OPEN DESIGN IN FAB LAB ECOSYSTEMS: THE CASE OF FABRIKALAB IZMIR

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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ABSTRACT

OPEN DESIGN IN FAB LAB ECOSYSTEMS: THE CASE OF FABRIKA LAB IZMIR

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Master's Program in Design Studies

Advisor: Assoc. Prof. Dr. Onur MENGİ

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As the design discipline has become an ever-evolving area, its main scope has shift itself to become an openly accessible medium for anyone to become utilized as the main driver behind innovative outputs. Throughout this process, open paradigm has emerged within the design research field to re-frame this rapid extension which directly refers to openness ideology. Within the scope of the given paradigm, open design has emerged as the foundational term to signify the transparent and democratic distribution of design-based knowledge. The main purpose of this study to evaluate and understand the crucial role of open paradigm and thus the open design framework itself within innovation ecosystem through multiple actors, participants, institutions, workshops and related spatial aspects. This study investigates the open design's operational framework within fabrication processes while considering the fab labs ecosystem of İzmir and its emerging innovation network as its main scope. The methodology has built on the following steps: 1)

framework & conceptual analysis, 2) a field study to explore the spatial dynamic of the ecosystem of FabrikaLab İzmir through pilot survey and personal observations, 3) The use of exponential snowball sampling and in-depth interviews which structured through open design drivers and fab labs ecosystem components for selected participants. The findings of this research present the contemporary operational dynamic of open design framework within FabrikaLab İzmir and its core utilities on fabrication methods. The findings also suggest potential research areas for future implications within the given framework.

Keywords: open paradigm, open design, open fabrication, co-creation, open service, fab labs ecosystem.

ÖZET

FAB LAB EKOSİSTEMLERİNDE AÇIK TASARIM: FABRİKALAB İZMİR ÖRNEĞİ

DEMİRBİLEK, Anıl Dinç

Tasarım Çalışmaları Yüksek Lisans Programı

Tez Danışmanı: Doç. Dr. Onur MENGİ

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Tasarım disiplini gelişmekte olan bir alan olarak değerlendirildiğinde, temel yapısının yenilikçi çıktıları sağlamak için herkesin açık bir şekilde erişebileceği bir araç haline dönüştüğü anlaşılmaktadır. Bu bağlamda, tasarım araştırması alanında açıklık ideolojisine doğrudan atıfta bulunan ve bu ideolojiyi yeniden yapılandıran açık paradigma ortaya çıkmıştır. Bu paradigma kapsamında, açık tasarım tasarım temelli bilginin şeffaf ve demokratik dağılımını simgeleyen temel bir terim niteliğindedir. Bu çalışmanın temel amacı, çoklu aktörler, katılımcılar, kurumlar, atölyeler ve ilgili mekansal unsurlar aracılığıyla yenilik ekosisteminde açık paradigma, dolayısıyla açık tasarımın kritik rolünü değerlendirmek ve anlamaktır. Bu çalışma, ana kapsamı olarak FabrikaLab İzmir'in ekosistemini ve üretim süreçleri içerisinde açık tasarımın operasyonel çerçevesini araştırmaktadır. Çalışma İzmir'de ortaya çıkan yenilik ağını da incelemekte ve vurgulamaktadır. Araştırmanın yöntemi, sırasıyla şu şekildedir: 1) çerçeve ve kavramsal analiz, 2) FabrikaLab İzmir'in

mekansal dinamiğini keşfetmek için pilot anket ve kişisel gözlemler aracılığıyla gerçekleşmiş bir alan çalışması, 3) üstel ayırt edici kartopu örneklemesi ile seçilmiş olan katılımcılar için açık tasarımın temel unsurları ve fab lab ekosistem bileşenleriyle yapılandırılmış derinlemesine mülakat uygulaması. Bu araştırmanın bulguları, FabrikaLab İzmir'deki açık tasarım uygulamalarının çağdaş operasyonel dinamiğini ve üretim yöntemlerindeki temel kullanımlarını sunmakta ve gelecekteki uygulamalar için potansiyel araştırma alanları da önermektedir.

Anahtar Kelimeler: açık paradigma, açık tasarım, açık fabrikasyon, birlikte yaratma, açık servis, fabrikasyon laboratuvarları ekosistemi.

Dedicated to my sunshine, my one only grandmother.

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LIST OF ABBREVIATIONS

CNC: Computerized Numerical Control

CO: Collaborative Approach

CR: Crowd Approach

DEPARK: Dokuz Eylül University Technopark

DIY: Do-it-Yourself

Fab Labs: Fabrication Laboratories

İBB: İzmir Metropolitan Municipality

IZKA: İzmir Development Agency

NGO: Non-Governmental Organizations

OD: Open Design

OM: Open Manufacturing Approach

OP: Open Paradigm

OS: Open-Source Approach

P2P: Peer-to-Peer

TTO: Technology Transfer Offices

CHAPTER 1: INTRODUCTION

1.1. Need for Study

As the design discipline has become and ever evolving area, which deeply connected to mass-production and industry, it became the main driver for development, innovation and new outcomes for the society. Celaschi, Formia and García, (2010, p.63) consider the term design as the main cultural aspect between industrial production and artistic expressions to mention the dualisim and the joint presence of two different worlds: the "industrial" and the "artistic" one. They further presented their vision by stating,

> *"Design is the culture through which this relationship between art and industry progressively, and not unitarily, takes shape."* (Celaschi, Formia and García, 2010, p.63)

Eventhough the foundational bonds between these two worlds are still strong, over the years this exclusive connection between them has loosened (Gasparotto, 2019). This process eventually allowed design to become a crossroad for other disciplines and theoretical backgrounds, since design and its research scope benefits from varied fields (Cooper, 2019; Cash, Daalhuizen and Hay, 2022). According to Howard et al, (2012) design and the development of new products and outputs are in a constant change, specifically at a mid revolutionary point on post-industrialisation. They mention the main utilities of the given area such as, product development, industrial design, product design and new production technologies are no longer solely the creation of industry, but now it is possible to observe the presence of varied groups of individuals on the overall processes.

Participation of varied stakeholders and non-designers into design process from different professional background and fields is also evident within this scope (Sanders, Brandt and Binder, 2010). It is possible to observe the evolution of design landspace through collaborative aspects for innovative and creative approaches, since

> *"new technological possibilities for ordinary people to collaborate are enabling new ways of performingcreative actions and participating in design and production. This challenges our way of thinking design and production*

and affects the landscape of collaborative design research and practice." (Marttilla and Botero, 2013, p.99)

Thus, design itself changed into an openly accessible medium and a driver for innovation through the collaborative aspects presented by others and non-designer participants, rather than created and become utilized only by the interventions of the industry and conventional methods on manufacturing capabilities. This has resulted into the emergence of the term "open design" (OD) and created a significant field within the design research scope for further investigation and research.

In terms of consumer goods, industrial design outputs, products and digital components, OD emerges as a way of distributing product design knowledge and related technical properties of different projects to any participant without any restirictions or constraints through transparent ways of information distribution. Term's roots can be traced back to 2004, when Ronen Kadushin coined the title of "Open Design" in his Master's Thesis and later published OD manifesto to signify the crucial influence of the ongoing evolution of "Computerized Numerical Control" (CNC) machineries and related digital technologies on design medium, in terms of openness and diffusion of design-based knowledge.

The term has been acknowledged as,

"the state of a design project where both the process and the sources of its output are accessible and (re)usable, by anyone and for any purpose." (Boisseau, Omhover, and Bouchard, 2017, p.17)

According to the Gasparotto (2019) the literature and the overall research on OD has grown throughout the years and the knowledge of the given phenomenon has enlarged its spectrum through the definition of the practice and the analysis of varied cases. Emerging research areas such as making, do-it-yourself (DIY), co-creation, co-design, participatory design, open source and open innovation are only a small amount of examples of the mentioned growth and development within the design research field. As a result, emergence of terms referring to the framework of openness ideology and the process of design itself, refers to a larger term that defined as open paradigm in the field of design or open paradigm in design research (Aitamurto, Holland and Hussain, 2015; Gasparotto, 2019).

From a contemporary perspective, open paradigm (OP) and the openness ideology within the given framework, have the potential to explain the shift from closed to open systems in design research field and related practices. In their respective research, Aitamurto, Holland and Hussain (2015) focus on analyzing the OP within the lens of design research and investigation to present its core contribution to the field as well as design processes. According to them, within the OP's scope, the openness ideology consist of two main aspects (open products and open processes) which can be perceived as the main backgroud of the term itself. Following briefly highlights the important points of each two aspect to further explain the foundational nature of the paradigm.

- *Open Products:* First aspect mainly refers to the creation of new products and the processes related to it. Within the provided framework, previously conducted research shows the utilization of free and open source sofwares as well as the usage of open source hardware, specially on manufacturing processes. (Vallance, Kiani and Nayfeh, 2001)
- *Open Processes:* Second aspect realizes the importance of collective efforts of multiple actors from varied background and specilizations to realized desired result when it comes to the development of new products and systems. According to Coimbatore, Prahalad and Ramaswamy (2000), specially between a company and customers, this collective manner can be observed as two-way interactions both for groups and peer-to-peer interactions between customers. Thus, provided aspect mentiones multiple design methodologies like; co-creation, co-design, participatory design and specially crowdsourcing to provide a process which can be considered under the paradigm's overall scope.

Within the paradigm's framework, the crucial aspect of manufacturing and fabrication methods on the creation of new design objects and outputs has evolved even further and altered itself to become an overall movement.

> *"Ever-increasing accessibility of information technologies, such as cheap small-scale production tools (such as subtractive technologies including 3D printers), combined with today's capability to share information rapidly over the internet has stimulated the rise of the so-called "maker movement."* (Bonvoisin, Galla and Prendeville, 2017, p.77)

Maker movement now can democratize decision making processes within design and making procedures on a social scale (Bonvoisin, 2016), as well as it has the potential to bring people together to foster their passion towards creative and innovative acts through a community of learning and making (Hynes and Hynes, 2018). The movement's emergence goes back to when Dale Dougherty first coined the term in order to indicate the overall scope. His creation "Maker Faire" back in 2005, provided a space for individuals to initiate new discussions and allowed them to extend the scope (Dougherty, 2012).

Referring to the paradigm's influence on the overall movement, OD can become evident within the scope of the "maker" approach. For instance, methods like DIY embraces the "openness" in design processes (Bouchez, 2012) and refers to the new fabrication techniques within the overall scope. Eventually the concept of designing, making and fabricating has changed as an inevitable outcome,

> *"This change is also cultural and social since the user can achieve greater ease of access to information and the necessary technology and is no longer a mere consumer of products and services without the capacity to make actual decisions about them or the knowledge or technology to alter the industrial process or operation."* (García-Ruiz and Lena-Acebo, 2022, p.1)

Given explanation refers directly to the paradigm's and OD's main approach through democratizing decision making processes and allowing users to embrace the open approach on fabrication processes. This relation results into the development of new products, starting from individual level actions to alter into a more complex structure as services then eventually become innovative systems as a total structure. In order to realize these mentioned phases, which accompanied by OD's core utilities as a design approach, fabrication laboratories (fab labs) were emerged as significant spaces and ecosystem to facilitate the mentioned process. In early 2000s from Massachusetts Institute of technology (MIT), they emerged as newly defined spaces to encourage students and users to utilize digital tools, manufacturing equipments and fabrication techniques in an openly manner. Defined and presented by Proffessor Neil Gershenfeld, fab labs were emerged to facilitate users on altering their design-based ideas into reality by sharing, diffusing and distributing knowledge and

information for innovative results and solutions.

Regarding all of the discussions above, following section further explains the paradigm's four varied clusters under two main categories (design phase and production phase) which directly influence the design-based development and creation processes.

1.1.1. Open Paradigm Clusters

In their paper (Gasparotto, 2019) examined the given term and proposed a contemporary categorization, which defines the total cluster of OP via the preliminary contributions from (Bailey, 1994) to signify certain methodologies within design processes. According to the selected research, OP clusters can be classified under four main categories as; OS (Open-source approach), CO (Collaborative approach), CR (Crowd approach), OM (Open manufacturing approach). Following adapted table presents the distribution of each cluster with related keywords. Given part continues to discover each four cluster briefly to explore the foundational aspect of OP.

Table 1. The four clusters of the "open paradigm". (Gasparotto, 2019, p.3).

Design Phase		**Production Phase**	
OS	**CO**	**CR**	**OM**
Open design Open-source Open hardware Peer production	Co-design Co-creation Participatory design Design thinking Co-development Co-innovation User-creation Community based development Meta-design	Crowdsourcing Crowdfounding Open innovation Decentralized innovation Crowd production Crowd-creativity Crowd-innovation Horizontal innovation	Open manufacturing Open distribution Open production Distributed manufacturing Open fabrication Making DIY Personal or self-fabrication/fabrication

It is apparent from the distribution of each cluster that, OS, CO, CR and their related keywords corresponds with the process of design and development phases of projects and design-based idea generation, whereas OM focuses specifically on fabrication and production stages. In order to undestand each cluster's nature, following part

briefly mentiones each of them.

1.1.1.1. Open Source Approach

First cluster of open source approach has been realized to propose an answers to the discussions revolving around the intellectual property rights and ethical issues regarding it. According to the given resarch, term later embraced by the OD philosophy which resulted into its expansion towards new goals and missions such as;

- Eliminating the invisible barrier between designers and users.
- Designing and manufacturing new artefacts which belongs to specific communities without any regulations or limitations.
- Motivating users and other participants to contribute to any given project for its development.

One of the most important contribution of the cluster to the overall paradigm is its ability to provide a horizontal dynamism on management capabilities. This way, any given phase of project development does not refer to the top-down or bottom-up models, but rather focus on enabling the peer-to-peer model of managing and distributing responsibilities, contributed with information between multiple actors.

1.1.1.2. Collaborative Approach

Second cluster emphasizes the crucial aspects related to the involvement of non-designer participants to the designing and manufacturing processes. As mentioned in the selected research, it is apparent that there are small yet significant differences between co-creation, co-design and participatory design, which thesis points out each nuances in detail throughout the following chapters. One important factor which the given cluster mentiones is the importance of individual creativity and motivation behind designing and creating.

However, starting from this individual level act, CO approach heavily relies on the collective efforts from multiple participants and collaborators. According to Levy and Bononno (1997) the collaborative approach relies not only on the creative capabilities of individuals, but aims to utilize the collective intelligence and skills of non-designers and other participants, which makes them able to come together and collaborate.

