D9.1 Evaluation Methodology, Plan and Metrics

AIDIMME

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Executive Summary

The deliverable D9.1 is the result of the work regarding the shaping of the evaluation methodology definition for the six cMDFs (collaborative Manufacturing Demonstration Facilities), concretely, the execution of the validation and feedback to the developers for incremental improvement, the measurement of the usability and the reporting of results following a common Evaluation framework. Consequently, WP9 "Validation, Demonstration and Evaluation of the iPRODUCE Social Manufacturing Space", defines the evaluation methodology along with the components to be used in the Open Innovation Space (OpIS) and the evaluation activities to be carried out at each of the six cMDFs for the OpIS validation.

Within WP9 the core functionalities and co-creation tools of OpIS will be validated demonstrating the value of the platform for the cMDFs assessing the impact of the iPRODUCE Social Manufacturing Framework.

In addition to the validation of the OpIS tools and services against the use cases, a comparable approach but at local and network level will be taken into account.

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List of Abbreviations & Definitions

Abbreviation	Definition
AR / VR	Augmented Reality / Virtual Reality
cMDF	collaborative Manufacturing Demonstration Facility
KPI	Key Performance Indicator
MMC	Maker, Manufacturer, Consumer
OpIS	Open Innovation Space
SME	Small and Medium Enterprise
SMS	Social Manufacturing Space
UC	Use Case
UX	User Experience

1. Introduction

WP9 is focused on the validation, demonstration, and evaluation of the iPRODUCE Social Manufacturing Space and how to apply it to the different cMDFs, the physical spaces acting as local interfaces of manufacturing companies, from each of the different countries, reporting later the results of the analysis. Figure 1 shows the list of all use cases (UCs) in the six cMDF along with their title, country of origin and the prototype to be validated. A prototype in iPRODUCE is a product or a service to be validated within a use case.

Country	cMDF	UC#	"Prototype" for validation
	Collaborative Engineering in Customer-Driven Home Furnishing Products	1	Inteligent Headboard
		2	Smart adjustable Gamer chair
		3	3D printed components for assembling customized furniture
	Open Consultation, Collaborative Product Development, Collaborative Learning	1	CoCreation – Introduction for SME's
		2	Machinery Training
		3	Guided Product Development as a Service (GPDaaS)
		4	MSB IoT Education Kit
	Establishment of cMDF in French industrial ecosystem for developing collaborative projects in the automotive/mobility area and associated consumer goods sectors	1	Prototyping equipment tutorials to train and involve fablab user
		2	Entrepreneurs & SME support to develop new devices in mobility sector
	Collaborative manufacturing environment with cross-competences sharing for product development/enhancement in the microelectronics consumer sector	1	Linear Translation Robo shaker
		2	Distributed Watering System
	Establishment of a mobile BetaFactory Unit	1	Co-creation in schools
		2	Distributed Design Market
		3	Temporary Architecture
	Upgrade of the design of a 3D printed medical equipment including IoT sensors integration	1	IoT-based Orthopaedic back brace
		2	Splints for fractures
		3	Splints for pets
		4	Customized face shields
		5	3D printed smart luminous artifacts
		6	3D printed (bio) scaffolds

Figure 1 – iPRODUCE's list of prototypes for validation overview

D9.1 documents the first phase of the Evaluation Framework of the iPRODUCE Open Innovation Space (OpIS), the digital platform to be developed in iPRODUCE, in the scope of the Social Manufacturing Space (SMS), the ecosystem of interpersonal relationships.

D9.1 defines the criteria for assessing the iPRODUCE performance and impact (in accordance with the established project's KPIs) with regard to the establishment, user experience and actions that take place within the iPRODUCE Open Innovation Space (OpIS).

Being developed within task T9.1, *Validation, Demonstration and Evaluation Methodology, Plan and Metrics*, this deliverable provides the basis for testing, assessing and validating the scenarios of usage of the iPRODUCE solutions in all cMDF pilots. These solutions will be supported by the iPRODUCE software developers in preparing the environment and identifying the key elements to be used in the validation process. A second version of this document, D9.2, Evaluation Methodology Plan and Metrics II, will follow, covering the next six months after submission of D9.1 dealing with a more in depth approach on how the OpIS tools and services at local and network level will be evaluated as well as the value proposition for the cMDFs.

1.1. Purpose and Scope

The objective of this deliverable is to illustrate the process of defining a methodology for the evaluation of the software components developed in the OpIS platform from a user's point of view, based in the KPIs defined at the beginning of the project and thinking in the expectations from the user´s point of view from each cMDF. Once the methodology will be clear to all cMDF, they will be prepared to validate the technological solutions giving a proper feedback to the technical developers.

The engagement of makers and FabLab spaces jointly with the iPRODUCE technological partners for the implementation of this methodology in all real environments is a very important objective in the future scope in order to demonstrate how well this methodology assesses the effectiveness of the iPRODUCE solution.

1.2. Relation to other iPRODUCE Work Packages and Tasks

This deliverable is framed within the "Validation, Demonstration and Evaluation Methodology, Plan and Metrics", Task 9.1. As Figure 2 shows, WP9 (Validation, Demonstration & Evaluation of the iPRODUCE Social Manufacturing Space) shares interactions with mostly all work packages in the project. WP9 is particularly linked to **WP2** (Business Challenge Definition for Social Manufacturing in Consumer Goods Sectors), since this WP will confirm the project vision and user scenarios aligning such vision with collaborative production models and technologies as well as providing the global requirements, KPIs and a framework illustrating the IPRODUCE Open Innovation Space.

In addition, WP9 is related to **WP3** (Establishment of Local Collaborative Manufacturing Demonstration Facilities (cMDFs) where the different local cMDFs are established and **WP4** (iPRODUCE Core Services and Digital Platform for Social Manufacturing) where the core platform of tools and services will be developed to be tested in WP9.

Additional interconnections are established between WP9 and **WP5** (Customer-Driven Production and Co-Creation Enabling Tools) since WP5 contains some of the components being evaluated such as the Generative Design Platform widely used during the idea generation process. WP9 is related to **WP6** (Social Media-Enriched Engagement Strategies for Makers and Consumer Communities) mainly with the mobile app to be used to assess the user's opinions and with **WP7** (iPRODUCE Sharing Economy Business Models and Execution Tools) because of the business models to be developed within each cMDF that will affect the use cases validation.

Finally, WP9 is related to **WP8** (iPRODUCE Integrated Social Manufacturing Space) because it addresses the Social Manufacturing Space (centerpiece for WP9 and later described in section 2) for acceptance testing of the whole iPRODUCE platform.

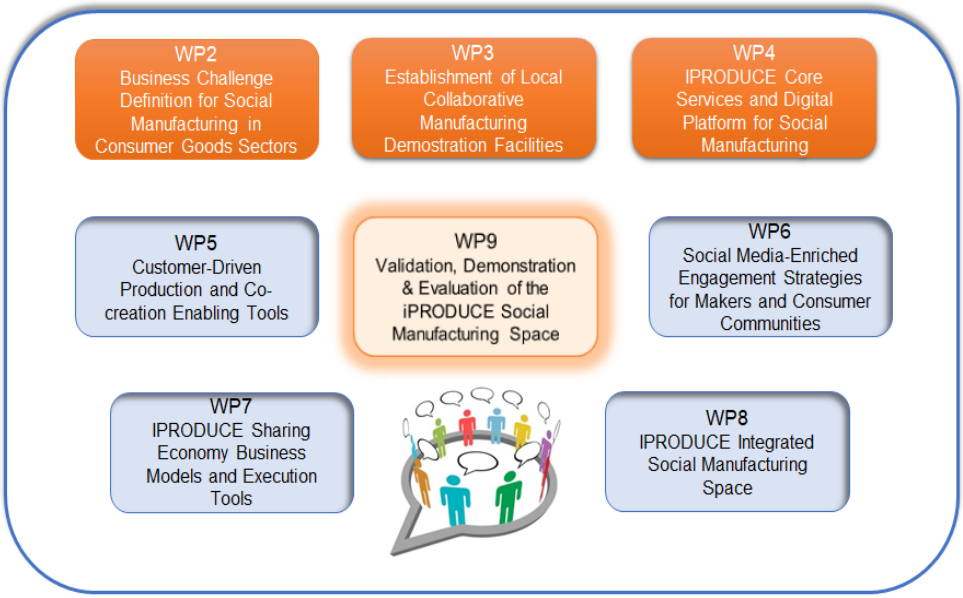

Figure 2 – WP9 relationship with the rest of WPs

1.3. Structure of the Document

This document is divided into three main sections, apart from the introductory one, section one. Section two called "Evaluation Framework of the iPRODUCE Social Manufacturing Space (SMS)" describes the space being evaluated, that encompasses the whole of the iPRODUCE project, including the stakeholders associated within that space along with the software components that act as connectors between the space and the users. The document introduces the necessary set of actions that each cMDF will have to carry out in order to proceed with the evaluation process such as the questionnaires and KPIs as main instruments used to perform the iPRODUCE evaluation in addition to the identification of the main stakeholders involved in the process. Then OpIS tools and means of evaluations are introduced as main points of the evaluation process.

