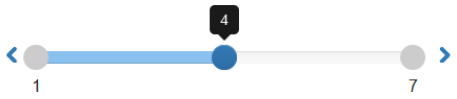
Move the slider or accept the initial position.

not interesting interesting



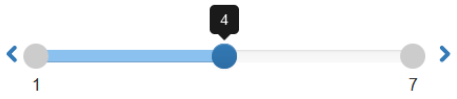
Move the slider or accept the initial position.

conventional inventive



Move the slider or accept the initial position.

usual leading edge



	1 (Strongly disagree)	2 (Disagree)	3 (Neither agree nor disagree)	4 (Agree)	5 (Strongly agree)
* The tool meets my needs.	○	○	○	○	○

	Not at all Likely 0	1	2	3	4	5	6	7	8	9	Extremely Likely 10
* How likely are you to recommend **the iPRODUCE Marketplace** to a friend or colleague?	○	○	○	○	○	○	○	○	○	○	○

The following, much shorter questionnaire parts are about the other tools of the OpIS platform. Each part is very concise, as only a few questions are asked for each tool.

Please select those OpIS tools that you have either used recently or that you are using regularly and that you would like to evaluate by answering a few questions. Your help in evaluating the OpIS platform is much valued.

- ☐ Generative Design Platform
- ☐ AR/VR Toolkit
- ☐ Data Analytics & Visualization Suite
- ☐ IPR Authoring Tool
- ☐ cMDF Training Platform (Training View & Training Flow)
- ☐ Process Automation Tool
- ☐ Mobile Application for Social Media

Perceived feasibility

	Not at all Likely 0	1	2	3	4	5	6	7	8	9	Extremely Likely 10
* I would participate again in social manufacturing activities (comparable to iPRODUCE).	○	○	○	○	○	○	○	○	○	○	○

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
* The cMDF (like in iPRODUCE) is a feasable concept for enhancing the collaboration of Makers, Manufacturers, and Consumers.	○	○	○	○	○

Informed Consent

Thank you very much. You have almost reached the end of the survey.

If you agree to submit your response data, please click "Next" below. Your participation in this study is voluntary. You may choose not to participate. If you decide not to participate in this study, you will not be penalized.

Your responses will be confidential, and we did not collect identifying information such as your name, email address, or IP address. The results of this study will be used for scholarly purposes only.

The lawfulness of the processing of personal data is determined pursuant to Article 6 of the EU's General Data Protection Regulation (GDPR). With respect to personal data, the processing of personal data is based on consent.

Please click "Next" now to send your responses.

Survey End

Thank you for your participation. Your response has been received.

If you have any questions or remarks, feel free to send an email to: Dennis.Paul@fit.fraunhofer.de.

Feel free to follow the iPRODUCE social media accounts on Twitter and LinkedIn for more information!

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Additional comments

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 870037.