1.1.1.3. Crowd Approach

Similar to the CO approach, CR approach refers and acts in unison with multiple people and a specific amount of participants. However, the third cluster focuses

mainly on subjects related to the crowd and its total ecosystem. Topics like crowdsourcing, open innovation or crowd creativity can be considered as initial examples within this wide ranged spectrum. With the rise of the internet and networking capabilities the emergence of crowd-sourcing and CR approach has been enhanced, now it is possible to observe many varied platforms which have been established by companies to allow users to propose ideas and suggestions on different phases of product and service development (Bayus, 2013). This constant flow of data and information which provided by the crowd, enables designers to understand the true and real problems about any given product-service and system. This way it has become possible to propose quick and coherent design solutions to current and possible issues regarding usage, distribution and diffusion of design artefacts. Selected research emphasizes that, within the field of design study the crowd is usually involved within the pahse of research and development (R&D) of new products. Because of this, in most of the cases, the crowd factor has been considered as the main driver behind the competitiveness, rather than collaborative effects.

1.1.1.4. Open Manufacturing Approach

As the last classification part of the OP clusters, open manufacturing refers to the production and fabrication stages. Unlike first three cluster's main focus on design process and development, open manufacturing directly refers to the openly accessible production and fabrication tools for anyone after the process of designing and exploring varied possibilites for any given product or system. Therefore, Seravalli (2014) defines it as an example of a production type which is not limited to certain spaces or districts but disseminated across any given territory to reach others.

1.1.2. Emerging Innovation Ecosystem of İzmir

Izmir Development Agency (IZKA)'s Annual Report of 2019, the regional plan of İzmir has been established back in 30.12.2014 as a specific development plan which spans between the years of 2014-2023. Plan's vision is to establish a culture of design and innovation within the city and its citizens for future development through generation of knowledge and information. To realize this goal, certain milestones have been defined by the agency; *strong economy, high quality of life and strong society*. Each designated milestone aims to aid the process towards realizing the ultimate vision of altering the city of İzmir to a design-based ecosystem. Following further explains each milestone to open up new discussions towards the justification

of case selection and framing:

- *Strong Economy:* First milestone aims to understand the complete capaticity and potential of local economic variety through the sustainability perspective in terms of production.
- *High Quality of Life:* Second miletone aims to realize a sustainable city scale development while considering the quality of life of each citizen within social and economic spectrums.
- *Strong Society:* Last milestone aims to establish a strongly connected and integrated society model, through improving certain societal processes like, education, employment, health, transportation, urbanation and institutional decision mechanisms.

Regarding each given milestone above and their supplementary goals, IZKA further presents their essential values to identify their institutional principals (IZKA Annual Report, 2019). According to them, IZKA as an institution aims to contain their unique attributes towards society by becoming;

- Participatory
- Innovative
- Impartial
- Transparent
- Reliable
- Solution Oriented
- Efficient

Each principal on their own represent the main culture behind the agency's operational structure and overall institutional attitude. In terms of participatory, innovative and transparent approaches, each principal were also considered as motivative factors behind the case selection and overall framing reled to the OP and openness ideology as well.

When considered, İzmir carries a unique fabric of an effective ecosystem dedicated to "entrepreneurship". According to IZKA's Annual Report of 2020, the "Innovation and Entrepreneurship Result-Oriented Program" has enabled the overall region to start establishing an interconnected entreptreneurship ecosystem through varied strategies. Events and establishments like, "Start in İzmir Platform" has already initiated its main operational functions to coordinated the entrepreneurship

ecosystem of İzmir under its main institutional identity. Furthermore, established back in 2018, "İzmir Innovation Monitoring System" started as a parallel networking component, which annually maps the overall entrepreneurship diffusion and clustering within the city of İzmir. According to the agency, these reports have become accessible for all users and citizens online in a transparent attitude (IZKA Annual Report, 2020). On the other hand, there are also certain activities and programs dedicated to monitor and identify early stages of entrepreneurship activity within İzmir. Programs like "Young Minds New Ideas" and "Young Leaders" programs focuses on the new generation of participants from universities and other education levels, to work on projects for social development and innovation. As well focsuing on participant's individual ideas and project proposals, provided program also enable students to learn and develop new skills through emerging technologies and manufacturing capabilities. For instance, the project titled as "RoboCode Entrepreneurs of İzmir" provided young entrepreneurs and students with new options on project and design development phases via contemporary solutions on robotics and coding. Project included multiple participant within a rich newtwork consisted of, Dokuz Eylül University Technopark (DEPARK), Technopark İzmir, İzmir Sciencepark and Yaşar University.

A significant follow up to the presented information, IZKA Annual Report of 2021 higlights the positive outcomes of the previously established "Start in İzmir Platform" to create a new ecosystem within İzmir. Report signifies that, throughout the one year span, the visibility and the influence of the provided platform has enlarged and played a crucial role on establishing such an environment where entrepreneurs and other stakeholders can meet and collaborate. The platform has even become such a driving force that, its operational spectrum has been enlarged on a global level. According to the report, "Start in İzmir Platform" has become a member of "StartupBlink Platform", which is a global entrepreneurship network dedicated to list and index other platforms around the globe. With this membership, İzmir has become the 384th ecosystem model on the StartupBlink index, thus making the city appear on such a scale for the first time (IZKA Annual Report, 2021).

Throughout this emerging entrepreneurship ecosystem of İzmir, a significant organization named as FabrikaLab İzmir has been established as an outcome of the project titled as "İzmir City College Guided Project" under the governance of İzmir Metropolitan Municipality (İBB). The project has been authorized to start back in

25.12.2014 and ended in 31.12.2017, resulting into the creation of a fabrication space which would operate within the mentioned ecosystem (History of FikrimİZ Meslek Fabrikası, 2023). Referring to the previously presented goal of İzmir's regional development plan back in 2014, project with the estimated budget of 10.763.274 TL with the contributed value by 8.072.455 TL from the agency, aimed to reduce unemployment rates within the city as well as to create added value through focusing on local economic growth and development (İzmir Kent Koleji Projesi, 2023).

1.2. Aim and Scope of the Study

This study, aims to understand and present the potential of OP in design and innovation ecosystems including different agents, actors, institutions, laboratories and other spatial aspects in terms of its influence on allowing new and open ways to design, create and produce innovative outputs. Contributed with the mentioned theoretical background, rather then embracing the term "design" itself only as a tool for realizing products and services through conventinal approaches within the industry to meet the demands and needs of users, study acknowledges the term as the main driver for individuals to explore and allow them to discover their creativity to further expand the diffusion of innovative practices. Considering the paradigm as an umbrella term, it has been analyzed to understand the transition to openness ideology within design field and research related to it. Initially this dissertation contributed by the total flow of each chapter's structure, focuses on the transaction of design-based knowledge between individuals and large group of people within a certain ecosystem for the sake of creating new possibilities and results.

Starting from the nature of openness ideology to the foundational aspects of OD processes, this research expands its spectrum via analyzing OD through fabrication methods and tools. The scope of the research channels its focus on understanding the dynamic of OD approach within the process of creating new outputs and artefacts, from the perspective of innovative outcomes with respect to the management of design through a certain service structure. Therefore, this study approaches OD drivers through the ecosystem perspective and explores *how* o*pen design operates in the fab lab ecosystems.*

Throughout the research process given main question has enabled this dissertation to propose several sub-questions to further investigate the mentioned frame within the overall scope. Following sub-questions are raised throughout the chapters;

- *"What are the Main Methodologies and Drivers of Open Design?"*

- *"Which Factors and Components Shape the Total Ecosystem Structure of Fabrication Laboratories?"*
- *"How Open Design can be Considered As an Integral Method Within Fabrication Laboratories?"*
- *"What are the Essential Drivers of Open Design Within Fabrication Processes?"*

Following part explains the overall methodology and the phases constructed while implementing it. Furthermore, the selected case of "FabrikaLab" in İzmir, Türkiye, is analyzed though the derived criteria set from the thoretical background of OD and the analysis of the fab labs ecosystem in order to understand certain aspects and dynamics of the selected area.

1.3. Methodology

The thesis focuses on the contribution of OD processes within fabrication laboratories. This way, research defines its intention on understanding the connection between openness ideology, fabrication technologies and innovative outcomes as new design outputs. The case study analyzes the process of OD within the selected fab lab ecosystem of "FabrikaLab" in İzmir, contributed by certain drivers and ecosystem components as criteria sets for in-depth interviews with participants. This way, in accordance with OD's ability to diffuse and distribute design-based knowledge, the effect of the selected case and spatial area has been analyzed through varied participants and how they have contributed to the realization of new design outputs through fabrication. Research also identifies this and presents the overall flow of service ecosystem of the selected area, contributed by the opennes and OD frameworks.

The methodology used for this research and its utilization order can be broken down into following phases of data collection and curration: literature review, analysis of preliminary theoretical and conceptual structures to shape the main focus, creation of the overall research approach with a pool of drivers which act as the main criteria set through qualitative meta analysis, preliminary study for testing and enhancing the overall approach, and as a final phase the case study to employ the method through proposed variables to analyse and extract the conclusive statements. Following part divided into two major steps as Data Collection I and Data Collection II to breakdown each phase under the methodological approach of the study. Each section defines the previously executed approaches on both the creation of the main

theoretical framework and the application of the main methodological approach to gather findings and results in accordance with the research question of the thesis.

1.3.1. Data Collection I

Data collection I highlights the initial approach on framing and understanding the concept of OD itself within the design research field, how it emerged and its overall significance as a contemporary concept on the field of design. Furthermore, the data collection process continues to explain the review and the framing of the spatiality of OD by investigating fabrication spaces, in order to establish the theoretical relation between openness and fabrication processes within fab labs ecosystems. To establish this relation, certain elements of fab labs ecosystems which defined as components were matched with the essential drivers of OD to further frame the overall theoretical approach. Given phase shows each step on the overall review of the academic literature on openness and its contribution on design-based development through fabrication methods, while mentioning each title to further identify the frameworking process within the overall study.

1.3.1.1. Literature Review

Within the scope of the thesis, the literature has been gathered through desk research and online academic search engines. Overall literature has been compiled through academic journals, conference proceedings and books published specifically on the subjects of OP in design research, the emergence of OD and its concept, fabrication spaces, fab labs and their ecosystems on a global scale to establish the initial theoretical background. The literature search has been conducted through specific combinations of keywords of open paradigm, open design, open manufacturing, fabrication spaces, open fabrication, fabrication laboratories and fab labs ecosystems.

1) Open Design Understanding

As an initial approach, first step aims to understand the overall concept of OD within the contemporary structures through theoretical discussions and preliminary work. In order to establish an understanding towards the term and its emergence within academic field, OD divided into three foundational groups: *definition*, *methodologies* and *features.* Each group refers to the nature of OD and its conceptual significance within design research.

2) Open Design Framing

After the first step of investigating the concept of OD, following approach consisted of establishing a framework of the given term through the division of tree main

groups as well: *features*, *nature* and *terminologies*. While OD features and the nature of the term focuses on how it has been implemented within certain process and its utilitary areas within design development, terminologies of the term presents its overall scope and spectrum which enhances the methodological approach to signify an initial framing.

3) Reframing Open Design

Derived from the overall review, reframing OD proceeded with an evaluation format to re-define the concept of OD through three main layers of the term: *systems*, *processes* and *tools*. Compiled through theoretical discussions and the currated literature, each layer were defined through existing drivers of OD and its methodologies (co-creation, co-design, participatory design, peer-to-peer) which derived from the literature to further identify the term's positioning within the scope of the thesis.

4) Understanding the Spatiality of Open Design

The overall examination of the concept of OD allowed research to further signify its spatial factors for generating new outcomes. Within this scope, literature has been analyzed in terms of understanding the ecosystemic structure which surronds the overall approach on delivering design as a transparent and an equal utility. Given analysis enabled research to focus on defining fabrication spaces to present the total available and potential spaces to further investigate the suitable ecosystems for OD to emerge and become integrated to the foundational system flow.

5) Examining the Context of Fab Labs

Investigation of fabrication spaces further signified a significant ecosystem of fab labs, which belongs to the overall cluster of the mentioned spaces as a sub ecosystem model. This phase facilitated the overall approach on positioning the concept of OD by justifying the utilization of the term within a spatial environment, where varied fabrication tools and methods are evident. To understand the dynamic of the selected space, fab labs were dived into four main groups as topics which frames the selected area through academic literature: *definition*, *emergence*, *nature* and *significance*. Given division focuses on the overall framing of the selected ecosystem model to understand its connection with the concept of OD and their potentital connection on generating new and varied oucomes whether tangible or intagible.

6) Investigating Fab Labs Within the Global Context

Within the investigation of fab labs ecosystems, research focused on spotting the

global structure of recorded initiatives on a contemporary level to understand the current stituation of how each lab have been distributed on different continents and countries. In order to achieve the mentioned approach and utilize a reliable source as a preliminary data source, “The Fab Foundation” has been selected as the main initiative when it comes to mapping the global context of fab labs. As a sub-system under the main body of the selected initiative, “The Fab Lab Network” provided the necessary data for the visiualization of the total distribution of each lab around the globe. Moreover, through the utilization of data which derived from the initiative, allowed the initial data collection process to signify varied organizational structures which operated under the foundation to facilitate the diffusion of the maker culture and digital fabrication processes.

7) Defining the Components of Fab Labs Ecosystems

Based on the literature review and the investigation of the global context of fab labs ecosystems, data collection process on the selected area proceeded with defining certain ecosystem components to categorize and frame the overall fabrication and manufacturing dynamics. Within this approach, each component of the fab labs ecosystem were defined as: *events*, *capabilities* and *networking* structures, which directly effect the overall operational procedures of the selected area in terms of sustaining an efficient process on generating desired outcomes. Given phase also provided an essential base for the thesis to identify an interconnected relation between the framework of OD fab labs ecosystems.

8) Reframing Open Design Within Fab Labs Ecosystems

In order to understand the spatial factors which would effect the utilization process of OD within such defined ecosystems of fab labs, reconsideration of OD through previously defined ecosystem components from the litreature provided significant findings. Overall analysis and reframing process enabled thesis to define three main essential drivers of OD in fabrication processes; *open fabrication*, *co-creation* and *open service*. Each defined driver signify the spatiality of OD and its main integration within the selected ecosystem model.

9) Positioning of Türkiye within Fab labs Ecosystems on a Global Scale

Utilizing the previously defined reframing process, research proceeded with positioning the overall fabrication ecosystem and its related attributes within the geographical scale of Türkiye. Given approach served as an initial step on the transition phase to Data Collection II for case study through analysing the

contemporary status of each lab within the selected area. Each essential drivers of OD framework within fabrication methods and the ecosystem components of fab labs wre also once again utilized to find out which labs have been integrating the openness attributed to their service provisions and system structures.