The third section called "Prototype Validation" adds a series of "validation" tables by cMDF with their corresponding use cases. The tables identify the AS-IS value for each KPI, how it has been calculated and how the target value (TO-BE) is expected to be achieved through the OpIS platform, specifically by using the individual OpIS´s components to finally achieve the projected value.

A fourth section named "Contribution to iPRODUCE Project success indicators" is introduced to contemplate the global IPRODUCE project KPIs which all cMDF should achieve, assuring the success of the project.

Finally, a section for next steps is presented to open the way for D9.2, Evaluation Methodology Plan and Metrics II.

2. Evaluation Framework of the iPRODUCE Social Manufacturing Space

The iPRODUCE Evaluation Framework provides the procedures to be followed in order to gather the evaluation data, plan and metrics throughout the project in the scope of the Social Manufacturing Space in order to validate all functionalities and co-creation tools offered. These procedures will be considered together with all the partners to accommodate the different contexts of the pilots involved.

The Social Manufacturing Space is also framed within the main project objectives as listed in the Description of Action as Objective 8: "*To define the iPRODUCE open innovation challenges and validate and demonstrate the proposed social manufacturing space through 6 pilot cMDFs and 15 open innovation missions in 4 consumer goods subsectors*". This project wide objective is targeted to be reached by the realization of these three KPI:

- At least 50 SMEs use iPRODUCE platform to conduct social manufacturing activities
- At least 1 manufacturing process of 7 Fablabs is scaled up (adopted at SME level) through iPRODUCE
- A detailed roadmap for the sustainability and continuity of iPRODUCE is drawn before the end of the project

The Social Manufacturing Space is the center of an ecosystem surrounded by the MMC (**M**anufacturers, **M**akers and **C**onsumers) communities, which are the basis of the iPRODUCE project, as Figure 3 depicts. The MMC communities include manufacturing companies, maker communities such as Fablabs, Maker spaces, DIY, startups, etc., and Consumers. The OpIS developed in the project are geared to these MMC communities, who are the main stakeholders. Therefore, the evaluation framework and all the assessment that takes place in this work package must be addressed to these MMC communities.

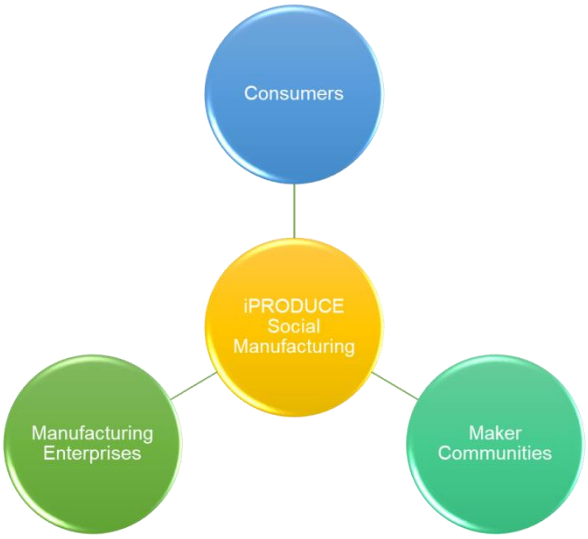

Figure 3 – MMC and the Social Manufacturing Space

This Social Manufacturing Space is driven by a set of software components that can further empower the establishment of successful interconnections between MMCs. These software components fall under the Open Innovation Space (OpIS) for Social Manufacturing, which are the main gear

mechanisms that can bring together and facilitate connection among the MMCs, stimulating multi-stakeholder co-creation processes and collaborative production engineering in the consumer goods sector. Figure 4 illustrates the initial conceptual architecture of the iPRODUCE platform.

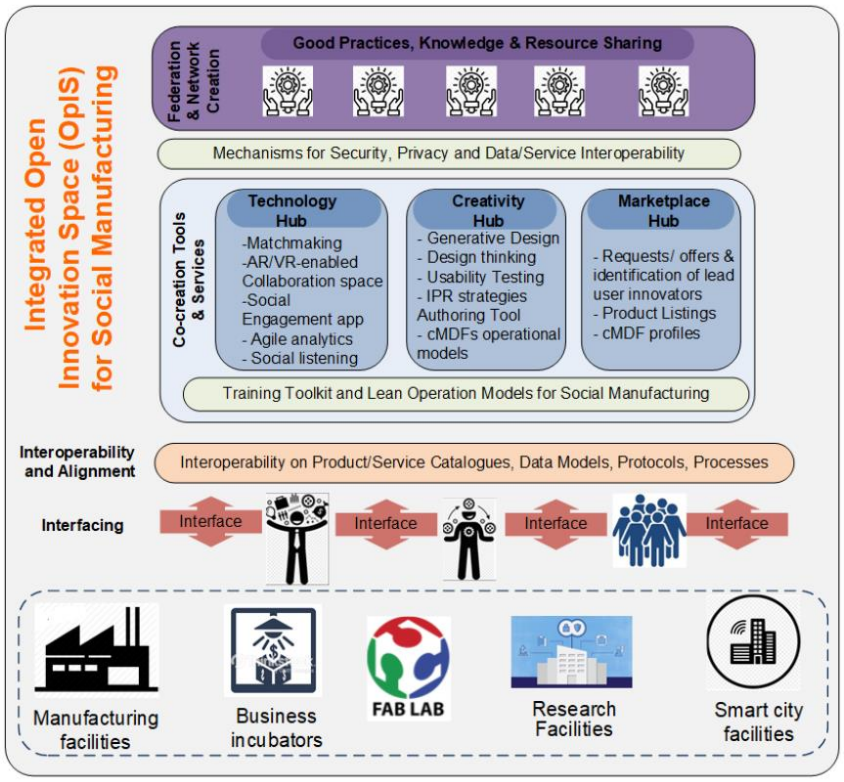

Figure 4 - iPRODUCE initial conceptual architecture of the Digital Open Innovation Space

The software components, mostly defined in T4.1 "Architecture and Design of the OpIS Innovation Platform, will finally be evaluated by the MMC communities within each of the cMDF. The cMDFs are the physical spaces acting as local interfaces of manufacturing companies, ensuring the main local knowledge fields and needs are covered in collaboration with the consumers and maker communities, consequently activating the innovative energy of consumers.

In order to assist the reader in the understanding of each OpIS component, a summary of all components with a short description is shown in the below table.

Table 1 - Summary of the OpIS components

Name	Description
Generative Design Platform	Explores different possibilities of developing and maturing ideas, enabling stakeholders to innovatively personalize new ways of bringing them to reality.
Ricardian Toolkit	Executes a contractual document (smart contract) among the interested parties.
Marketplace	Provides the ability to register new users (makers, communities).
Matchmaking	Allows the platform´s users to find suitable partners, products and services to enable the development of agile collaboration networks.
Agile Network Creation Tool	Supports the creation of collaborative networks that can jointly address specific business opportunities.

AR / VR	Real time social manufacturing space for co-creation process under Augmented and Virtual environments.
Mobile App	Gets customer feedback.
Agile Data Analytics and Visualization Suite	Focuses on analysis and storage of Big Data.
Digital Fablab Kit	Digitizes existing knowledge and common practices in makerspaces.
OpIS Data Repository	Covers the data access, security, exchange and analytics within iPRODUCE.

iPRODUCE fosters an ecosystem of collaborative product engineering where various stakeholders are engaged across different phases of the consumer product lifecycle. The iPRODUCE OpIS will be rolled out across its network of cMDFs. The infrastructure of the cMDF is enhanced through iPRODUCE to match the requirements for co-design, testing, validation, and training parts of collaborative production engineering.

The lead role of the cMDF is purposefully assigned to a core native partnership that has the base infrastructure to support collaborative production and the spaces for user, co-creation, validation and training.

The work in task T9.1 focuses on the evaluation of the OpIS platform. Each cMDF will start from:

- their defined use cases specifying a list of requirements that will derive in the use of the iPRODUCE Platform,
- a selection of the OpIS components to be used (why and what is the expectation to be solved),
- stakeholders involved (MMCs and the cMDF as such).

This evaluation will be performed by the MMC communities within each of the six cMDFs that are part of iPRODUCE. The complete interaction of the OpIS components with the MMC stakeholders and the processes involved are shown in specific activity diagrams. These diagrams are part of the work carried out in Work Package 2 (WP2), concretely deliverable "D2.6- iPRODUCE Social Manufacturing Vision and Reference Model" and "D2.5- Definition of iPRODUCE demonstration framework".

Validation activities will be carried forward as part of the pilot operations while executing the use cases, paying special emphasis to the user experience and the performance indicators, including all major actors (MMC) involved in the locals cMDFs.

2.1. OpIS Evaluation Methodology

The methodology developed is based on a short-term comparison between the situation before (**AS-IS** value) and after (**TO-BE** value) applying the iPRODUCE tools in the OpIS platform. "Situation" must be interpreted in a broader sense, since several experiences must be evaluated (use cases) and performed at different cMDFs, using different OpIS components, so that in each of them, the environment changes, and therefore, their objectives.

Identification of the associated PIs for each challenge/problem and allocating them a target value (or minimum value) is the basis of this process. These KPIs are defined according to the Simplified ECOGRAI methodology (Doumeingts, et al., 1995), *[1]*.

The Simplified ECOGRAI method (Doumeingts, et al., 1995) is used for designing and implementing KPIs according to an initial "problem" or objective the cMDF wants to fulfill. Therefore, each cMDF selected a series of objectives in T2.4 they want the iPRODUCE to fulfill. Drivers are the iPRODUCE

technologies, namely OpIS components to reach the objectives in order to properly evaluate the KPIs defined. Summarizing, the KPIs are defined to provide an indication concerning the situation of the system in order to reach the assigned Objectives. ECOGRAI has been effectively used in other H2020 projects such as *PSYMBIOSYS* (Grant agreement ID: 636804) *[2]* or *HuMan* (Grant agreement ID: 723737) to cite a few.

Therefore, all cMDFs will gather:

- all stakeholders (MMCs) interacting within each use case,
- the OpIS components, and
- the means of evaluation necessary to perform a valid measurement of whether a specific component satisfies the needs of the stakeholders (customers) as predetermined objectives.

In iPRODUCE the means of evaluation are of two kinds and will consider both qualitative and quantitative aspects when evaluating:

User Experience (UX):

- Through Questionnaires defined using a standard and common methodology named UEQ (user experience questionnaire) that covers a comprehensive impression of user experience. Both classical usability aspects (attractiveness -overall impression of the product - efficiency, perspicuity, dependability) and user experience aspects (originality, stimulation) are measured. These questionnaires can be found at *https://www.ueq-online.org/* and will be filled by all the MMCs who interact with each OpIS component from different point of views, depending on the stakeholder answering, and considering of course the cMDF feedback as well. Another questionnaire will be filled for the complete OpIS platform overall.
- Through Interviews (qualitative technique) when the client is in front of us and we see that it is the moment to ask him/her and it will be difficult afterwards. Basically they will be the same questions as in the questionnaire but they can be addressed depending on the "client" (user) we are interviewing.

Key Performance Indicators (KPIs):

- Specific metrics will help evaluate the components, by applying already defined KPIs in the use cases, but only relevant if the component is decisive in the achievement of the KPI.

Figure 5 illustrates an example of a generic cMDF Use Case. The stakeholders are defined, the OpIS component interacted with, and finally the means of evaluation used to measure each component, whether it is a questionnaire or the application of a KPI. The application of a KPI will be only relevant if such KPI has an effect on the component, that is, it can be measured or it offers a value when the component is used or interacted with.

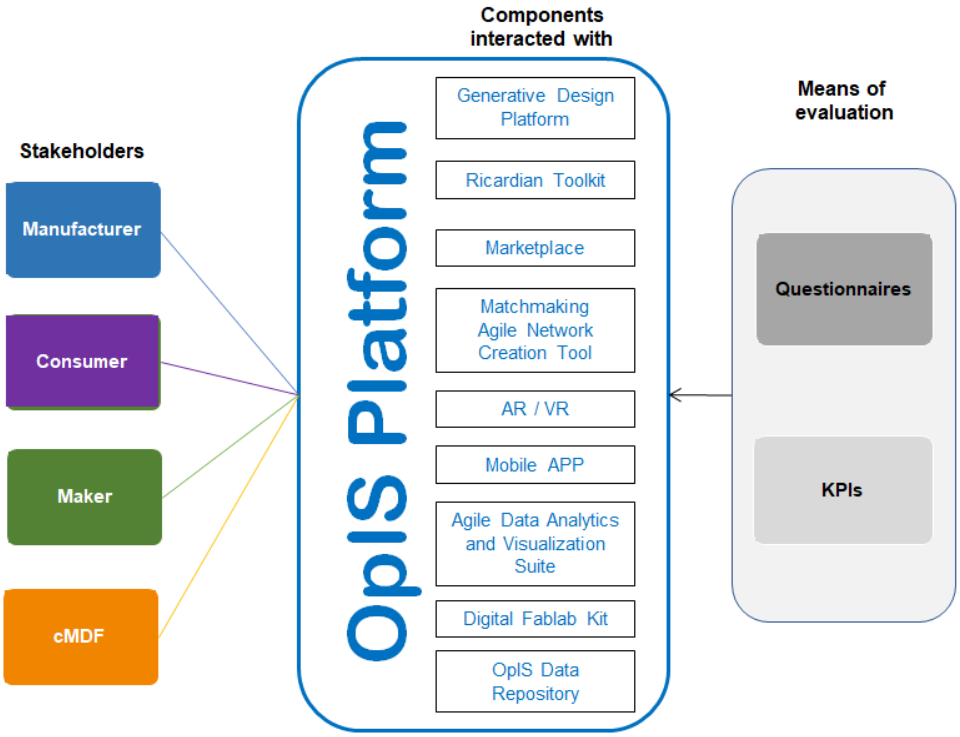

Figure 5 - cMDF use case generic example

To help in the validation process, the OpIS Map, shown in Figure 7, whose main purpose is to offer a quick look at who interacts with what, has been created. This is an excel file filled by all cMDFs and contains the list of all the use cases (what prototype is going to be validated) along with the stakeholders involved and the full list of all OpIS components interacted within each of the use cases.

It is important to notice that the methodology must support changes in, for example, the components to be used in a specific UC, or in the KPIs being measured. During the evaluation process, a cMDF may discover that another component not being used so far, or the change of a component by another one, is necessary to be applied within the UC. This also applies to the detection of other stakeholders, both individuals and companies. This could occur anytime and therefore, all these updates need to be taken into account for the final evaluation.

Figure 6 shows a diagram where the evaluation methodology flow is shown. Each of the color circles is later explained in more detail in the sections below.

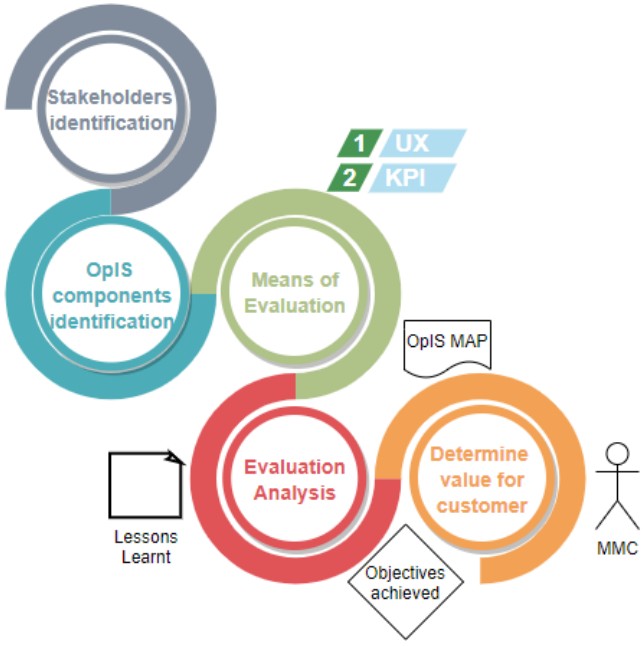

Figure 6 – iPRODUCE Evaluation Methodology

2.1.1. Stakeholders Identification

Each cMDF described in all their use cases, who are all the actors and their involvement in the cMDF. These actors belong to the MMC communities and will be the ones interacting with each of the OpIS components used within the scope of each use case scope. Stakeholders will serve as evaluators and will decide whether a component is suitable or not within each of the use cases scope via the means provided in the preceding section.