1.3.2. Data Collection II

After the process of shaping a foundational theoretical background process has been resulted into examining OD and its essential attributes through spatial factors within an ecosystem flow on Data Collection I as a whole structure, Data Collection II presents the following approach on realizing this mentioned result into tangible outputs through multiple sub-divisions. Following section have been divided into multiple steps to present a concise form of delivering the necessary information in terms of applying the selected methodological approaches. Provided sections starts with defining the overall case study process by its criterias in terms of its selection and relevance to the given framework. In order to realize this, the main reasons and related information were provided behind the selection of FabrikaLab İzmir and why it has been considered as a potential area to apply the overall methodology of the thesis. This allowed research to signify the emerging innovation ecosystem of İzmir, derived the from official development reports and files. Furthermore the main focus of the case study has also been addressed to deliver the filtration behind the consideration of the selected organization. Data Collection II proceeded with explaning the pilot study which consisted of a preliminary filed study through individual observation and a pilot survey which has been applied on each personnell on FabrikaLab İzmir's management structure. The final section of the collection highlights the selected snowball sampling methodology and its significance regarding the given research in terms of expanding its reach through varied actors within the ecosystem of fabrication and development in İzmir. To provide an efficient approach on applying the main methodology, multiple in-depth interviews were conducted with each participant under the exponential discriminative snowball sampling approach, since certain criterias on selecting each pariticipant were a crucial aspect o provide related and reliable findings. While utilizing the results of pilot survey and its draft questionnaire structure in terms of flow and categorization of each concept, in-depth interviews were matured to further signify an efficient way on conveying the main idea to each participant. Following sections breack down each mentioned step to provide related information regarding the application of the overall

case study.

1.3.2.1. Case Study

After defining the overall scope and the research framework of the thesis, FabrikaLab İzmir has been selected as a case study to be implemented in İzmir, Türkiye. A preliminary study has been held with the personnell of the selected organization as a pilot survey to understand and become introduced to the overall ecosystem of the lab itself. The main aim of the pilot survey was to understand whether FabrikaLab İzmir was suitable as a case, in terms of utilizing the OD approach on fabrication and manufacturing processes to provide innovative outcomes. As a result, the case study area was determined as the main ecosystem to answer the resarch question of the thesis. FabrikaLab İzmir plays a crucial role of providing necessary space, equipment and technologies for citizens to utilize and eventually contribute to the realization of the targeted goal. Moreover, lab also aims to eliminate inequalities in terms of gaining knowledge and information distribution, while focusing on educating new and qualified personnel for multiple industries where specialization is the priority demand.

Within the provided scope and presented information regarding the developments throughout the years, research considers FabrikaLab İzmir as a potential space to further examine and take it as a significant case. Furthermore, contributed by the steps provided on Data Collection 1 and reframing process also signifies the potential contribution of the mentioned space in terms of its suitable structure within OP and OD approach. When considering the positioning of the selected lab, its intersection between the emerging ecosystem of entrepreneurship in İzmir and other design and innovation related projects governed under the municipality allows research to consider FabrikaLab İzmir as a viable case selection.

Referring to the OP's clusters, selected case contributed by its previously explained role within the main goal of IZKA and İBB on converting İzmir into a design-based ecosystem which supports innovation and development, positions itself efficiently within the total scope and theoretical framing of the research. Contributed by the figure below, following part explains case study's focus and identifies the overall approach on examining the selected space.

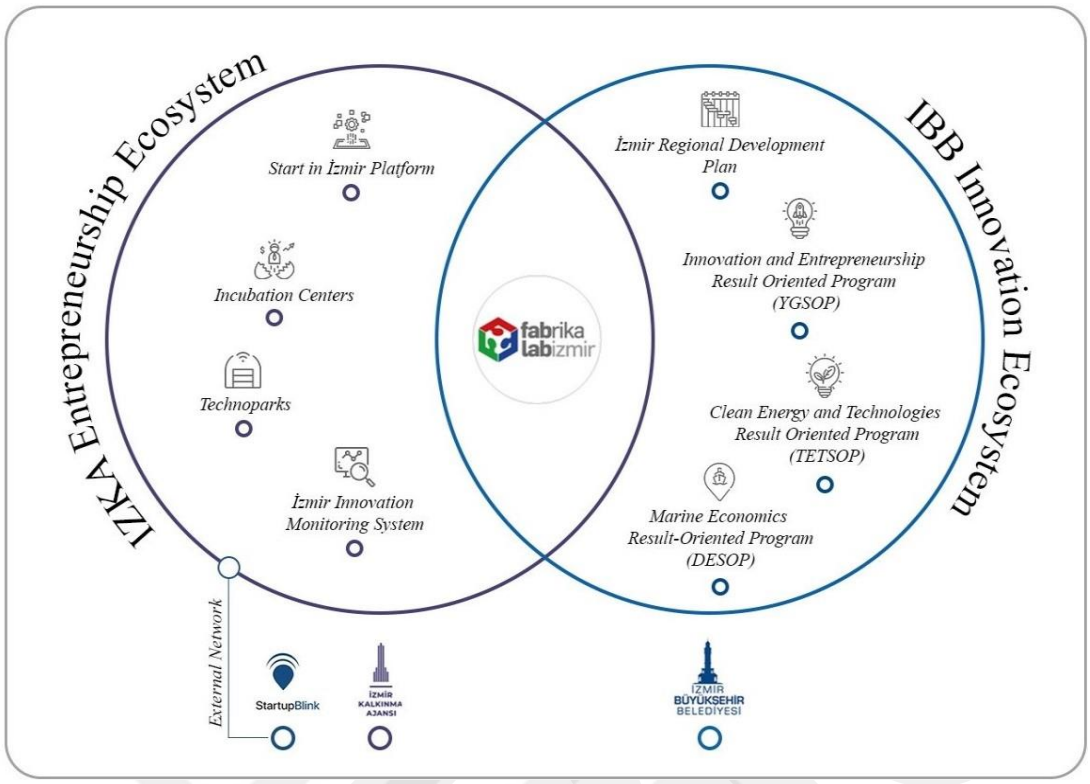


Figure 1. Positioning of the FabrikaLab İzmir.

1.3.2.2. Focus of the Case Study

The overall focus of the case study relies on a certain criteria set derived from the analysis of the academic literature on the framing of OD within fabrication methods and tools. Essential drivers of OD framework in fabrication processes and the overall ecosystem components of fab labs were matched and sampled together to identify the main perspective of the case study. Derived from this approach following sections identify each sub-step on applying the overall methodological approach.

1. Preliminary Research: Field Study

On 5 th of January 2023, a preliminary field study was applied on the selected location of FabrikaLab İzmir. The main goal of the given phase was to have an initial idea about how the selected ecosystem regulates itself with varied actors on operational structures as a service delivery. Given preliminary approach enabled research to propose multiple approaches under the field study and the overall visit during the selected date. Following identifies each phase to further explain the chronological structure of the case study.

- *Site Visit & Observation:* The fist site visit was conducted on 5 th of January 2023, on "Historical Coal Gas Factory Youth Campus" on Konak District (Alsancak Neighborhood) of İzmir, where the organization has been

relocated. It has been observed that the overall organizational structure consisted of a lateral approach with five employees, who have been defined as the main personnel on delivering the total scope of the service and management of the selected area. Moreover, the general infrastructural and spatial aspects of the organization have been observed through identifation of varied and multiple manufacturing tools, 3D prints, CNC machineries and the distribution of each fabrication tools on the provided space of the lab.

- *Pilot Survey:* During the same defined time period, a pilot survey has been conducted to identify the comprehensibility of the initial survey questions, which were derived and shaped from the previously defined criteria set. Given phase aimed to allow the research to evaluate, revise, define the necessary improvements for the following phases and finalize the overall structure of each question sets on the survey. Pilot survey was executed through the participation of each five personnel of FabrikaLab İzmir and each of them were questioned face-to-face within and approximate time period of 20-30 minutes. Regarding the initial feedbacks from the participants, several revisions were made accordingly on the questions and the overall flow of the survey itself to finalize it.

2. Snowball Sampling

To understand the total effect of İzmir's emerging innovation ecosystem and varied contemporary interventions made by the municipality to support the creation of a design-based city, snowball sampling method was utilized to enlarge the scope and reach to different actors who were and still a part of the generated fabrication ecosystem of FabrikaLab İzmir. The main justfication behind the given methodological selection was to identify and understand how varied participants from different occupational backgrounds diffused within the mentioned ecosystem and what kind of roles they have played in terms of shaping up the main system and service delivery of FabrikaLab izmir. Referring to the previously mentioned and utilized criteria set from the analysis of the literature on OD framework in fabrication practices and fab labs ecosystems, the exponential discriminative snowball sampling method was selected as the main driver on the selection of each participant from varied occupational backgrounds. Within the scope of the given approach six participants were determined and reached in order to proceed with the selected methodology.

When examined the distribution and the spread of each participant on the selected ecosystem, it was possible for research to proceed with the method within the frame of two main timelines around the emergence and establishment process of FabrikaLab İzmir. Thus, the overall methodology considered each participant according to their previous and current roles while considering the establishment of FikrimİZ division under the governance of İzmir Metropolitan Municipality as the main time stampstamp to divide the complete timeline into two. This way, it has become possible to observe and identify the how the integration process of OD framework within the fabrication ecosystem of the selected case has evolved throughout the years within the perspective of actor-based interventions and utilization. Morover, process also enabled research to signify and compare the ecosystem components between two timelines and how previous developments by the municipality and related organizations have altered the overall service delivery of FabrikaLab İzmir.

On 24 th of February 2023, an academician from TU Delft University who was an active participant and a director for the development project of the selected lab under the municipality, an ex supervisor of FabrikaLab İzmir, now working as urban designer at Izmir Metropolitan Municipality, an ex design and event coordinator of the selected lab, a lecturer from İzmir Kavram Vocational School, the current branch manager of FabrikaLab İzmir and the current supervisor of it have been reach via e-mail to collect the data regarding the research question and the investigation on the overall ecosystem. Each participant were selected according to their previous and current roles around the selected ecosystem and how they have been potentially utilized each ecosystem components within the framework of fabrication and manufacturing purposes. To identify the data and proceed with the method, under the snowball sampling process an in-depth interview format was defined via the revisions and feedback from the initial pilot survey process in terms of formating of questions and shape up the general structure of the interview.

- *In-depth Interview:*

Since snowball sampling process has referred to varied participants who have been distributed into two main timelines, participants were asked to answer the questions according to their own experiences and time periods which they have been a part of the selected ecosystem. This allowed methodology to identify how each actor has become a part of the selected case via different occupational backgrounds. Each

participant were informed about the theoretical background of the study and the overall scope of the dissertation before the interview started to make them become used to the terminology regarding openness ideology and fabrication processes. Due to scheduling conflicts and distancing, a hybrid approach was conducted during the application of each interview. Each three participant distributed on the timeline depicted for the period before the establishment of FikrimİZ division were interviewed online through zoom meetings platform. On the other hand, each participant from the current timeline after the establishment of the division were interview face-to-face, since their actor-based roles and responsibilities regarding the utilization of the ecosystem were accessible during that time. Each participant were questioned approximately 40-50 minutes and with their consent each session were recorded for further analysis of the findings. The questionnaire has been divided into six main categories which define the overall flow of the interviews (*infrastructural capabilities*, *networking*, *services*, *events*, *participatory approaches* and *open design*). Each category were shaped as the result of the matching process of essential drivers of OD and the ecosystem components of fab labs between eachother to signify the main criteria behind proposed questions to the participants. Questions were specifically focused on the FabrikaLab İzmir and the surrounding innovation ecosystem to understand the overall utilization of OD framework for fabricating new outcomes.

1.4. Descriptive Analysis

After the methodological application resulted, the research proceeded with the descriptive analysis of the findings and the qualitative data gathered from each participant after the interviews. This way, within a descriptive manner, each tangible and non-tangible factors related to the contemporary status of OD framework within the ecosystem of FabrikaLab İzmir have been analysed. The findings were currated through the pre-defined structure within the in-depth interview questionnaire, thus focusing on participant's answers related to the proposed answers.

1.5. Evaluation of the Key Findings

The evaluation section was currated specifically to re-state the general aim of this dissertation and organized within the scope of the main research question. To create a connection between each key finding and the overall framework of OD within fabrication processes, evaluation section emphasizes several findings to signify the main operational dynamic of OD and to what extend it has been implemented within

the respective ecosystem of the selected case. To provide a concise approach within the evaluation section, the previously defined ecosystem components and essential drivers of OD within fabrication processes from the third chapter were unified and designated as “ecosystem units”. This allowed the section to continues with the evaluation through three main units as; *capabilities*, *events* and *networking*, regarding the selected ecosystem model.

1.6. Limitations

Certain limitations were encountered during conducting this research. One of the most significant one was about the process of identifying a viable case selection for the research to proceed with further investigation during desk research and preliminary analysis. As previously mentioned, FabrikaLab İzmir has been considered as a sub-ecosystem within the emerging innovation model of İzmir in accordance with the annual reports provided by IZKA and related initiatives. As a similar ecosystem example, Fab Lab Ödemiş has also been spotted during the analysis on the network of The Fab Foundation. Being placed within the operational and geographical limits of Izmir Metropolitan Municipality and as a partner of The Fab Lab Network, Fab Lab Ödemiş has been inactive for a significant period according to preliminary research. Thus, it has been excluded during the case selection process to proceed with a more potential and an active area when it comes to the implementation of the methodological approach.

As for in-depth interviews, the current personnel of FabrikaLab İzmir have been contacted once again to proceed with the methodology. However, some of the actors have declined this request due to scheduling conflicts and personal preferences. In terms of focusing on the operational system of the lab and its integral management structure, this has affected the overall research to re-consider its methodological approach, specially when it comes to identifying potential actors to participate within Data Collection II.

1.7. Structure of The Study

As an initial approach, study defines the theoretical background of OP to present the emergence and the concept of OD within the contemporary design field. Then study proceeds with the investigation of physical spaces for OD to become utilized as a tool for fabrication technologies. While considering fabrication spaces as an umbrella term to signify various environments for fabricaton and manufacturing purposes, research focuses on fabrication laboratories (fab labs), where OD drivers for

fabrication phases is possible to examine. Following figure presents the overall theoretical positioning of the study.