2.1.2. OpIS components Identification

The OpIS components are the main gear devices that link the main stakeholders together and serve as facilitators, empowering all collaborative production engineering in the consumer goods sector. Each cMDF will have identified in their use cases what components are being used according to the component´s specifications and their own expectations. Most of these components are defined and developed in WP4 and were presented in Table 1.

For example, to receive feedback from customers the Mobile App will give such support to the cMDF. Another example would be the possibility to co-create in the design process through Virtual or Augmented Reality.

2.1.3. Means of Evaluation

Questionnaires will be a key element to capture stakeholders' interactions with each of the components being tested. Users will fill out these questionnaires which will assess users' experience and opinions deriving from their involvement. Weighting can be applied here as well according to the importance of thought of each of them or its influence on the experimentation.

The essential difference between questionnaires and interviews is the way to address the feedback. Through questions with closed answer options according to opinions or perceptions of users.

However, the interviews facilitate the taking of quality (qualitative) information from the user to express their perception and suggestions with greater precision and quality of information.

KPI will also be used to evaluate the platform. As mentioned before, each use case has defined at least one indicator that should be connected to a component. That is, only KPIs that are relevant to the use of a specific component will be taken into account.

2.1.4. Evaluation Analysis and Lessons Learnt

Once the means of evaluation are applied in each of the use cases, being KPI or questionnaires, evaluation scores will be extracted and analyzed in order to determine if the corresponding OpIS component satisfied its original intended use and need. Questionnaires will yield a potential score and will be somewhat subjective since it will depend on the opinion and use of the corresponding stakeholder, whereas KPIs will throw a more objective measurement.

The application of this methodology will yield a set of lessons learnt that will potentially generate new ideas for new developments or just improvements on the already existing components. It is needed to contemplate the evaluation between local cMDFs to see how the OpIS platform can support the collaboration of a cMDFs network.

2.1.5. Value for Customer

The analysis of the evaluation will assess primarily the fittingness of a component in the use case that is employed at. Analysis will also determine if this specific component has a value for the customer. Since the results of the application of the methodology will be reported in D9.3, the iPRODUCE methodology must contemplate now the application, analysis and consequently, final value for the stakeholder, the customer.

The question to answer on each validation by each cMDF should be: Were our objectives achieved?

3. Prototype Validation

Section two described the evaluation methodology based in ECOGRAI, along with a selection of the OpIS components to be used and the stakeholders involved (MMCs). Section three wraps everything up and shows how to apply such methodology in the **prototype validation** of all cMDFs. A prototype could be a physical / virtual product or a service to be validated.

Figure 7 shows the **OpIS Map**, a quick way to present the reader with a list of all cMDFs, their use cases, the stakeholders involved and the list of all OpIS components.

It is important to notice that the OpIS Map as well as the subsequent cMDF validation´s tables may vary due to unexpected changes during the project's development. A revision of all use cases and their corresponding cMDFs Validation Tables will have to be undertaken to achieve a correct association before any evaluation process begins.

			MMC involved			OpIS Platform							
cMDF	UC	PROTOTYPE BEING VALIDATED	MANUFACTURER	MAKER	CONSUMER	GENERATIVE DESIGN PLATFORM	AR/VR	MARKETPLACE	MATCHMAKING & AGILE NETWORK	DIGITAL FABLAB KIT	AGILE DATA ANALYTICS & VISUALIZATION SUITE	MOBILE APP	RICARDIAN TOOLKIT
Spanish	UC1	Intelligent Headboard	X		X	X	X	X		X		X	X
	UC2	Smart adjustable gamer chair	X		X	X	X			X		X	X
	UC3	3D printed components for assembling customized furniture		X		X	X	X		X		X	X
German	UC1	CoCreation – Introduction for SME's			X	X			X	X			
	UC2	Machinery Training		X	X	X	X						
	UC3	Guided Product Development as a Service (GPDaaS)				X			X	X			
	UC4	IoT Education Kit		X			X		X				
Italian	UC1	Collaborative Engineering in Customer-Driven Robo-Shaker	X	X	X	X	X	X	X	X			X
	UC2	Collaborative Engineering in Customer-Driven Watering System		X	X	X	X	X	X	X			X
Greek	UC1	IoT-based Orthopedic back brace	X		X	X	X	X	X		X	X	X
	UC2	Customized face shields	X		X	X	X	X	X		X	X	X
	UC3	Splints for fractures		X	X	X	X	X	X		X	X	X
	UC4	Splints for pets	X		X	X	X	X	X		X	X	X
	UC5	3D printed smart luminous artifacts		X	X	X	X	X	X	X	X	X	X
	UC6	3D printed (bio) scaffolds		X	X	X	X	X	X	X	X	X	X
Danish	UC1	Co-creation in schools	X	X	X		(x)			X	(x)	(x)	
	UC2	Distributed design market	X	X	X		X			X	(x)	(x)	
	UC3	Temporary Architecture	X	X	X		X			X	(x)	(x)	X
French	UC1	Digitalization of FabLab Training Material		X	X		X	X		X	X		X
	UC2	Co-creation from idea to product for mobility entrepreneurs project	X	X	X	X	X	X	X	X	X	X	X

Figure 7 – Initial OpIS Map view of all cMDFs use cases

With the OpIS map serving as an initial introduction to the use case validation, we're ready to go one step further and put everything together addressing each specific cMDF in detail. The sections below are organized as "*XX cMDF Validation*" where *XX* defines the country owning the cMDF. Each one has its corresponding table in which each use case is broken down with the following structure:

- Use case number,
- Prototype to be validated,
- KPI used as means of evaluation for the different OpIS components associated with (as said earlier, wrong associations will have to be corrected in D9.2),
- AS-IS Value
- How the AS-IS Value has been calculated (without iPRODUCE)
- TO-BE Value
- How will be achieved the TO-BE Value (the KPI performance) through which OpIS component/s to assess such KPI (inside iPRODUCE).

3.1. Spanish cMDF Validation

The Spanish cMDF is composed by the technological institute AIDIMME, the furniture manufacturer Lagrama and the Fablab Océano Naranja, all located in the Valencian region in Spain. The cMDF deals with collaborative engineering in customer-driven home furnishing products and incorporates three use cases. Validation is intended to be performed by the MMC representing a pool of Lagrama target customers and consumer organizations in the Valencian regions among others.

Table 2 – ES cMDF Validation table

#	Prototype	KPI	AS-IS Value	How is Calculated	TO-BE Value	HOW WILL BE ACHIEVED (the KPI performance)
1	Intelligent Headboard	Number of proposals for the conceptual design based on the initial idea	1 proposal	Count the number of renders, or designs made by the designer for the manufacturer.	> 3 proposals	By using the Generative Design Platform, it can host and manage more proposals
		Reduction of the time spent searching for the right partner	≈ 15 days	Value obtained from the ERP or from direct observation.	< 2 days	By using the Marketplace, it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF
		Number of actors in the co-design phase	2 actors (Designer and Manufacturer)	Direct count.	> 2 actors	"By using the OpIS, more actors can co-design. Designer, environmental expert, market analyst, manufacturer..."
		Number of opinions assessing the virtual prototype	12 opinions at most that are part of a small focus group.	Direct count.	> 30 opinions	By using the Mobile app, many actors can evaluate the prototype
		Improve the time for the collaborative management of complete prototype process	70 days with manual work: excel emails, etc.	The time is obtained by direct observation.	≈ 30 days	By using the Digital FabLab Kit monitoring the workflow in real time among the different stakeholders involved.
		Time between the manufacturer first contact and the final prototype production	90 days Contact with designers, planning, final production	Observe the time elapsed from the first contact until the final production.	< 60 days	By using required tools in the OpIS, the reduction of time will be assessed
2	Smart adjustable gamer chair	Number of proposals for the conceptual design based on the initial idea	1 proposal	Count the number of renders, or designs made by the gamer.	> 3 proposals	By using the Generative Design Platform, it can host and manage more proposals
		Reduction of the time spent searching for the right partner	≈ 15 days	It will be obtained from direct observation.	< 2 days	By using the Marketplace, it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF

		Number of actors in the co-design phase	1 actor (gamer)	Direct count.	> 2 actors	By using the OpIS, more actors can co-participate. Designer, environmental expert, market analyst, gamer, manufacturer...
		Number of opinions assessing the virtual prototype	3 opinions	Direct count.	> 30 opinions	By using the Mobile app, many actors can evaluate the prototype
		Time between the gamer first contact and the final prototype planning	90 days	Observe the time elapsed from the first contact until the final production.	< 60 days	By using all OpIS involved in the use case, the reduction of time will be noted
		Increase the number of ideas for new furniture product design addressing young people (target)	1 idea	Direct count	> 3 ideas	By using the Generative Design Platform, more ideas can be managed and worked collaboratively
		Improve product innovation and co-creation activities	Design Thinking activity	Mind map	≈ 20% more improvement over the initial value	By using the Generative Design Platform, Matchmaking, collaboration and co-creation increases making product innovation easier to achieve
		Improve user satisfaction	Questionnaire score	Questionnaire administered to users (before and after) to deliver a score that can be measured	> 50% on user satisfaction over the original score	"By using the AR / VR Toolkit between different users through voice and text working in the same product. By using the Mobile App for user involvement in prototype assessment"
3	3D printed components for assembling customized furniture	Improvement of the time in the decision making process	≈ 15 days	Direct observation.	> 20% improvement	By using the Matchmaking tool, the service request to the cMDF can be greatly improved, this improving the decision making process
		Improvement of product innovation and co-creation activities	Creative and Innovation Management activity	Direct observation.	> 30% improvement	By using the AR / VR Toolkit users will view and configure the same product in real time
		Reduction of the time spent searching for the right partner to develop the prototype	≈ 15 days	It will be obtained from direct observation.	< 2 days	By using the Marketplace, it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF
		Improve makers and users satisfaction	Questionnaire score	Questionnaire administered to users (before and after) to deliver a score that can be measured	> 50% on user satisfaction over the original score	By using the AR / VR Toolkit between different users through voice and text working in the same product. By using the Mobile App for user involvement in

						prototype assessment
		Number of makers proposals based on the initial idea	1 proposal	Count the number of renders, or designs made by the maker.	> 3 proposals	By using the Generative Design Platform, it can host and manage more proposals
		Reduction of the time for the final prototype planning	90 days	Observe the time elapsed from the first contact with makers, planning until the final production	< 60 days	By using all OpIS involved in the use case, the reduction of time will be noted

3.2. German cMDF Validation

The German cMDF is composed by the maker space MakerSpace Bonn, the SME Zenit, and the research institute Fraunhofer all located in Germany. The German cMDF main topic is the open consultation, collaborative product development and collaborative learning and incorporates four use cases. Validation is intended to be performed by the MMC representing a pool of customers of the maker space along with Zenits and Fraunhofer main channels of manufacturers and contacts.

Table 3 - DE cMDF Validation table

#	Prototype	KPI	AS-IS Value	How is Calculated	TO-BE Value	HOW WILL BE ACHIEVED (the KPI performance)
1	Co-Creation Introduction for SMEs	Participants in the pilot activities	8	Count the number of people who participate in projects that are initiated via this use case	100	The Marketplace offers the possibility to advertise services to a broad audience. The Matchmaker helps companies find services for their specific needs.
		Consumer goods sectors addressed	0	Count the number of consumer goods sectors in projects that are initiated via this use case	1	The Marketplace offers the possibility to advertise services to a broad audience. The Matchmaker helps companies find services for their specific needs.
		Customer-driven products manufactured in cMDFs	0	Count the number of customer-driven products in projects that are initiated via this use case	2	Use case content is about learning how to become customer-driven
		Number of innovations of the company	To be measured before starting the project	Define with a company what counts as innovation. Then count	15% higher than AS-IS value	The taught process aims at increasing the number of innovations in the company
		Companies perceived	To be measured	Quantified questionnaire	20% higher than	The taught process aims at opening peoples

		readiness to participate in collaborative manufacturing	before starting the project		AS-IS value	minds for collaborative processes
		Innovations that find their way into products	To be measured before starting the project	Define with company what counts as innovation. Then count	20% higher than AS-IS value	The taught process aims at increasing the number of innovations in the company
		Makers and consumers involved in the co-design of products	0	Count the number of makers and consumers who participate in projects that are initiated via this use case	20	The taught process aims at opening peoples minds for collaborative processes
		Community members as beneficiaries of co-creation training	0	Count the number of community members who participate in projects that are initiated via this use case	50	The Marketplace offers the possibility to advertise services to a broad audience. The Matchmaker helps companies find services for their specific needs.
		Time of generating ideas	To be measured before starting the project	Define with company what counts as innovation. Then count	15% higher than AS-IS value	The taught process aims at speeding up the time for generating ideas in the company
2	Machinery Training	Amount of digitized training material	Not yet collected	Direct count.	5% higher than AS-IS value	Training Support Tool facilitates the creation of digitized material
		Number of available virtual workshops	Not yet collected	Count existing sample projects.	5	Training Support Tool facilitates the creation of digitized material
		Digital Fablab Kit	0	Direct count.	1	
		Makers who complete sample projects with material, machinery or tools they have not used before	0	Direct count.	10	10
3	Guided Product Development as a Service	Demand-driven sharing economy business models	0	Direct count.	1	Knowledge received over Matchmaking & Agile Network Creation Tool is used as base for defining business model
		Number of start-ups consulted	0	Direct count.	20	The Marketplace offers the possibility to advertise services to a broad audience. The Matchmaker helps companies find services for their specific needs.
		Improved time to market of products	To be reported by participating start-ups	Average turnaround time of prototypes	Higher than AS-IS value	Guided Product Development as a Service aims at improving time to market of products
		Makers and consumers	0	Count the number of makers and	20	The Marketplace offers the possibility to

		involved in the co-design of products		consumers who participate in projects that are initiated via this use case		advertise services to a broad audience. The Matchmaker helps companies find services for their specific needs.
		Start-ups' perceived ability to apply collective intelligence principles for the co-design on new products	To be measured before starting the project	To be measured before starting the project	Quantified questionnaire	By using the Generative Design Platform, it can host and manage more proposals
		Development costs for new products	To be reported by participating start-ups	To be reported by participating start-ups	Number of workshops and Number of consultancy hours relative to manufacturing time and cost	Guided Product Development as a Service aims at reducing development costs of products
4	IoT Education Kit	Consumer goods sectors addressed	0	Count the number of consumer goods sectors in projects that are initiated via this use case	3	The Marketplace offers the possibility to advertise services to a broad audience. The Matchmaker helps companies find services for their specific needs.
		Customer-driven products manufactured in cMDFs	0	Count the number of customer-driven products in projects that are initiated via this use case	2	The Marketplace offers the possibility to advertise services to a broad audience. The Matchmaker helps companies find services for their specific needs.
		Validated, market ready products	0	Direct count.	1	The IoT Education Kit as part of the Digital Fablab Kit.

3.3. Italian cMDF Validation

The Italian cMDF is composed by the company Trentino Sviluppo, the Fablab MUSE (FabLab of the Trentino regional Science Museum) and the maker space Noitech. The Italian cMDF main topic is the Collaborative manufacturing environment with cross-competences sharing for product development/enhancement in the microelectronics consumer sector and incorporates two use cases. Validation is intended to be performed by the MMC representing a pool of customers of the maker space and Fablab all located in Northern Italy.