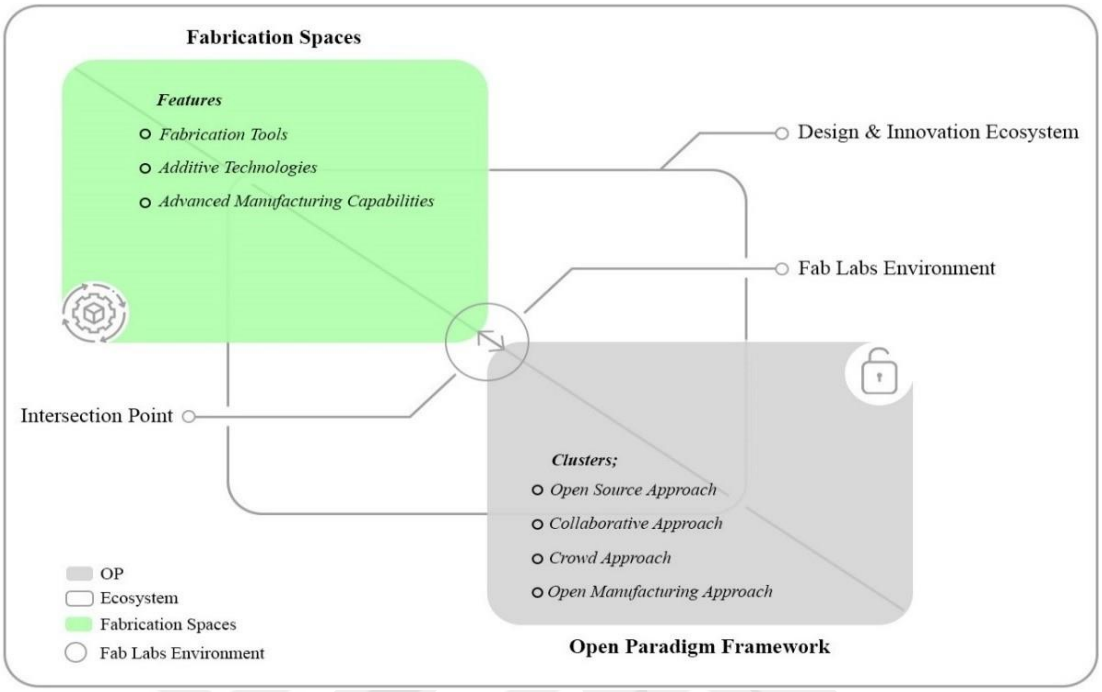


Figure 2. Theoretical positioning.

Following a brief introduction and the definition of the main research question in chapter one, chapter two defines the concept of OD through its methodological tools within the opennes idology to become a design approach for further implementation and utilization. Chapter also focuses on the conceptual layers of the term to present overall nature of it, contributed by multiple terminologies within each layer.

Chapter three discusses the physical environments for OD processes and initiates its argument through selecting fab labs ecosystems as its focus area. Within the chapter the emergence and the nature of fab lab ecosystems have been analyzed to understand the crucial contribution of the space to fabrication processes. As well as higlighting the current status of fab labs on a global scale, chapter opens up its discussions through the reconsideration of OD within fabrication processes to understand the main drivers behind the utilization of openness ideology on fabricating and making.

Chapter four presents an empricial work based on the collection of literature, site visit to the selected area as an preliminary field study, meeting with the administrative and operational unit of “FabrikaLab” İzmir, direct observations and analysis, which consisted of a multiple questions within a pilot survey format to further evaluate and improve the given method. In order understand the diffusion of

design-based development which derived from FabrikaLab İzmir's main positioning on the İzmir's innovation ecosystem, thesis advanced its methodological process through snowbal sampling method. This allowed research to alter its focus on an actor-based approach to identify varied participants from different occupational status and attributes. Within the sampling method, derived from the evaluations on pilot approach and further revision made by the results of the process, survey has been altered into a finalized questionare which dedicated for the usage on multiple in-depth interviews with the selected actors within the ecosystem.

CHAPTER 2: THE CONCEPT OF OPEN DESIGN

This chapter focuses on the nature of OD, its features, overall scope and its foundational aspects within the design field. Chapter initiates its discussions through the definition of the term and its operational spectrum as one of the main theoretical framework of this dissertation. While represeting the evolution of the term within the academic literature, chapter also higlights the methodologies of OD as well. Within this scope chapter presents the term's methodologies under three main levels: *tools*, *processes* and *systems*. Then chapter continues by presenting the terminologies of OD on different layers. Chapter concludes its discussions through a brief evaluation and reconsideration of each terminology in accordance with the defined methodological layers of the frame itself.

2.1. Definition Open Design

The term OD has gained its place among academic field throughout the years. On a more contemporary scale, the term has been observed on post-industrial economies and practices. Contributed by the ever increasing potential to utilize the ''openness'' ideology, the term gained its position on a wide range of spectrum. Manzini (2009) states that, OD has been considered as a vital term for the creation of beneficial outcomes through varied practices like, open co-design processes, open hardware, open product development and democratization acts. It is also been suggested OD has become the main driver to provide creative and innovative acts with the help of users and participants among societal structures. Furhermore, OD also creates opportunities for enterprises and entreprenaurs and eventually creates benefits in terms of financial gain and economic positioning (Raasch, and Herstatt, 2011). In this perspective, starting from political decision-making processes to peer-to-peer production and manufacturing capabilites, open design has expanded its reach. Van der Beek 2012 (cited in Tamminen and Moilanen, 2016, p.51) acknowledges the term's disruptive nature and how OD embodies a paradigm shift in which the given design object's instability caused by its no fixed identity.

> *"Thereby, open design operates in between individuals, who has the potential to change it and alter it according to needs and goals."* (Tamminen and Moilanen, 2016, p.51)

Both on manufacturing procedures and for creative processes, OD can create transparent ways of distributing knowledge and design-based idea generation. This process resulted into an influential effect on distributing more democratized and equally created knowledge based information to varied actors on different service or system models. As a design approach, open design can provide inclusive, democratic and accessible ways of design-based innovation on production flows, networks and services on an efficient level. This can be observed on multiple levels; openness of blueprints and technical details of products and related production methods, distribution of design-based knowledge and openness to participation or collaboration during the total design process (Bakırlıoğlu and Kohtala 2019).

OD's ability to create a culture of design and production methods through collaborative acts is apparent on varied projects. One of the key components of this creation process are the users and participants. *Co-creation and Co-design* terminologies not only play an important role to shape up this cultural approach of OD but also terms include non-designer participants and professionals to the overall flow of implementation of design on multiple scales. *Co-creation* provides a fundamental approach by enabling multiple actors come together and create ideas or solutions to specific issues on institutional level. Prahalad, and Venkatram, (2000) define the term as a bridge between employees and external participants which would make them work together with two-way interactions for the sake of creating innovative outcomes for companies and organizational level operations. *Co-design* can become a useful method to help individuals shape their own ways of designing and generating ideas through openly shared design-based knowledge. In contrast to their initial definitions when they first emerged on the literature, nowadays it is appropriate to mention these keywords on individual level of utilization as well, which means that eventhough terms refer to execute the total design processes with the help of multiple actors, their effectiveness does not have to become necessarily observable on large margins. On a more contemporary scale, individual actors can also reach openly shared design tools to enable this collaborative nature and utilize these tools to create innovative outcomes on smaller scale acts and development opportunities.

On the otherhand, multiple actors and participants facilitate eachother on the adaptation processes to project development procedures through designing. *Participatory design* reflects the same ideology but its specific focus on design

processes and idea generation through collaboration creates a difference between each keywords. Term's main focus is to enable users and stakeholders generate solutions to certain problems by making them participating on the whole design projects. It shapes a perspective on mutual development through participation between multiple participants (Simonsen and Robertson, 2013). On the other hand, according to Boisseau, Omhover, and Bouchard (2017), end-user contribution is important for the design process to happen and become implemented since it is explicitly emphasized. They continue to their discussions by stating the fact that, eventhough the term itself provides a sub-definitive approach it still differs from OD, since non-designer users and collaborators can not effect the total results during participatory design projects. As an initial feature, between each participant OD ideology can create an equally distrubuted knowledge process for the sake of the democratization of design attributes and let participants directly alter the impact. *Peer-to-Peer* as a keyword emerges on the spectrum to suggest a collaborative development which is less hierarchical and more lateral way of operation between each collaborator (Mechinelli, 2016). To summarize the overall importance of user or participant contribution to OD approach it is safe to state that, designing and creating value through collaborative ways enables OD to completely integrate itself to selected cases and projects.

Derived from the previous discussions and brief explanations, following will focus on selected four main keywords, which have been considered as the foundational pillars of OD as its core methodologies: co-design, co-creation, participatory design and peer-to-peer. Each term compliments OD's main influence on providing transparent methods of sharing design-based knowledge and capabilities to varied and multiple actors in order to provide socially innovative outcomes.

2.2. Methodologies of Open Design

Methodologies of OD: co-creation, co-design, participatory design and peer-to-peer keywords perform as foundations for OD processes through varied mediums and operations. Each method is utilized as an approach to make design-based knowledge accessible, visible and most importantly, openly configurable to users and related actors in respect to open knowledge usage and integration. Each method, with their own specific operation areas on design-based systems, enable knowledge transfer and sharing on multiple layers on a wide-ranging spectrum, ranging from the level of individual level of ideation to organizational level executions for desired outcomes.

Study considers given four main methodologies under three specific categories, which signify their usage levels: systems, processes and tools. Given levels separate each method to provide a more controlled and focused approach when it comes to explaining OD's integration to new service and system models.

2.2.1. Tools: Co-Creation

By nature, co-creation embraces every other mentioned key word of OD concept, since its core beneficial aspects provides the fundamental aspects of any operational field. From an organizational perspective, co-creation is a crucial concept that provides engagement between employees, improved supply chain integration, re-defines stakeholder commitment, and enhances workflow and knowledge sharing with external stakeholders and competitors in the market to create innovative outputs (Hatch and Schultz, 2010; Jüttner, Christopher and Godsell, 2010; Madden, Fehle and Fournier, 2006; Kohlbacher, 2008).

As a foundational approach,

> *"co-creation refers to any act of collective creativity, i.e., creativity that is shared by two or more people."* (Sanders and Stappers, 2008, p.6)

While this definition is broadly true and explains the initial scope of the term, Fleischmann, Hielscher and Merrit, (2016) considers co-creation within digital fabrication processes and refers to the term as a unique process which allows users and collaborators to benefit from a new service, product or procedures to be developed or improved to actively participate on the creation processes.

2.2.2. Tools: Participatory Design

Participatory design, emphasizes the role of collaboration both in the process of designing and of ideation. It enables users and stakeholders to generate solutions to resolve certain problems while participating in the whole structure of design projects. It adds a perspective on mutual development through participation between multiple participants (Simonsen and Robertson, 2013). Democracy and participation appear as two main principles of participatory design (Bratteteig et al, 2013), these concepts provide opportunities for different users to work collaboratively without inequalities in terms of development and knowledge sharing with equalised power relations (Kensing and Greenbaum, 2013). Like the co-design approach, participatory design refers to a collection of design practices which involves target users of design outputs

as collaborators during the design processes (van der Velden and Mörtberg, 2015). Furthermore, participatory design deals not only with the designing process, but also with the aftermath and results of each project.

> *"as researchers or designers engage with more ambitious goals, such as ensuring that participants and organisations enjoy lasting gains from their participation, it becomes important to consider not only what happens during the project, but also what happens after the project has ended.''* (Iversen and Dindler, 2014, p.154)

Their explanation shows the importance of realizing that there are multiple actors to consider during the process and that, through design and development of new solutions, expand their reach through each participant's influence on both during and after the process ended.

2.2.3. Processes: Co-Design

Sanders and Stappers (2008) envisions co-design in a broader sense as a creative act where non-designer participants and designers work together to develop innovative solutions during the total design processes. Also, Steen (2013) mentions the term through design thinking and the pragmatic capabilities which it can offer when compared to engineering and other forms of science, his explanation states that, co-design proceeds with a particular form of logic, which considers alternative ideas, contributed by solutions as well as alternative forms of problem definitions to widen the range of operation where designers and selected actors can deal with facts and values around certain topics. In addition, Trischler, Dietrich and Tiele (2019) explains the term as a framework derived from its contribution to create innovation within public sector and states that, the term itself is an instance of co-creation practice, where user contribution to design teams and experts is visible and apparent throughout the total progression of design and configuration.

During the process of co-designing, it is possible to observe knowledge transaction and creation between multiple groups. Kleinsmann, Valkenburg and Buijs (2007) explains this situation by design communication tools, which eventually leads to shared understanding between each actor within diverse groups to elaborate the common perception on design conceptualization. Derived from their previous work, following figure not only explains the basic flow of co-design projects but also shows the knowledge transaction process between two multidisciplinary design teams and how diversified knowledge can alter itself to become an integrated component on creating design solutions.

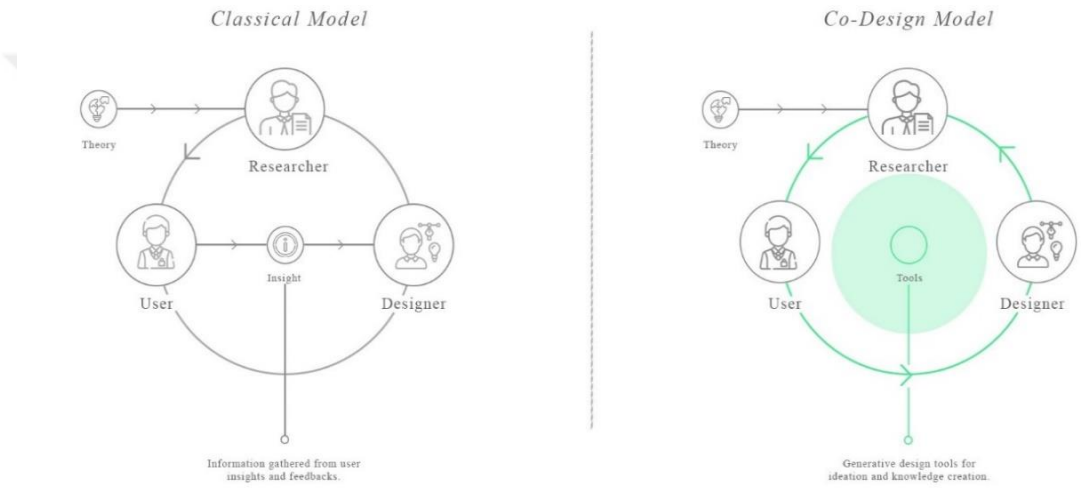


Figure 3. The Co-design process & knowledge transaction flow between multidisciplinary design teams. (Source: Kleinsmann, Valkenburg and Buijs, 2007, p.61).

It is the core fundamental feature of the term itself and previous research from the literature enlightens this fact to provide more sufficient information. Kleinsmann and Valkenburg (2008) refers to this feature and mentions that knowledge creation and its integration to varied systems and processes are the true goals of each co-design project. To understand the basic working mechanism of the approach and differences created by the influence of design ideology, following figure provides insights of the contemporary utilities of the term itself in terms of conversion of ideas and theoretical aspects to knowledge-based design development processes.

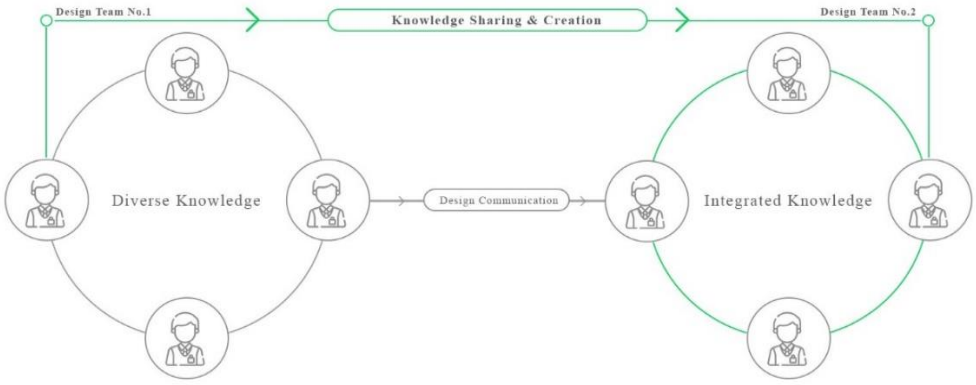


Figure 4. Comparison of classical (left) & co-design (right) models of knowledge and idea generation within design processes. (Source: Sanders and Stappers, 2008, p.12).

Regarding the comparison above, classical model suggests the observation of users or related actors by researchers can become the sole main source of knowledge, thus designers receive information without even communicating or interacting with the target group. While, co-design provides a circular model, where designers, researchers and users can create an ongoing knowledge transfer between themselves to articulate solutions and design proposals. Furthermore, the roles have changed between each actor, since co-design provides users the ability to share their own experiences when it comes to knowledge development, idea generation and concept creation (Sanders and Stappers, 2008). Generative design tools can be utilized during the process to facilitate the ideation processes and brainstorming sessions. As a result, knowledge and design related ideas becomes accessible between each actor to be altered for desired outcomes.

2.2.4. Systems: Peer-to-Peer

Peer-to-peer (P2P) proposes a more democratized management approach within organizational structures to understanding the overall picture in terms of knowledge and information sharing. It generally refers to the decentralization of communication and information distribution without considering any hierarchical collaboration within organizations, thus enabling a more lateral approach in terms of executing design and development processes (Menichinelli, 2016).

Menichinelli (2016) considered P2P from a socio-technological perspective and proposed a framework integrating P2P and open dynamics. Derived from this integration, P2P was divided into four sub-systems to explain its true contribution

within the overall conceptual framework of OD; *diffused, distributed, decentralized* and *centralized* systems. Following explains each system's functions and focus points according to the pre-defined conceptual framework.

- *Diffused Systems:* Refers to the system models, where there is no certain pattern of flow of information, and agents are not specifically organized in terms of homogenously distribution of operations.
- *Distributed Systems:* Refers to computer and digital networks, where data and information are stored and shared among each coordinated device.
- *Decentralized Systems:* Refers to the distribution of functions, information and data without reliance on any central authority. Decentralized systems enable the equitable distribution of activities and assets between agents and selected peers.
- *Centralized Systems:* Refers to systems where main operation and functions are stored within a selected focus point to provide control and central monitoring.

Each sub-system act as skeleton structure to enable P2P within socio-technological networks. Furthermore, their relationship with the ideology of openness plays a vital role regarding the information and knowledge sharing for organizational level procedures through software networks and infrastructures.

2.3. Features of Open Design

The term 'openness' carries a significant value for the implementation of the OD as an approach. On a basic understanding openness directly relates itself with the manufacturing capabilities. Avital (2011) clarifies this connection by emphasizing the apparent relationship between 'distributed manufacturing' and OD, plus how openness directly effects the use-related capabilities and options. OD is mainly related to end-users or consumers, since its core ability to provide openness to the overall flow of product usage scenarios. This means that, eventhough it is possible to observe OD throughout manufacturing processes and related steps of production; its main feature is directly pointed towards the users to make them able to access certain properties of any given design output, wheter it is tangible or intangible.

2.3.1. Conceptual Layers

OD carries unique features, all of these properties have inter-related connections to shape up conceptual layers. Furthermore, these layers compliment and depend on

each other to signify a strong structural model. Avital (2011) explains these features on four different categories;

- *Object Layer:* Refers to the distributive potential of OD objects, their configurable and interchangable nature. Layer specifically focuses on design blueprints and technical properties of any given object.
- *Process Layer:* Refers to the fabrication processes of OD objects. Layer focuses and explains the related machinery like CNC tools and printing components to build up no-mold customized objects.
- *Practice Layer:* Refers to the conceptualization process of OD. Layer contains key concepts like, OD culture, craftsmanship, professional standarts to enable complete democtratic approaches, rituals and normative values.
- *Infrastructure Layer:* Refers to the institutional and technical factors which enable the sustainability of design practices. Layer focuses on infrastructral capabilities such as, market structure, architecture and operative systems for the future and the evolution of the OD practices.

These four layers complete the total structure and the body of the term OD through definitions. Each layer stand as a step for implementing the design attitude to any selected system flow under different circumstances.

2.3.2. Design Process Layers

Throughout of its development as a term, OD has been converted into varied frameworks on academic literature. One of the important perspectives provided by Aitamurto, Holland and Hussain, (2015) re-considers the term in respect to OP and design research. According to the selected work's perspective, OD can be considered under a new conceptual framework as an updated approach. It has been emphasized that, OD should focus on every step of design and development, starting from ideation processes to production phases, its integration is crucial throughout the whole structure. To justify this perspective, previously referred research provides three new layers of OD;

- *Listening In:* Refers to the observation processes, created by designers through online and offline communties or target groups. In respet to OP, phase focuses on more openly ways to reach user related information rather than utilizing traditional design methods. Layer suggests the usage of online and digital tools for designers to reach data and knowledge about user needs

beyond their reach. Furthermore, layer also emphasizes the potential contribution of crowd to the definition of product requirements and production techniques to impact the outcome.

- *Interacting and Creating With:* Second layer refers to the role changing between users and designers during designing process. This time, designers become the main observers of the whole process by letting non-designer participants use design based tools and knowledge to enable co-designing and co-creation. During this phase, layer also suggests the possibility to observe crowdfunding for design to let users and customers to alter and shape the development procedures of certain product aspects. During this process it is vital to utilize digital platforms to enable users mass-customize their desired designs and outputs.
- *Share With:* Third and last layer refers to make design and other blueprints of certain product aspects publicly accessible, whether they are source related data or hardware details. Layer expands its scope by suggesting the usage of additive production technologies like 3D printing tools to create an easiness on making design based data accessible and transparent in a more efficient way.

In terms of providing a perspective within OP framework, selected layers gives information related to the basic structure of OD and openness ideology as a whole. Each layer focuses on crucial and diverse steps for facilitating OD's integration to knowledge distrubution and democratizatin design processes in order to propose innovative solutions and opportunities for improvement.

2.3.3. The Nature of Open Design

From another perspective, Freire, Monteiro, and Ferreira (2018) states open design features are crucial for developing countries. In order to explain their approach, they put their scope on The Open Knowledge Foundation (2012) to provide three different and essential levels which have the potential to create frameworks to sustain the total development process of OD ideology;

- *Collaboration:* During the process of design, becoming fully collaborative from non-collaborative practices.
- *Accesibility:* Complete alteration on shared format of knowledge on digital platforms to provide easiness on accessibility.

- *Intellectual Properties:* Maintaining and protecting the original rights of authors/designers before providing public access and ability to reproduce.

These three main levels and related principals facilitate the process of integration of openness ideology on varied layers of operation, specifically on developing countries context. From citizen empowerment to economical sustainability through responsible consumption, OD and openness ideology contains a potential to become the main drivers of change and innovation. They continue to their explanations by providing four main principals of OD and its core contribution to design field, derived from previously given three main levels. These four different terms are related to the basic nature and the significance of the term OD itself;

- *Transparency:* Refers to the complete observation and collection of design materials and knowledge without any restrictive acts or prohibitions. Suggests openness for contributors outside of any given and specified system models, in order to create innovative results and positive outcomes.
- *Accessibility:* Refers to the facilitation of utilizing any source of knowledge. Related to previous principal, accessibility provides easiness on reaching any transparent data and design tool. Term also refers to the complete participation of users and participants to OD projects.
- *Replicability:* Refers to the capabilities of reproduction processes of designed products and artefacts through similar methods and techniques. Principal also points out the importance of usage of local materials and components.
- *Modularity:* Refers to a designed product's ability to become seperated to facilitate user manipulation in order to provide easiness on development and further designing processes.

These four main principals help developing a framework for the implementation processes of OD on multiple scales. With the help of pre-defines three main levels by The Open Knowledge Foundation (2012), each term signify the core structure of OD's main approach as an ideology.

2.4. Terminologies of Open Design

To clarify the true meaning of the term OD, related sub-terminologies and key concepts can provide a better perspective towards the topic's scope. Because of its wide range of reach on design spectrum, OD gathered multiple and varied key terminologies throughout of its development on academic field. As an evolving

concept, the term ‘open’ used under multiple topics. Under different context, it is apparent that results can become divergent or can point out the same outcomes. One of the significant research created by Pomerantz, and Peek (2016) provides a crucial categorization of the usage of the term ‘open’. Their main goal was to create an attempt to detect and collect every usage of the term itself. At the end they grouped them under seven main categories; *rights, access, use, transparency, participation, enabling openness, and aligned with open principles*.

In the light of this information, OD has expanded its reach even further and introduced new terminologies rather than only focusing on the concept of ‘open’. Following tables show the attempt of categorizing related keywords according to their definitions, significance in terms of their contributions to OD principals, their usage levels and most importantly their relationship with OD features layers according to the categorization from Avital (2011);

Table 2. Object layer terminologies.

Keyword	Definition	Significance	Usage Area	Layer
Downloadable Design	Refers to downloadable product features and technical details.	Term creates the opportunity to distribute product design knowledge and related capabilities.	Individual Level.	Object Layer
Meta Models	Design models which refers to connections between bigger models to provide areas for interventions and alterations.	Model creates opportunities, where participants can intervene to the whole flow of production process.	Organizational Level.	Object Layer.

Table 2. (Continued). Object layer terminologies.

Open Hardware	Refers to design solution through electric components and design schematics.	Provides users with new capabilities through technological pieces and technical components for futher development.	Individual & Organizational Level.	Object Layer.
Pre-hacked	Refers to enabling design artefacts to develop on a continous manner through user preferences and alterations.	Creates full alteration processes for users to change and manipulate products or components for improvement and development.	Institutional & Organizational Level.	Object Layer.

Object layer of OD introduces terminologies about configurable and interchangable characteristics of tangible outputs, created by manifacturing and production processes. On a basic level, product design and tangible output knowledge plays a significant role on the implementation of OD approach. *Downloadable design* serves as a facilitation factor for this implementatiton process. Term basically refers to the downloadable nature of product details and technical guide lines for re-production and alterations (Atkinson, 2011). Eventhough terms emphasizes the free distribution of design knowledge, it does not necessarly points out the importance of user's participations or effects on end-results and thus it differs from the overall definition of OD (Boisseau, Omhover, and Bouchard, 2017). Production cycles and relevant methods build up crucial models to shape frameworks about implemention processes of OD as an approach to product development. *Meta models* contribute to this characteristic nature of the selected layer by refering to multiple sub-models of a broader production model. These sub-models enable users and participants to build connections between design attributes to create solutions and innovative outcomes by interventions and alterations according to their goals. *Open hardware* refers to a same approach but it focuses mainly on hardware and component capabilities.

Moreover, term focuses on design schematics and technical opportunities to facilitate production processes. It is also possible to observe OD's contribution to the creation of ongoing development processes for products and objects through *pre-hacked* approach. Unlike open hardware and meta models, pre-hacked refers to enabling design artefacts and related components to become developed on an ongoing flow with the help of users and non-designer participants. This means that necessary equipment and product properties are already avaiable to users for further development and improvement.

Table 3. Process layer terminologies.

Keyword	Definition	Significance	Usage Area	Layer
Open Fabrication	Utilization of fabrication spaces for knowledge and design distribution.	Enables the integration of digital production and development technologies to fabrication areas in order to create an open process for certain participants.	Organizational Level.	Process Layer.
Open Manufacturing	Refers to building up communication platforms for both designers and users to enable sustainable manifacturing practices.	Enables a connection between non-designer participants and professional designers in order to provide an efficient manifacturing flow.	Institutional & Organizational Level	Process Layer.

Table 3. (Continued). Process layer terminologies.

Open Production	Refers to user's or consumer's abilities to shape materials and production methodologies.	In terms of production methods, provides full access to overall processs of building-up product life cycles.	Organizational Level.	Process Layer.
Peer Production	Suggests a decentralized way of production and distribution of related technologies.	Distribution of the total process of manifacturing capabilities in an equal way during the overal system flow.	Institutional & Organizational Level	Process Layer.

Referring to fabrication processes of OD objects, process layer contains varied terminologies to expand user's perspective towards customization possibilities. One of the key aspects provided by this layer is the introduction of OD spaces, which created for manifacturing processes. The term o*pen fabrication* refers to these spaces by emphasizing the possibile integration between digital medium and conventional production technologies in order to utilize open approaches for participants (Philips et al., 2014). Through open fabrication and the emergence of related spaces, *open manufacturing* becomes a crucial term among the layer itself. It suggests connections between non-designer participants and professional designers through communication platforms and networks to enable knowledge sharing to create efficient methods on manifacturing processes as well as innovative outcomes (Gasparotto, 2017). *Open production* focuses on users on selected environments by referring to participants's capabilities on shaping up materials and new production methodologies through OD approach. Process layer also emphasizes the importance

of utilizing an inclusive approach by participatory practices. *Peer production* is one the main drivers of these pratices, since it suggests a decentralized method of shaping up new production ways and distributes knowledge in an equal way on multiple and varied participants.

Table 4. Practice layer terminologies.

Keyword	Definition	Significance	Usage Area	Layer
Co-creation	The generation of value, idea generation and implementation by more than one person.	Creation of value through/with customers and participants within business models.	Organizational Level.	Practice Layer.
Co-design	Creative co-operation and collaboration throughout whole design process.	Collaboration of multiple and varied experts or actors for co-operative thinking.	Organizatonal Level.	Practice Layer.
Mass Participation	Refers to the potential collaboration between large amount of participants, who work and design for the same goal.	Opens up the opportunity to observe work distribution between varied participants.	Institutional Level.	Practice Layer.

Table 4. (Continued). Practice layer terminologies.