Table 4 - IT cMDF Validation table

#	Prototype	KPI	AS-IS Value	How is Calculated	TO-BE Value	HOW WILL BE ACHIEVED (the KPI performance)

1	Collaborative Engineering in Customer-Driven Robo-Shaker	Number of proposals for the conceptual mechanical design based on the initial idea	1 proposal	Count the number of sketches or designs made by the designer for the manufacturer.	>= 2 proposals	By using also the Generative Design Platform, it can host and manage more proposals
		Reduction of the time spent searching for the right partner	≈ 15 days (excluding the formality of signing the contract)	Value obtained from the ERP or from direct observation	< 5 days	By using the Marketplace, it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF
		Number of actors in the co-design phase	2 actors (Manufacturer, designer)	Direct count.	>= 10 actors	Co-creation meetings and by the use of the OpIS more actors can co-design. Designer, maker, students, manufacturer, professionals.
		Number of opinions assessing the virtual prototype	≈4 opinions (internal experts of cMDF and the client)	Direct count.	>= 10 opinions	By survey/use of the Mobile app, many actors can evaluate the prototype
		Improve the time for the collaborative management of complete process	≈60 working days: management (administrative, technical)	The time is obtained by direct observation.	≈ 30 working days	By using the Digital FabLab Kit monitoring the workflow in real time among the different stakeholders involved.
		Time between the manufacturer first contact and the final prototype production	≈90 working days Contact with designers, planning, final production (prototype alpha)	Observe the time elapsed from the first contact until the final production.	< 60 working days	By using required tools in the OpIS, the reduction of time will be assessed
		Stakeholder satisfaction	85%	Results of a customised questionnaire (before and after)	>90%	By survey/use of the Mobile app, many actors can evaluate the prototype
2	Collaborative Engineering in Customer-Driven Watering System	Number of proposals for the conceptual design based on the initial idea	1 proposal	Count the number of sketches or designs made by the designer for the manufacturer.	>= 2 proposals	By using also the Generative Design Platform, it can host and manage more proposals
		Reduction of the time spent searching for the right partner	≈ 15 days (excluding the formality of signing the contract)	Value obtained from the ERP or from direct observation	< 5 days	By using the Marketplace, it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF
		Number of actors in the co-design phase	2 actors (Manufacturer, designer)	Direct count.	>= 10 actors	Co-creation meetings and by the use of the OpIS more actors can co-design. Designer, maker, students, manufacturer,

						professionals.
		Number of opinions assessing the virtual prototype	≈4 opinions (internal experts of cMDF and the client)	Direct count.	>= 10 opinions	By survey/use of the Mobile app, many actors can evaluate the prototype
		Improve the time for the collaborative management of complete process	≈60 working days: management (administrative, technical)	The time is obtained by direct observation.	≈ 30 working days	By using the Digital FabLab Kit monitoring the workflow in real time among the different stakeholders involved.
		Time between the manufacturer first contact and the final prototype production	≈90 working days Contact with designers, planning, final production (prototype alpha)	Observe the time elapsed from the first contact until the final production.	< 60 working days	By using required tools in the OpIS, the reduction of time will be assessed
		Stakeholder satisfaction	0.85	Results of a customised questionnaire (before and after)	>90%	By survey/use of the Mobile app, many actors can evaluate the prototype

3.4. Greek cMDF Validation

The Greek cMDF is composed by the company AidPlex, and the research center CERTH. The Greek cMDF main topic is the upgrade of the design of a 3D printed medical equipment including IoT sensors integration and incorporates six use cases. Validation is intended to be performed by the MMC representing a pool of customers of AidPlex, CERTH and their local ecosystem who will act as a networking partner.

Table 5 - HE cMDF Validation table

#	Prototype	KPI	AS-IS Value	How is Calculated	TO-BE Value	HOW WILL BE ACHIEVED (the KPI performance)
1	IoT-based Orthopaedic back brace	Number of proposals for appearance customization based on the initial conceptual design (e.g. size, shape, color, engraved logo/name, type of straps etc.)	1	A render, design made by the designer for the manufacturer	> 3	By using the AR/VR Toolkit, it can host and manage more proposals, measuring different selections for (e.g. size, shape, color, engraved logo/name, type of straps etc.)
		Reduction of the time spent searching for the right partner	15 days	It could be even months or days but this is an average. Manually, excel emails, etc.	< 2 days	By using the Marketplace (enhanced by Matchmaking & Agile Network Tool) measuring the time that takes to perform an intelligent

						search based on proximity and skills and select a cMDF (e.g. timestamps)
		Number of actors in the co-design phase	2	Designer and manufacturer	> 3	By using the OpIS, more actors can co-participate (e.g. Designer, environmental expert, market analyst, manufacturer etc.), measuring the number of users utilizing the collaboration tools (e.g. Marketplace, Matchmaking & Agile Network Tool, AR/VR Toolkit, Mobile app)
		Number of participants in surveys assessing the prototype	2	Currently at most 2 people are part of a small focus group	> 20	By using the Mobile app, measuring the participants that can evaluate the prototype
		Time between the manufacturer first contact and the final prototype production	45 days	Contact with designers, planning, final production	< 15 days	By using the AR/VR Toolkit, Marketplace, collaboration and co-creation increases making product innovation easier to achieve
		Improve product innovation and co-creation activities	N/A	N/A	≈ 20%	By using the overall OpIS toolkits involved in this use case
		Improve user satisfaction in open innovation	N/A	N/A	> 30%	By using Ricardian Toolkit, Agile Data Analytics and Visualization Suite
2	Splints for fractures	Number of proposals for appearance customization based on the initial conceptual design (e.g. shape, color, engraved logo/name, type of straps etc.)	1	A render, design made by the designer for the manufacturer	> 3	By using the AR/VR Toolkit, it can host and manage more proposals, measuring different selections for (e.g. size, shape, color, engraved logo/name, type of straps etc.)
		Number of proposals for size customization based on the initial conceptual design	1	A render, design made by the designer for the manufacturer	> 3	By using the Generative Design Platform, it can host and manage more proposals, measuring different selections for size
		Reduction of the time spent searching for the right partner	15 days	It could be even months or days but this is an average. Manually, excel emails, etc.	< 2 days	By using the Marketplace (enhanced by Matchmaking & Agile Network Tool)it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF (e.g. timestamps)
		Number of actors in the co-design phase	2	Designer and manufacturer	> 2	By using the OpIS, more actors can co-participate (e.g. Designer, environmental expert, market analyst, manufacturer etc.), measuring the number of users utilizing the collaboration tools

						(e.g. Marketplace, Matchmaking & Agile Network Tool, AR/VR Toolkit, Generative Design Platform, Mobile app)
		Number of participants in surveys assessing the product	2	Currently at most 2 people are part of a small focus group	> 20	By using the Mobile app, measuring the participants that can evaluate the prototype
		Time between the manufacturer first contact and the final prototype production	30 days	Contact with designers, planning, final production	< 10 days	By using the Generative Design Platform, AR/VR Toolkit, Marketplace, collaboration and co-creation increases making product innovation easier to achieve
		Improve product innovation and co-creation activities	N/A	N/A	≈ 20%	By using the overall OpIS toolkits involved in this use case
		Improve user satisfaction in open innovation	N/A	N/A	>20	By using Ricardian Toolkit
3	Splints for pets	Number of proposals for appearance customization based on the initial conceptual design (e.g. shape, color, type of straps etc.)	1	A render, design made by the designer for the manufacturer	> 3	By using the AR/VR Toolkit, it can host and manage more proposals, measuring different selections for (e.g. size, shape, color, type of straps etc.)
		Number of proposals for size customization based on the initial conceptual design	1	A render, design made by the designer for the manufacturer	> 3	By using the Generative Design Platform, it can host and manage more proposals, measuring different selections for size
		Reduction of the time spent searching for the right partner	15 days	It could be even months or days but this is an average. Manually, excel emails, etc.	< 2 days	By using the Marketplace (enhanced by Matchmaking & Agile Network Tool), it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF (e.g. timestamps)
		Number of actors in the co-design phase	2	Designer and manufacturer	> 2	By using the OpIS, more actors can co-participate (e.g. Designer, environmental expert, market analyst, manufacturer etc.), measuring the number of users utilizing the collaboration tools (e.g. Marketplace, Matchmaking & Agile Network Tool, AR/VR Toolkit, Generative Design Platform)
		Number of participants in surveys assessing the product	2	Currently at most 2 people are part of a small focus group	> 20	By using the Mobile app, measuring the participants that can evaluate the prototype