Participatory Design	A process, where participants work and design collectively to achieve a common goal or target.	Empowerment of idea generation to maximize idea generating and designing.	Organizational Level.	Practice Layer.
Peer-to-Peer	In terms of design process and production capabilities, suggests a lateral approach to distrubute knowledge equally.	Democaraticaly distributed knowledge and design capabilities	Institutional & Organizational Level	Practice Layer

Pracite layer teminologies directly refers to the specifi time periods within design and production processes. Also considered as one of the foundational pillars of OD co-creation emphasizes the inclusion of customers and users to the designing phases to create a holistic envrionment where knowledge and value generation is evident. Following terminologies like; co-design, mass participation and participatory design act through a similar approach with small differences. For instance, while co-design process can focus on to a specific group when it comes to generating new products or services, mass-participation as it name suggests demands the potential contribution from large amount of people and participants in order to generate new value and outputs. When it comes to participatory design, the term focuses directly on the process itself as a practical manner rather then justifying the importance of the amount of participants. For participatory approach, it is important to maximize idea generation on design and related components like its usage, affordances and capabilities. Last term peer-to-peer considers design processes and production phases as unseperable steps. Throughout these two steps, term emphasizes a lateral approach rather than considering a hierarchical system. This way the design-based knowledge distribution becomes a democratized process and eventually each process become

enhanced in their respective operation methods.

Table 5. Infrastructure layer terminologies.

Keyword	Definition	Significance	Usage Area	Layer
Open Access	Making knowledge sources openly accessible to anyone without considering their afilliation and aim.	Democratization of knowledge distribution between multiple and varied participants.	Individual & Organizational Level.	Infrastructure Layer.
Open Authorship	Design solutions and outcomes, which enables users to adapt them into desired states.	Provides the opportunity of interference of non-designer participants to create an inclusive development process.	Individual & Organizatonal Level.	Infrastructure Layer.
Open Design Network	A network of systems which define the standarts and pre-compiled parts.	Builds up a controllable service flow for multiple participants	Institutional & Organizationl Level.	Infrastructure Layer.

Table 5. (Continued). Infrastructure layer terminologies.

Open Education	Refers to the accessibility of education and related knowledge for people who do not have sufficient ways of accessing to traditional and formal educational content.	In terms of open design, term has been used as a driving force on design education and knowledge sharing on academic contex.	Individual & Organizational Level.	Infrastructure Layer.
Open-ended Design	Design features and details which are taken away from their original states for easier iteration and manipulation.	High potential to observe the integration process between design and related participants	Individual & Organizational Level.	Infrastructure Layer.
Open Knowledge	Refers to accessible knowledge without any restrictions or prohibitons.	Enables rapid way of accessing related knowledge and physical attributes of any given object in an equally distributed way.	Individual & Organizational Level.	Infrastructure Layer.

Table 5. (Continued). Infrastructure layer terminologies.

Open Service	Refers to making products-systems and services accessible to public domain.	Complete collaboration with external participants and actors throughout the development process of product-system and services.	Organizational Level.	Infrastructure Layer.
Open Source Networks	Enables actors and participants to Exchange knowledge between large scale systems and institutional level networks.	Term signifies the ability to build up new service flows with the help of its network structure through varied actors and knowledge distribution processes.	Institutional Level.	Infrastructure Layer.

Table 5. (Continued). Infrastructure layer terminologies.

Open Source Innovation	Refers to creating a connection between multiple organizations to solve problems as their main focuses.	Rather that providing a centeralized work distribution, model provides equally distributed management and work flows.	Institutional & Organizationl Level.	Infrastructure Layer.
Open Source Intelligence	Refers to shaping-up a collective intelligence through micro-operating actors on large scale networks.	Points out the fact that their is a potential of collaboration generated by a larger number of people working on various tasks.	Institutional Level.	Infrastructure Layer.
Open Innovation	Converting external knowledge to internal potential of creating innovative acts.	Creation of new bussiness and opportunities for development.	Institutional Level.	Infrastructure Layer.

Infrastructural layer and its related terminologies signify the crucial institutional and technical factors around OD ideology to make it sustainable and avaiable for alteration under different circumstances. Service and system capabilities when combined with design attitudes provides knowledge based development on organizational and institutional level of operations. Accessing knowledge and the distribution of design to participants takes a significant spot on the overall process. Terms like *open access* for example, signifies the change of academic knowledge and information into openly accessible tools for anyone regardless of their aim and

affiliations (Pearce, 2012). Similar to open access, *open knowledge* also emphasizes the importance of making knowledge and its core features, wheter it is related to products or intagible outputs openly accessible to public domain without any restrictions or legal prohibitions (Powell, 2015). Sometimes, shared knowledge can alter itself to become design components or solutions, which would become a tool for users to alter, change and manipulate it according to their aims, this is called the *open authorship* (Herst, and & Kasprzak, 2016). *Open-ended design* takes this a step further by referring to the possibilities of taking design knowledge and solutions out from their original context to make alteration and re-shaping processes easier for users (Ostuzzi et al., 2017). Related to the open authorship keyword, *open education* refers to the accessibility of education and related knowledge for people who do not have sufficient ways of accessing to traditional and formal educational content (Ostuzzi et al., 2016*).* Following a more structural term, *open design networks* on the other hand compliments the discussion on a wider perspective. It refers to re-defined standarts and scales for assembly details, manifacturing processes and software utilization for the long term (Betthauser et al., 2014). Standarts which have created for design networks provide opportunities to build up *open source networks* as well. These types of network structures, rather than focusing on a centeral operative system, creates balance between multiple actors on large scale systems to distrubute work load equally and let its actors reach out to eachother in a more efficient way (Quilley et al., 2016). Through software usage, open source networks can provide innovative outcomes, this can result into the observation of *open source innovation* on different scales of institutional level operations. Open source innovation, means to create strong connections between sub-organizational divisons of an institution to solve problems in an efficient way. Each sub-division contains varied actors who are crucial for implementing the total system flow, to tolarate this process it is inevitable not to shape up an organizational culture and intelligence among each participant. *Open source intelligence* refers to the creation of this collective intelligence among micro-operating actors through pre-defined open network structures.

Institutional level operations through their sub-organized divisions can create products-systems and services to provide solutions to different issues. In order to implement this process, organizations can collaborate with stakeholders such as non-designers or public participants to stay more user oriented in terms of their product lines. *Open services* help organizations to make this collaborative process happen.

This way any given product-system and service development processes can contain external knowledge from stakeholders to create outcomes and solutions which are more relevant to user groups (Howard et al., 2012). Open innovation drives its core features as a term from the previous process, since it refers to converting external knowledge and information through observation to internal power and potential to utilize design and other related tools to create innovation and improvement. Chesbrough (2006) also adds the usage of external paths and options to seek out internal potential to create knowledge for further development and research.

2.5. Evaluation: Framing the Open Design Terminologies

Following evaluation presents the framing of OD terminologies according to their distinct utilization levels. Referring to the previously defined methodologies of OD and their distribution of distinct usage levels (systems, processes and tools), this section presents a new categorization and provide sufficient information to further explain the potential of OD on distribution of information and democratization of access to data. System level, for instance, through the peer-to-peer approach, deals with infrastructural capabilities, and acts as a main layer of executing data-based systems for managing design-based solutions. At the process level, co-design suggests the involvement of non-designers and other actors in the overall designing processes within the perspective of OD's ability to transform diverse knowledge into an integrated component within design teams and organizations. The final level, tools, and its sub-topics, co-creation and participatory design, focuses on mass participating actors in any given project within organizational and institutional structures. Following table configures itself as a toolbox of OD's methodologies and collects selected terminologies to present a brief summary of previous explanations. Table also summarizes the existing drivers of OD to illustrate each level's functions in terms of distributing design-based knowledge through each defined methodology.

Table 6. Open design methodologies and drivers

Levels	Methodologies	Existing Drivers of Open Design
Systems Layer	Peer-to-Peer	Diffused Systems Distributed Systems Decentralized Systems Centralized Systems
Processes Layer	Co-design	Dialogue Interaction Relationships Knowledge Exchange
Tools Layer	Participatory Design	Equity, Experience, Personalization Knowledge Sharing
	Co-creation	Democracy, Participation

CHAPTER 3: SPATIALITY OF OPEN DESIGN

This chapter focuses on the implementation processes of OD and its spatiality, contributed by the conceptual layers of the mentioned ideology named as process and infrastructural layers. As well as illustrating the contemporary status of fab lab ecosystems on a global context, chapter provides the main drivers behind the utilization of OD within the fab labs ecosysystems. Chapter highlights and briefly reviews the emergence of fabrication spaces and selects the specific ecosystem of fab labs as its core focus area through its significance and features. Contributed by the literature, chapter introduces the components of fab labs ecosystems as events, capabilities and networking to further explain the essential ecosystem tools for fabrication processes to become realized. With the evaluation part and the reconsideration of OD within fabrication methods, chapter not only introduces a certain criteria set to act as a guide for the implementation of the selected methodological approach for the upcoming phases, but also establishes the connection between components of fab labs ecosystems and OD framework.

3.1. Fabrication Spaces

In the last decade, the processes of design, production and manufacturing have gone through a significant change through the emergence of digital technologies, manufacturing tools and production techniques. This phase enabled the overall interest on manufacturing technologies to be considered as tools, which can become diffused and democratized in terms of accessibility (Gershenfeld, 2005). On a contemporary status, general public and professionals now have the opportunity to reach and utilize additive and advance manufacturing capabilities with the realization of fabrication spaces (Thiesse et al, 2015). These spaces incorporate the organizational structures, which can provide a set of manufacturing tools and technologies openly accessible to varied users (Mortara and Parisot, 2018). These kind of opportunities and facilitation processes on accessibility and transparent methods on fabrication and production, enable the process of innovation to become a democratized and evenly distributed concept for collaborators and participants. Academic literature and preliminary research show that, fabrication spaces have become crucial environments which act as enablers for the creation of new products and related practices to become realized through developing technologies.

Moreover, these spaces can boost co-creation processes or any project defined under the scope of open collaborative innovation projects (Baldwin and von Hippel, 2011). Through collaborative and democratized methods, rapid digitalization and technological development within the mentioned spaces enable socially innovative processes to alter the overall steps of fabricating and realizing ideas into a more shared and distributed concepts through digital mediums and tools.

3.1.1. Definition of Fab Labs

Referring to the activity on digital transformation and ongoing shift on the way to design, fabricate, produce and consume goods and services, these steps now have become cooperative processes where it is possible to trace user activity, who can become the main actor or a vital part on the given procedures (Savastano et al, 2017). Thus, the overall relationship between users and design and production has altered itself to become a democratized process, fueled by the emergence of openly accessible fabrication spaces and environments where users have the ability to become active collaborators and producers of knowledge based projects and proposals (García-Ruiz and Lena-Acebo, 2022). These newly emerged spaces defined as "Fabrication Laboratories" (fab labs) have become an integral part of communities by providing advance capabilities like; learning processes, designing, prototyping, production opportunities for both tangible and intangible assests through predefined equipments and manufacturing tools for users and non-professionals to realize their ideas and projects via knowledge sharing and diffusion processes (Naboni and Paoletti, 2015; Mortara and Parisot, 2016; Blikstein et al, 2017; García-Ruiz and Lena-Acebo, 2022; Soomro, Casakin and Georgiev, 2022). Furthermore, they have also been considered as collaborative spaces which enable innovation, contributed by development through the exchange of information and knowledge between its participants (Wolf et al., 2014).

3.1.2. Emergence Of Fab Labs

Emerged back in the early 2000s as a subject output from Massachusetts Institute of technology (MIT) with the contribution of Proffessor Neil Gershenfeld and his students from his course, project's initial aim was to provide opportunities for students to make them able to convert their knowledge and ideas into reality with the help of techonological tools and hardware (Cohendet, Grandadam and Suire, 2021). Starting from the beginning to the end, project continued to assist students and future generations on how to design and produce artefacts as well as how to disseminate

localized production processes and bottom-up experiences for the community and territorial aspects in which they will be used (Lena-Acebo and García-Ruiz, 2019, cited in Vacanti, Tumay and Vian, 2019, p.56). Today, "The Fab Foundation" acts a global hub for fabrication and manufacturing related acts and collaborative movements, to promote the digitalization process of creating and designing any tangible or intangible assest (The Fab Foundation, 2023). According to the foundation's contemporary definition, the given space can be considered as "a technical prototyping platform for innovation and invention, providing stimulus for local entrepreneurship. A Fab lab ecosystem is also a platform for learning and innovation; a place to play, to create, to learn, to mentor, to invent" (Getting Started with Fab Labs, The Fab Foundation, 2023). Derived from their initiative, "The Fab Lab Network" now acts as an open creative community of fabricators, artist, scientist, engineers, educators, students, amateurs and professionals located more than 100 countries and 1,750 Fab labs across the globe (The Fab Lab Network, 2023).

3.1.3. Nature of Fab Labs

In October 20, 2012 The Fab Charter of MIT provided a brief and an explanatory list on the fundamental aspects of fab labs to further open up the true nature of the selected ecosystem, in terms of their features, provisions and possible opportunities for users and participants (The Fab Charter, 2012);

- *What is a fab lab?*

Fab labs are a global network of local labs, enabling invention by providing access to tools for digital fabrication.

- *What's in a fab lab?*

Fab labs share an evolving inventory of core capabilities to make (almost) anything, allowing people and projects to be shared.

- *What does the fab lab network provide?*

Operational, educational, technical, financial, and logistical assistance beyond what's available within one lab.

- *Who can use a fab lab?*

Fab labs are available as a community resource, offering open access for individuals as well as scheduled access for programs.

- *What are your responsibilities?*

Safety: Not hurting people or machines. *Operations:* Assisting with cleaning, maintaining, and improving the lab. *Knowledge:* Contributing to documentation and instruction.

- *Who owns fab lab inventions?*

Designs and processes developed in fab labs can be protected and sold however an inventor chooses, but should remain available for individuals to use and learn from.

- *How can businesses use a fab lab?*

Commercial activities can be prototyped and incubated in a fab lab, but they must not conflict with other uses, they should grow beyond rather than within the lab, and they are expected to benefit the inventors, labs, and networks that contribute to their success.

3.1.4. Significance of Fab Labs

Multiple examples from the literature have considered the significance and importance of fab labs from varied perspectives. Following part will explore and discuss these considerations to higlight the crucial aspects and contributions of the defined ecosystem to design and generation of new prodcust and services. In terms of application of design based methods, Soomro, Casakin and Georgiev (2022) consider fab labs as a driver for creativeness and propose a strong yet a brief review on the academic literature to present related contributions around the topic. According to their review on the selected space, utilization of digital technologies and tools, enable fab labs to become crucial ecosystem models for those who are wiling to enhance their creative capabilities and idea generation.

> *"Digital fabrication technology used in fab labs and makerspaces affects users' thinking, ideas, creation skills, and the ability to produce creative solutions in a wide variety of domains such as art, science, and engineering."* (Soomroo, Casakin and Georgiev, 2022, p.2)

An another approach with the same perspective has been percieved by Culpepper and Gauntlett (2020) by stating the fact that, maker spaces and fab labs are settings for generating creativy and fostering individual curiosity towards any topics and concept. They argue that, given spaces can be altered into creative platforms to make users understand and learn about themselves as well as other co-creators by

generating and sharing knowledge. Furthermore, Wolf et al (2014) realizes this feature and considers the given ecosystem through the lens of OD and its core mechanic on enabling democratic and transparent methodologies and approaches to signify the democratization and equal distribution of knowledge and data for social development and change.

Moreover, the literature underlines the importance of the issue by stating that, all pieces of knowledge and data created within the fab lab ecosystem should become freely accessible intellectual outputs for other participants and collaborators to utilize to propose collective solutions and ideas on varied topics and issues, since it is a foundational feature of fab labs as an important example of maker spaces (Gershenfeld, 2005; Blikstein, 2013; Cohedent, Grandam and Suire, 2021).

3.2. Fab Labs: A Global Context

Formed back in 2009 in United States, to facilitate and tolerate the overall growth of the international fab lab network on the global scale, "The Fab Foundation" acted as the main non-profit organization on providing beneficial opportunities for society and communities to empower them through promoting digital fabrication capabilities, open access on technological components, fabrication tools and technologies (The Fab Foundation, 2023). Foundation's core purpose is to make anyone become capable of fabricating and creating (almost) anything, starting from a personal scale to provide positive impact and outcomes on social scales. Formed within the Boston MIT Center for Bits and Atoms, starting from the beginning to the end, project continued to assist students and future generations on how to design and produce artefacts as well as how to disseminate localized production processes and bottom-up experiences for the community and territorial aspects in which they will be used (Lena-Acebo and García-Ruiz, 2019, cited in Vacanti, Tumay and Vian, 2019, p.56). Today, "The Fab Foundation" acts a global hub for fabrication and manufacturing related acts and collaborative movements, to promote the digitalization process of creating and designing any tangible or intangible assets. According to the foundation's contemporary definition, the given space can be considered as "a technical prototyping platform for innovation and invention, providing stimulus for local entrepreneurship. A fab lab ecosystem is also a platform for learning and innovation; a place to play, to create, to learn, to mentor, to invent. (Getting Started with Fab Labs, The Fab Foundation, 2023)

Derived from the original initiative of The Fab Foundation, “The Fab Lab Network” now acts as an open creative community of fabricators, artist, scientist, engineers, educators, students, amateurs and professionals located more than 100 countries and 1,750 fab labs across the globe (The Fab Lab Network, 2023). According to their statement, their aim is to provide constant and sustainable improvement on manufacturing technologies, personal fabrication tools and to digitalize fabrication for future development and possibilities (The Aim of the The Fab Lab Network, 2023). To provide a narrowed down approach, starting from the overall picture to the selected geographical framework for the implementation of the overall methodology, following figure represent the current picture on the distribution of each fab lab around the globe.

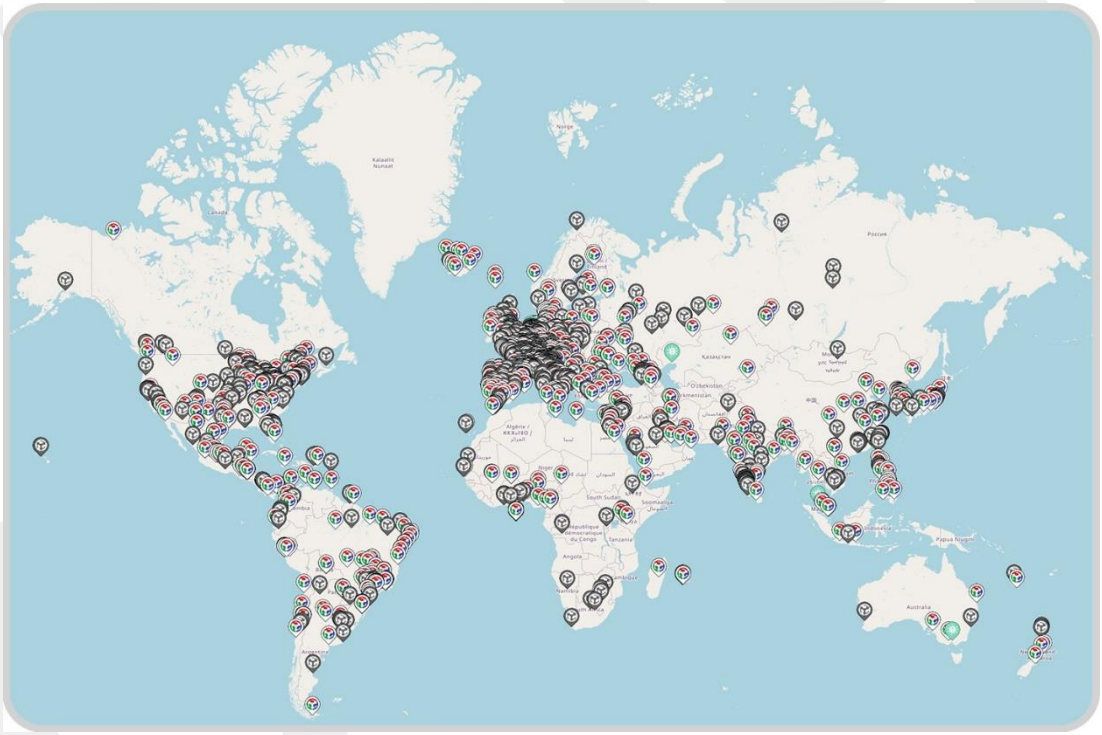


Figure 5. Contemporary map of fab labs on a global scale (source: fablabs.io, 2022)

When analyzed, it is possible to observe several organizational structures of Fab Foundation, which they have defined as global initiatives. According to the foundation, each initiative serves the total goal and mission of the foundation itself for further implementation and diffusion of the maker culture on the global level (The Global Initiatives of The Fab Foundation, 2023). Following part briefly covers each of them to showcase the contemporary structure of the considering fab lab ecosystem as global level initiatives.

- *FabX Event*

FabX event consist of online and international conferences which host members of over 2,000 worldwide fab labs to let each participant discuss, share and collaborate on topics regarding digital manufacturing, innovation and technology.

- *Fab Research*

Fab research dedicates itself to learning and education capabilities through digital archives of manufacturing projects and academic contributions of varied researchers around the globe. Initiative also provides online library to let anyone reach to related terminologies and data in an open manner, regarding the evolution of fab lab environments and the maker culture.

- *Fab City Global Initiative*

Fab City defined as a global initiative, focuses on promoting and enabling locally productive and globally connected self-sustaining cities and networks. According to initiatives definition, it is a new urban, economic, social and industrial model that redefines production to the city and its bioregional context. It is a challenge to transform how people produce and consume (almost) everything.

- *The Resilience Collective*

The Resilience Collective is an initiative which consists of multiple development, research and humanitarian organizations working together with the utilization of design, testing and documentation capabilities to define a collective effort on help most vulnerable populations and community groups.

- *Future Workforce Now*

Future Workforce Now brings together pioneering economic, education, industry and workforce experts together to make them become able to share knowledge and expertise on technological trends, which heavily effect the current and the future state of workers and workplaces.

- *Fab Economy*

Fab Economy defines a community-based business platform. It aims to define a new economic system for everyone, where local manufacturing and customization is the core element on the overall systemic approach. According to the foundation, given initiative is an exchange space, where companies can collaborate and work together with the members of fab labs.

- *Fab House*

Fab House is an intersective initiative, which operates between digital manufacturing and human capital. Focused specifically on the selected vicinity of Cleveland, Ohio's Glenville neighborhood, provided initiative aims to provide community development through the stabilization of neighborhood scale with the aid of certain residency programs. With the help of the initiative anyone within the initial neighborhood would have access to digital manufacturing tools and methods.

Fab Foundation also provides multiple academy programs under the name of "Academany" to strengthen the process of diffusing maker culture and digital fabrication tools (Academany Programs of The Fab Foundation, 2023). Starting from fabrication, synthetic biology to interactive textile capabilities and productions, their operational spectrum became eve larger in terms of education and knowledge sharing trough varied topics. Currently it is possible to analyze three main academies as global level organizations: *Fabacademy, Bioacademy* and *Fabriacademy*. Following, briefly explores each academy to further investigate the status of the influence of fab lab and maker culture in terms of education capabilities and options.

3.3. Components of Fab Labs

Derived from the provided data from the network, in order to shape a well-defined framework for the future implementation of the selected methodology, fabrication processes within fab labs can be re-defined under certain components in terms of their provided *capabilities* to users, their activities regarding *events* and organizations, their strategical partners and stakeholders which study defines as *networking* options within the maker culture and design-based knowledge generation and distribution through varied processes.

Based on the literature review and analysis of the emergence of fab labs in the global context, the following figure conceptualizes the features of fab labs and presents the significant features of each defined component within the structure of the given ecosystem. Each component refers to the fundamental features of the given ecosystem to users, makers and other participants on the fabrication processes. The component of *capabilities*, refers to the basic machinery and technologies within the fab labs and presents the fundamental tools for producing new products, systems and outputs. *Events*, as a component group refers to a more individual level of learning and fabricating through workshops, seminars, maker training programs and exhibitions. Last component group of *networking* refers to each fab labs connections

with external services and system structures. In some cases, these connections can become realized through collaborations with govermental bodies, institutions, universities and international organizations as well. Each component of fab labs allows study to create a vital connection between OD framework through its previously defined conceptual layers in chapter 2. When taking a closer look, fab labs as ecosystems, define openly accessible service models for multiple participants in order for them to collaboratively create through digitally accessible and re-usable product components. Within this process, it is also important to remember the significant contribution of manufacturing tools to production and creation processes. Following part focuses on this connection and reconsider open desgin process within the lens of fabrication processes. In order to explain the connection between the conceptual layers of OD and the current components of fablabs ecosystem, following part refers to the prelimenary work defined in the previous chapter.

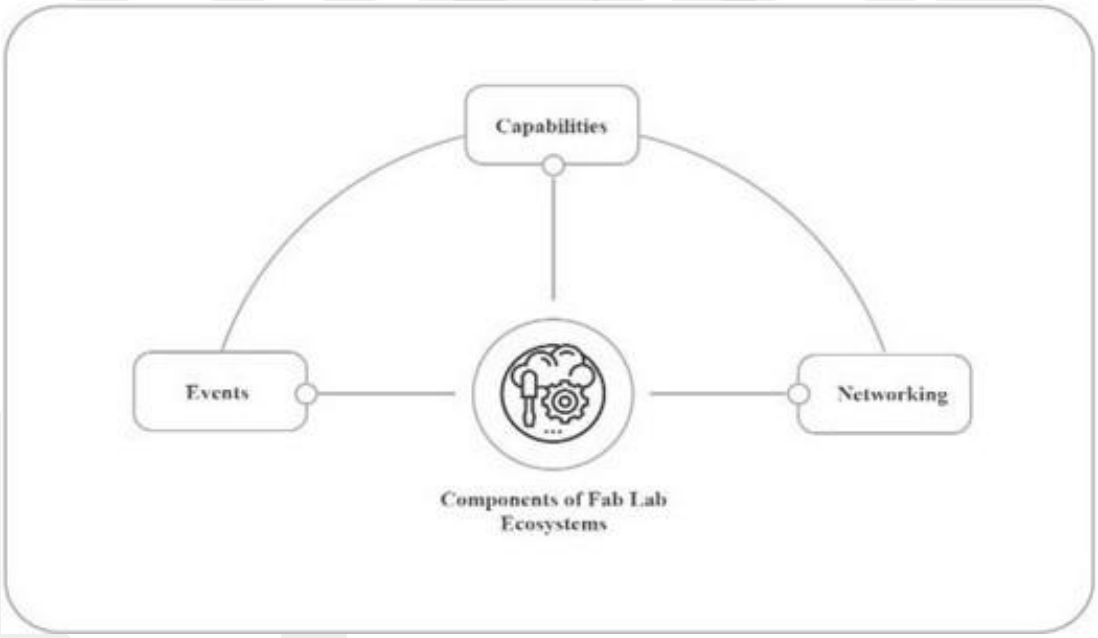


Figure 6. Components of fab labs ecosystem.

3.4. Evaluation: Reconsidering Open Design for Fab Labs

Both on manufacturing procedures and for creative processes, OD can create transparent ways of distributing knowledge and design-based idea generation as well as creation of both new tangible and intangible outputs.

> *"Open design provides individuals with the 'source code' to make, adapt and disseminate their own products with the assistance of digitally enabled tools, such as CNC machines, 3D printers and laser cutters."* (Gershenfeld, 2005, p.15)

These features enable OD to provide access to design information and knowledge, as well as optimization on outputs through the creation of new products, systems and service structures to control inputs with the help of digital fabrication and rapid manufacturing techniques (Philips, Baurley and Silve, 2014). In terms of the given explanations, it is appropriate to consider OD and its key utilities as vital methods within the usage of fabrication tools to manufacture, distribute and diffuse design-based knowledge through technical capabilities.

Reconsidering OD through the lens of fabrication processes enables overall research to define and refers to the conceptual layers of OD. These layers have been mentioned as vital methodological steps to enable the potential integration of OD within the defined lens. OD carries significant features which are related and interconnected with each other through varied conceptual layers. As mentioned previouly on chapter 2, OD has been considered within four main layers: *object, process, practice* and *infrastructural*. Each of them refers to this interconnected relation which suggests a flow of implementing OD within varied context and practices. Related to the given conceptual layers within OD framework, Aitamurto, Holland and Hussain (2015) introduces a new perspective, in terms of considering OD through OP and design research. To provide a concise approach, selected work discusses OD's conceptuality in terms of its contribution to design and fabrication processes through three new layers and mentions that at least one these following layers can occur during OD processes: *listening in*, *interacting and creating with* and lastly *sharing with*. Initial layer (listening in) defined by the selected work, suggests the usage of online and digital tools for designers to reach data and knowledge about user needs beyond their reach. Furthermore, layer also emphasizes the potential contribution of crowd to the definition of product requirements and production techniques to impact the outcome. For the next step, secondary layer (interacting and creating with) suggests the change of roles between designers and users. Throughout this process, designers become the main observers by letting non-designer participants use design-based tools and knowledge to enable co-designing and co-creation. Third and the last conceptual layer (sharing with) refers to make design and other blueprints of certain product aspects publicly accessible, whether they are source related data or hardware details. Layer expands its scope by suggesting the usage of additive production and fabrication technologies like 3D printing tools to

create an easiness on making design-based data accessible and transparent in a more efficient way.