		Time between the manufacturer first contact and the final prototype production	45 days	Contact with designers, planning, final production	< 10 days	By using the Generative Design Platform, AR/VR Toolkit, Marketplace, collaboration and co-creation increases making product innovation easier to achieve
		Improve product innovation and co-creation activities	N/A	N/A	≈ 20%	By using the overall OpIS toolkits involved in this use case
		Improve user satisfaction in open innovation	N/A	N/A	>20	By using Ricardian Toolkit
4	Customized face shields	Number of proposals for appearance customization based on the initial conceptual design (e.g. shape, color, type of strips etc.)	1	A render, design made by the designer for the manufacturer	> 3	By using the AR/VR Toolkit, it can host and manage more proposals, measuring different selections for (e.g. size, shape, color, type of strips etc.)
		Number of proposals for size customization based on the initial conceptual design	1	A render, design made by the designer for the manufacturer	> 3	By using the Generative Design Platform, it can host and manage more proposals, measuring different selections for size
		Reduction of the time spent searching for the right partner	15 days	It could be even months or days but this is an average. Manually, excel emails, etc.	< 2 days	By using the Marketplace (enhanced by Matchmaking & Agile Network Tool), it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF (e.g. timestamps)
		Number of actors in the co-design phase	2	Designer and manufacturer	> 2	By using the OpIS, more actors can co-participate (e.g. Designer, environmental expert, market analyst, manufacturer etc.), measuring the number of users utilizing the collaboration tools (e.g. Marketplace, Matchmaking & Agile Network Tool, AR/VR Toolkit, Generative Design Platform, Mobile app)
		Number of participants in surveys assessing the product	2	Currently at most 2 people are part of a small focus group	> 20	By using the Mobile app, measuring the participants that can evaluate the prototype
		Time between the manufacturer first contact and the final prototype production	21 days	Contact with designers, planning, final production	< 7 days	By using the Generative Design Platform, AR/VR Toolkit, Marketplace, collaboration and co-creation increases making product innovation easier to achieve
		Improve product innovation and co-creation	N/A	N/A	≈ 20%	By using the overall OpIS toolkits involved in this use case

		activities				
		Improve user satisfaction in open innovation	N/A	N/A	>20	By using Ricardian Toolkit
5	3D printed smart luminous artifacts	Number of proposals for appearance customization based on the initial conceptual design (e.g. figure of artifact, color, engraved logo/name etc.)	1	A render, design made by the designer for the manufacturer	> 3	By using the AR/VR Toolkit, it can host and manage more proposals, measuring different selections for (e.g. figure of artifact, color, engraved logo/name etc.)
		Number of proposals for size customization (of artifact and electronics housing) based on the initial conceptual design	1	A render, design made by the designer for the manufacturer	> 3	By using the Generative Design Platform, it can host and manage more proposals, measuring different selections for size of artifact and electronics housing
		Reduction of the time spent searching for the right partner	15 days	It could be even months or days but this is an average. Manually, excel emails, etc.	< 2 days	By using the Marketplace, it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF (e.g. timestamps)
		Number of actors in the co-design phase	2	Designer and manufacturer	> 4	By using the OpIS, more actors can co-participate (e.g. Designer, environmental expert, market analyst, manufacturer etc.), measuring the number of users utilizing the collaboration tools (e.g. Marketplace, Matchmaking & Agile Network Tool, AR/VR Toolkit, Mobile app)
		Number of participants in surveys assessing the product	N/A	N/A	> 30	By using the Mobile app, measuring the participants that can evaluate the prototype
		Time between the manufacturer first contact and the final prototype production	30 days	Contact with designers, planning, final production	< 10 days	By using the Generative Design Platform, AR/VR Toolkit, Marketplace, collaboration and co-creation increases making product innovation easier to achieve
		Improve product innovation and co-creation activities	N/A	N/A	≈ 20%	By using the overall OpIS toolkits involved in this use case
		Improve user satisfaction on training skills	N/A	N/A	>50%	By using Digital Fablab Kit
		Improve user satisfaction in open innovation	N/A	N/A	>20	By using Ricardian Toolkit
6	3D printed (bio) scaffolds	Number of proposals for appearance customization	1	A render, design made by the designer for the manufacturer	> 3	By using the AR/VR Toolkit, it can host and manage more proposals, measuring different

		based on the initial conceptual design (e.g. lattice structure, material, etc.)				selections for (e.g. lattice structure, material, etc.)
		Number of proposals for size customization based on the initial conceptual design	1	A render, design made by the designer for the manufacturer	3	By using the Generative Design Platform, it can host and manage more proposals, measuring different selections for size
		Reduction of the time spent searching for the right partner	15 days	It could be even months or days but this is an average. Manually, excel emails, etc.	< 2 days	By using the Marketplace (enhanced by Matchmaking & Agile Network Tool, it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF (e.g. timestamps)
		Number of actors in the co-design phase	2	Designer, manufacturer, end user	>2	By using the OpIS, more actors can co-participate (e.g. Designer, environmental expert, market analyst, manufacturer etc.), measuring the number of users utilizing the collaboration tools (e.g. Marketplace, Matchmaking & Agile Network Tool, AR/VR Toolkit, Generative Design Platform. Mobile app)
		Number of participants in surveys assessing the product	N/A	N/A	>10	By using the Mobile app, measuring the participants that can evaluate the prototype
		Time between the manufacturer first contact and the final prototype production	21 days	Contact with designers, planning, final production	< 7 days	By using the Generative Design Platform, AR/VR Toolkit, Marketplace, collaboration and co-creation increases making product innovation easier to achieve
		Improve product innovation and co-creation activities	N/A	N/A	≈ 20%	By using the overall OpIS toolkits involved in this use case
		Improve user satisfaction in open innovation	N/A	N/A	>20	By using Ricardian Toolkit

3.5. Danish cMDF Validation

The Danish cMDF is composed by the maker space BetaFactory and Copenhagen Business School. The Danish cMDF main topic is the establishment of a mobile beta-factory unit and incorporates three use cases. Validation is intended to be performed in different Danish cities educational institutions and public sector institutions.

Table 6 - DK cMDF Validation table

#	Prototype	KPI	AS-IS Value	How is Calculated	TO-BE Value	HOW WILL BE ACHIEVED (the KPI performance)
1	Co-creation In Schools	Develop a proof of concept for teaching and working with manufacturing for different age groups	0	Count number of courses developed	2	2 courses, which can be used and replicated across schools in the country. Digital Fablab Kit
		Reduction of waste through on-site manufacturing capability)	<5%	Define and ensure the amount of recycled materials to be used before the construction. The materials sourced for the use case needs to comply with this request.	>10%	Use at least 10% of recycled materials for the projects to be developed. Digital Fablab Kit
		Improve local manufacturing awareness through the deployment of the mobile unit	0	Count the number of people (teachers, students, parents) that will be reached with the deployment of the mobile unit. Fx. Number of students and teachers directly involved in co-creating and working on the use-case.	> 50 people (students and teachers)	With the deployment of the container, more people will see the unit and get to know about its capabilities. Reach min 50 new people from schools by the end of the project. Digital Fablab Kit
		Increase number of community involved in collaborative manufacturing	0	Count the number of schools reached by the end of the project (the ones which commit to having the mobile unit for one week in their grounds)	2 or + schools	Reach min 2 schools and around 30 new community members by the end of the project. Matchmaking
2	Distributed Design Market	Reduction of waste through on-site manufacturing capability). Proof of concept of waste as resource.	<5%	Define and ensure the amount of recycled materials to be used before the construction. The materials sourced for the use case needs to comply with this request.	>20%	Use over 20% of recycled material for new construction. Digital Fablab Kit

		Improve local manufacturing awareness through the deployment of the mobile unit	0	Count the number of people that will be reached with the deployment of the eMobile unit. Fx. Number of participants directly involved in co-creating and working on the use case.	>30	With the deployment of the container, more people will see the unit and get to know about its capabilities. Reach min 30 new people from schools by the end of the project. Digital Fablab Kit
		Increase number of community involved in collaborative manufacturing	32	Count the number of new companies that either join Beta Factory as members or get involved in the production process of the use cases	>20	Reach min 20 new community members by the end of the project. Matchmaking
		Improve the perceived ability of local manufacturing for local business stakeholders (large manufacturers)	0	Count the number of larger companies involved in the use cases	>2	Reach min 2 large manufacturers by the end of the project. Matchmaking
3	Temporary Architecture	Develop a proof of concept for working with AR within manufacturing	0	Count the number of projects developed within iPRODUCE making use of AR	>2	Develop at least two projects where AR can be used in the context of designing and training. Digital Fablab Kit, AR/VR platform
		Reduction of waste through on-site manufacturing capability). Proof of concept of waste as resource through parametric modularity.	0	Count the number of projects developed within iPRODUCE making use of this technology	>2	Apply parametric designs and modularity to repurpose materials. Digital Fablab Kit
		Apply co-creation and physical prototyping in architecture.	0	Count the number of projects developed within iPRODUCE making use of co-creation before construction	1	Develop a modular system where residents can experience and manipulate the physical space before construction. Digital Fablab Kit
		4. Increase number of architecture firms involved in collaborative manufacturing	0	Count the number of architects involved in the use-cases	>10	Involve at least 10 new community members by the end of the project. Matchmaking
		Improve the perceived ability of local manufacturing of 1:1 scale prototypes for local business stakeholders	0	Count the number of companies involved in the use-cases	>2	Reach min 2 new stakeholders (companies, museums or municipalities) by the end of the project. Matchmaking

3.6. French cMDF Validation

The French cMDF is composed by the FabLab of Excelcar, the FabLab Vosges and the company Materalia. The French cMDF main topic is the establishment of a cMDF in the French industrial ecosystem to develop collaborative projects in the automotive/mobility area and associated consumer good sectors and incorporates two use cases. Validation is intended to be performed by the MMC representing a pool of customers of the Fablabs, startups & entrepreneurs' networks along with Materalia main channels of contacts.

Table 7 - FR cMDF Validation table

#	Prototype	KPI	AS-IS Value	How is Calculated	TO-BE Value	HOW WILL BE ACHIEVED (the KPI performance)
1	Digitalization of FabLab Training Material	Time of the FabLab manager allocated to basic training	To be measured before starting the project	Observation and direct count.	20% lower than AS-IS value	By using the OPIS platform the FabLab will be able to store their digitalize workshop and thus spend less time on the basic training.
		Visibility and accessibility of the FabLab activities and equipment.	N/A	Direct count of the number of digitalised content and overview on the available equipment.	Number of "view" get through the IPRODUCE platform.	By giving access to their content and information and their equipment 24/7 through the Market place and therefore be more flexible with the time user can follow a training.
		Amount of digitized training material.	Not yet collected	Direct count.	2-3 digitalized tutorials per FabLab	By using the video intelligence tools, and the FabLab kit, the FabLab will be able to digitalize their content faster and have more content to offer.
		Increase of the FabLabs users satisfaction.	N/A	Questionnaire administered to users (before and after) to deliver a score that can be measured	> 80%	By giving access to their content 24/7 through the Market place and having more tools such as AR/VR tools, Digital FabLab Kit etc.
		Time spend to digitalize a tutorial.	To be measured before starting the project	Direct count and questionnaire.	25% lower than AS-IS value	By using the video intelligence tools, and the FabLab kit, the FabLab will be able to digitalize their content faster and have more content to offer.
		Number of user trained by the FabLab.	To be measured/given before starting the project	Direct count.	10% higher than the as is value	By being present on the Market place and having parts of their workshops digitalized, the FabLab will be able to train more people and give access to their material 7/7 and 24:24.
2	Co-creation from idea to product for mobility	Time spent searching for the right partner	≈ 20 to 35 days	Value obtained from direct observation.	< 15 days	By using the Marketplace and Matchmaking tool, it measures the time that takes to perform an intelligent search based on proximity and skills and select a cMDF

	entrepreneurs project	Time for the collaborative management of complete prototype process	To be reported by participating project holder before starting.	The time is obtained by direct observation and a questionnaire	20% less than the AS-IS Value.	By using the OpIS, it will be easier to have an overview of the project and manage the partners and next steps.
		Time between the manufacturer first contact and the final prototype production	To be reported by participating project holder before starting.	Observe the time elapsed from the first contact until the final prototype and questionnaire.	30% less than the AS-IS Value.	By Using the AR/VR toolkit and matchmaking tool the user will be able to accelerate the design phase and the search for partners to produce the first prototype.
		Number of opinions assessing the virtual or physical prototype	To be reported by participating project holder before starting.	Direct count and questionnaire.	2-3 time higher than the as-is value.	By using the Mobile app, many actors can evaluate the prototype
		Number of actors involved in the project	Usually 1 (Individual project)	Direct count.	2 to 3 (collaborative project)	By using the OpIS, more actors can co-participate. Designer, environmental expert, market, manufacturer...
		Effectiveness and quality of collaborative manufacturing outputs	N/A	Questionnaire administered to users (before and after) to deliver a score that can be measured	Greater than 80%	By Using OpIS, Matchmaking, AR/VR tools the collaboration will be facilitated and speed up.

4. Contribution to iPRODUCE Project success Indicators

Last section described all KPIs defined at use case level which are intended to assess one or more tools within the use case they belong to. iPRODUCE has a set of global KPIs that are to prove the efficiency of the OpIS platform. This section gathers these KPIs which are "use case transversal", that is, they should be measured by all cMDFs as part of their journey through iPRODUCE, offering an inclusive view of the efficiency of the OpIS platform.

Table 8 – Project Success Indicators

Code	Indicator	Target value
KPI-3	Number of MMC communities developed	1 per pilot area
KPI-4	Number of manufacturing SMEs involved in the collaborative manufacturing processes of the MMC communities	>120 (or 20 per pilot area)
KPI-5	Number of engaged makers and consumers in the collaborative manufacturing processes of the MMC communities	> 1200 (or 200 per pilot area)
KPI-6	Participants in the pilot activities	>600 (or 100 per pilot area)
KPI-7	Local cMDFs developed	6 (1 per pilot area)
KPI-11	Open innovation missions where collaborative manufacturing will be applied	15 missions
KPI-12	Customer-driven products manufactured in cMDFs	>12 (2 per pilot area)
KPI-13	Collaborative manufacturing business cases/model	>12 (2 per pilot area)
KPI-14	Improvement in the perceived ability of manufacturing SMEs to apply open innovation methods	>20% increase
KPI-15	Improvement in makers' and consumers' perceived readiness to participate in collaborative manufacturing.	>20% increase
KPI-17	Demand-driven sharing economy business model	6-12 (1-2 per pilot)
KPI-18	Validated, market ready (business models and plans) products	6-12 (1-2 per pilot)
KPI-19	Size of sharing economy developed	>3000 participants (>500/city; measured as no of people using our digital platform and block chain mechanisms to exchange knowledge, services and products)
KPI-20	Community members as beneficiaries of entrepreneurship training	> 300 (50 per pilot)
KPI-27	Makers and consumers involved in the co-design of products	> 120 (20 per pilot)
KPI-30	Reduction in the development cost for new product	>20% (as reported by participating SMEs)
KPI-31	Customer-driven products manufactured in cMDFs	>12 (2 per pilot area)
KPI-34	Number of engaged makers and consumers in the collaborative manufacturing processes of the MMC communities	> 1200 (200 per pilot area)
KPI-36	Consumers' satisfaction with regards to the co-manufactured products	> 90%
KPI-37	Consumers' willingness to support the manufactured products (loyalty)	> 70% (among the communities' and pilot participants)
KPI-38	Manufacturers, makers and consumers in the needs analysis	>3000 (>500 per pilot)

5. Next Steps

In this document, we have drafted the cMDF evaluation methodology to be followed and presented how it will be applied to the different cMDFs use cases at local level. This deliverable is the first of the two versions of the methodology to be produced within iPRODUCE. D9.2, *Evaluation Methodology Plan and Metrics II*, will follow in June 2021.

Due to the submission date of D9.1, December 2020, and that the final architecture has been recently finalized, several OpIS component interactions along with the association with their corresponding KPIs, might be somewhat inaccurate. We keep exploring means for refining the mapping exercise, enlisting OpIS component interactions along with the association with their corresponding KPIs. In addition, upcoming meetings between the component owners and the cMDFs will occur in the following weeks in order to correct the use cases and activity diagrams. This will correct the proper usage and association of all OpIS components, stakeholders and the means of evaluation used, to offer a clear way to perform a proper evaluation process.

All these changes will be reflected in D9.2. First, and as earlier explained in this document, a list of all activity diagrams of all use cases reflecting the correct components as defined in the technical deliverables by the developers. This way all interactions with the OpIS components will be ratified. Then, a more detailed plan for validation and the necessary metrics will be included as well as updated for potential new components or developments, new forms of validation through the already defined means of evaluation as new KPIs or questionnaires.

Finally, since the scope of iPRODUCE is broader than the local level, validation does not have to be strictly bound to this locality, but it can be taken beyond onto a network of local ecosystems. This aspect will be observed in D9.2 as well.

6. References

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[2] PSYMBIOSYS Consortium 2014: "Product-Service sYMBIOtic SYStems" Grant agreement no: 636804. FoF-05-2014: Deliverable 2.6. Socio-Business Research & Innovation Validation.

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