Since open design refers to the free distribution, documentation and accessibility on creating multiple variations of an object, product or service (Van Abel et al., 2014), its influence on fabrication processes is a crucial aspect to consider for further analysis to prepare the overall research on examining the emergence of socially innovative solutions through the development of new products, services and programmes within the selected ecosystem. To explain the influence of OD concept within the fab labs and to signify key drivers on implementing the term as a method, following part utilizes the previously defined conceptual layers of OD. Within the provided framework, research selects and focuses on process, practice and infrastructural based conceptual layers to narrow down the overall approach within theoretical framework. Since fab lab ecosystem refers to the importance of process-based design and knowledge generation through practices within infrastructural capabilities, signification of drivers was selected accordingly to the narrowed categorization. As a result, three main drivers were selected from the defined categorizations as sub-topics within the OD framework: *open fabrication*, *co-creation* and *open service*. Each three driver refers to the terminology of OD and related their key utilities with fabrication processes and in terms of this nature, each three of them were considered as essential drivers on practicing OD within the lens of fabrication tools and capabilities. In their paper, Bakırlıoğlu and Kohtala (2019) propose a significant attempt to frame OD through theoretical concepts and practical implications, plus its influence on emerging technologies in terms of fabrication tools. According to their contribution, they mention the fabrication process within the categorization of "open fabrication". From a relevant perspective, (Phillips et al, 2013) consider open fabrication as the potential driver on accessing to varied fabrication tools and manufacturing capabilities through digital parts and component for users. Following with the second essential driver and also a foundational pillar of OD, co-creation plays an important role in terms of practicing OD ideology through collaborative approaches. On a basic level of understanding,

> *"co-creation refers to any act of collective creativity, i.e., creativity that is shared by two or more people."* (Sanders and Stappers, 2008, p.6)

While this definition broadly true, Fleischmann, Hielscher and Merrit, (2016) considers co-creation within digital fabrication processes and refers to the term as a

unique process which allows users and collaborators to benefit from a service, product or procedures to be developed or improved to actively participate on the creation processes. As the third and the last essential driver, open service defines a specific process, which refers to the development of new design outputs and outcomes with the collaborative and supportive aspects in terms of external knowledge sharing from the crowd, users, stakeholders and participants (Howard et al, 2012). The table below summarizes the essential drivers for OD which significantly contribute to the fabrication processes and concludes the evaluation phase in a concise approach.

Table 7. Essential drivers of open design within fabrication processes.

Open Fabrication	***Co-creation***	***Open Service***
Ability to access digital tools and components to enable fabrication processes (Phillips et al, 2013).	Active participation from users to creation processes (Fleischmann, Hielscher and Merrit, 2016).	Distribution of external knowledge from specific actors like crowd, users and participants (Howard et al, 2012).

CHAPTER 4: EXPLORING THE ECOSYSTEM OF FABRIKALAB İZMİR

This chapter investigates the OD processes within FabrikaLab İzmir in Alsancak/İzmir through the lens of essential drivers of OD in fabrication processes and the components of fab lab ecosystems, unified under the definition of "units" (which were previously defined in Chapter 3). The chapter starts with the introduction to the emergence of FabrikaLab İzmir through exploring its vision and mission plus contributed by its evolution within the city of İzmir as a guided project under the collaboration of İBB and IZKA. Chapter proceeds with explaining its method and its execution via the introduction of preliminary study of field research through specific phases. Referring to the previous explanations of the overall methodology on the first chapter, given chapter opens each phase to identify the mentioned preliminary approach to emphasize the total approach before proceeding into evaluation of the findings. As a case study, selected ecosystem of FabrikaLab İzmir has been analyzed within the national context of Türkiye, where chapter reconsiders each 17 fab labs within the geographical regions of the country within the lens of essential drivers of OD in fabrication methods and fab labs ecosystem components. Thus, positioning of each fab lab within Türkiye, identified the status of each fab lab in terms of their utilization of OD approach in regards with the essential drivers (co-creation, open fabrication, open service) and the ecosystem components of fab labs (capabilities, events, networking). After establishing the overall framework and the lens to evaluate the selected ecosystem as a case, chapter proceeds with presenting the selected organization's internal structure to analyze its operational and technical infrastructure, plus with its current networking capabilities. Chapter ends by the analysis of each finding, their synthesis, the evaluation of the overall key findings and discussion to understand the core dynamic between ecosystem components and OD drivers for fabrication processes through ecosystem units. To conclude the mentioned process, chapter presents the overall ecosystem components of the respective structure of FabrikaLab İzmir as the output of the evaluation section.

4.1. Emergence of FabrikaLab İzmir

As a significant result of the project titled as "İzmir City College Guided Project" which supported by the collaboration of İBB and IZKA, FabrikaLab İzmir has been

established as an innovative fabrication space. Initiated back in 25.12.2014 and ended in 31.12.2017, project aimed to reduce unemployment rates within the city, while focusing on creating added value through local economic growth and development (Completed Projects of İzmir Metropolitan Municipality, 2023). According to (Bingöl, 2019), this four years of project development period has resulted into the agreement on making the provided space as an operational area for citizens to utilize and contribute. Selected dissertation also further suggests that FabrikaLab İzmir provides citizens with high technology tools and education services to make every participant become collaborative to realize innovative outcomes.

FabrikaLab İzmir has a specific vision toward supporting and tolerating new and innovative business ideas proposed by citizens and entrepreneurs, as well as focusing on the local development to help eliminating unemployment on a city-wide scale through vocational trainings. While creating added value on a social base, FabrikaLab İzmir aims to become an efficient organization, which acts as an educative fabrication ecosystem to accompany varied users and citizens to gain new skills and attributes in terms of earning new professions. In terms of its user and participant profile, the activity regarding the population of young unemployed, women, individuals who are willing to improve their skills towards specific professions and students who want to develop their ideas to further stages are evident (Bingöl, 2019).

According to their statement, FabrikaLab İzmir contains certain essential values within their own organizational culture to shape their mission (Vision of FabrikaLab İzmir, 2023). Following list presents each value to further explain the overall positioning of the organization.

- Being honest, reliable, fair and impartial.
- Protecting and sustaining the public and general interest.
- Being transparent to society.
- Participatory management approach.
- Citizen satisfaction.
- Respecting the law and ethical values.
- Respecting the historical context and nature.
- Utilizing technological and scientific development.

- Accessibility of information.
- Being open to change and development.
- Using resources effectively and efficiently.
- Being solution oriented.
- Sustainability in local development.
- Effective diffusion of organization's value and goals.

In terms of the organization's mission, FabrikaLab İzmir focuses on reducing the unemployment rate within the society by encouraging vocational and technical training through fabrication tools and components. Furthermore, through collaborating with relevant institutions and organizations FabrikaLab İzmir aims to increase the welfare of citizens. When it comes to their main mission, organization aims to contribute to encouraging creative thinking and creating design environments, where varied users and entrepreneurs act and utilize (Mission of FabrikaLab İzmir, 2023).

In order to present a concise approach, following information presents the overall development history of the FabrikaLab İzmir from organization's official website in a chronological way. Positioned under the directorate of İBB's Vocational Factory, which is an operational body within Social Projects Department of the municipality, the organization has been established under the name of "FabrikaLab İzmir" back in January 2018. FabrikaLab İzmir carries a unique feature, since it was the first ever fabrication laboratory in Türkiye to has been established and developed by a certain municipality. Throughout of its development, it has also become a member of The Fab Foundation to support the open-source movement and openness ideologies. Between 30.01.2018 and 19.05.2020, the organization operated for citizens and varied participants in Halkpınar/İzmir until it has been decided to change its initial location. According to their official statement, in order to make the given lab more effective on usage and utilization for citizens, it has been relocated on "Historical Coal Gas Factory Youth Campus" on Konak District (Alsancak Neighborhood) of İzmir on 19.05.2020 to operate under the newly created division of "FikrimİZ" (History of FabrikaLab İzmir, 2023). The lab still operates to this day to allow anyone who is willing to learn, design and distribute knowledge and technical skills regarding manufacturing and fabricating new outputs.

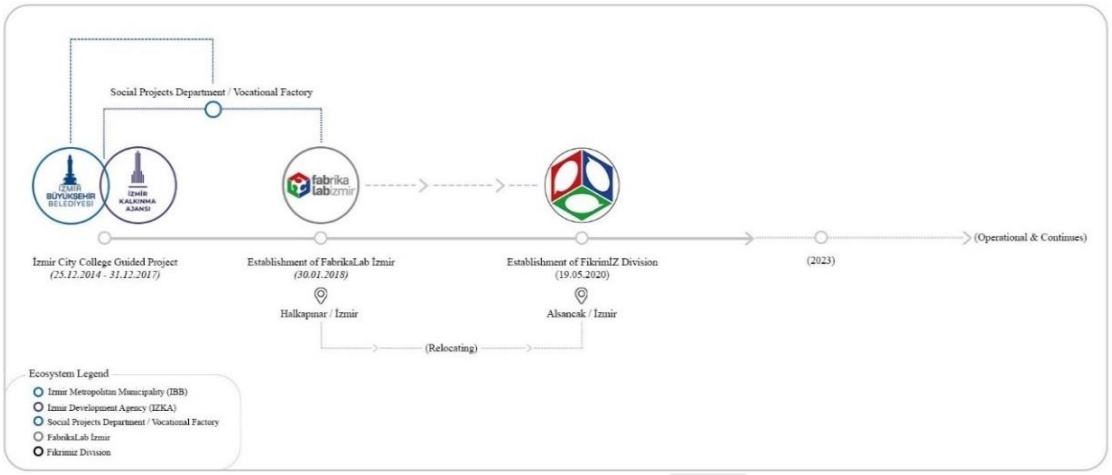


Figure 7. The evolution of FabrikaLab İzmir.

4.2. Methodology

After defining the contemporary status and the emergence of the selected case, as a preliminary approach, a field study has been realized to further understand the total ecosystem of FabrikaLab İzmir through observation and a pilot survey to the personnel of the selected lab. From a service design standpoint, each professional personnel within the ecosystem were considered as the main actors within overall operational service and system scheme of the selected lab. This enabled research to identify certain attributes and roles of each participant regarding the components of the fab labs ecosystem. Given preliminary phase enabled research to identify the significance and the utilization process of OD while considering each component of the ecosystem as its essential factors. As a final stage, an in-depth interview has been applied on the selected personnel to further investigate the contribution of OD and its significance within fabrication processes. Following breaks down each phase to further identify the overall application of each methodological approach.

1. Preliminary Research: Field Study

As a preliminary approach, a site visit has been conducted to comprehend and understand the status of the FabrikaLab in Konak/ İzmir on on 5 th of January 2023 between 10:30 AM and 12:00 PM. Within the scope of this visit, methods consisted of individual observation and a pilot survey have been applied to examine the implementation and integration processes of OD to fabrication procedures to realize new products, services or systems. Each mentioned approach has been considered as an initial field study, which enabled research to become familiar with the overall organizational and operational ecosystem of the selected case. Following section explains each methodological approach on a chronological structure to further

explain the preliminary findings.

- *Observation*

Observation method has been applied on the provided spatial aspects of the selected area to further understand the infrastructural capabilities of the Fabrikalab İzmir. During the field study it has been observed that, FabrikaLab İzmir provide multiple options in terms of fabrication tools and digital software to users and other participants. The fist site visit was conducted on 5 th of January 2023, on "Historical Coal Gas Factory Youth Campus" on Konak District (Alsancak Neighborhood) of İzmir, where the organization has been relocated. It has been observed that the overall organizational structure consisted of a lateral approach with five employees, who have been defined as the main personnel on delivering the total scope of the service and management of the selected area. Moreover, the general infrastructural and spatial aspects of the organization have been observed through identification of varied and multiple manufacturing tools, 3D prints, CNC machineries and the distribution of each fabrication tools on the provided space of the lab.

- *Pilot Survey*

A pilot survey was conducted on 5 th of January 2023 with the contribution of the personnel of FabrikaLab during the initial field study, to identify the necessary improvements on the general structure of the questionnaire (Appendix. A). Given phase also enabled research to identify how OD ideology has been represented and applied within the organization's main operational procedures. As well as highlighting the contemporary status of the usage of OD within the mentioned ecosystem, survey's main goal was to identify how each actor within the lab's ecosystem would consider the significant contribution of OD approach for realizing new outputs on different levels. To realize this goal, derived from the previously defined essential drivers of OD and each component of fab labs ecosystems on Chapter 3, certain criteria set has been curated within the overall flow of the survey. While considering fabrication and creation of new outcomes on both tangible and intangible levels such as generating value, survey aimed to find out the general picture of the ecosystem of FabrikaLab İzmir through following points; infrastructural capabilities, events, networking and additionally services which FabrikaLab İzmir outsource to sustain their own operations. Each participant was questioned face-to-face within and approximate time of 20-30 minutes. Regarding the initial feedbacks from the participants, several revisions were made accordingly

on the questions and the overall flow of the survey itself to finalize the general structure. Following table presents the overall pilot survey structure.

Table 8. Pilot survey and interview structure

NO.	OCCUPATION	ECOSYSTEM ROLES	INTERVIEW DATE	INTERVIEW TYPE	INTERVIEW DURATION
1.	Metalurgical and Materials Engineer	Branch Manager	05.01.2023	Face-to-face, semi structured not recorded, took notes	00:22:27
2.	Software Engineer	Software Expertise / Maker / Instructor	05.01.2023	Face-to-face, semi structured not recorded, took notes	00:21:12
3.	Industrial Designer	Project Manager / Designer / Instructor	05.01.2023	Face-to-face, semi structured not recorded, took notes	00:26:35
4.	Industrial Engineer	Strategist / Maker / Instructor	05.01.2023	Face-to-face, semi structured not recorded, took notes	00:27:22
5.	Mechanical Engineer	Designer / Instructor	05.01.2023	Face-to-face, semi structured not recorded, took notes	00:23:48

2. Snowball Sampling

To understand the total effect of İzmir's emerging innovation ecosystem and varied contemporary interventions made by the municipality to support the creation of a design-based city, snowball sampling method was utilized to enlarge the scope and reach to different actors who were and still a part of the generated fabrication ecosystem of FabrikaLab İzmir. The main justfication behind the given methodological selection was to identify and understand how varied participants from different occupational backgrounds diffused within the mentioned ecosystem and what kind of roles they have played in terms of shaping up the main system and service delivery of FabrikaLab izmir. Referring to the previously mentioned and utilized criteria set from the analysis of the literature on OD framework in fabrication practices and fab labs ecosystems, the exponential discriminative snowball sampling method was selected as the main driver on the selection of each participant from varied occupational backgrounds. Within the scope of the given approach six participants (P1, P2, P3, P4, P5, P6) were determined and reached in order to proceed with the selected methodology. Each participant were selected according to their previous and current roles around the selected ecosystem and how they have been potentially utilized each ecosystem components within the framework of varied goals and purposes. Following figure represents the overall process of identifying each potential subject through multiple referrals and how they have been recruited and considered as viable participants within the scope of research aim and focus.

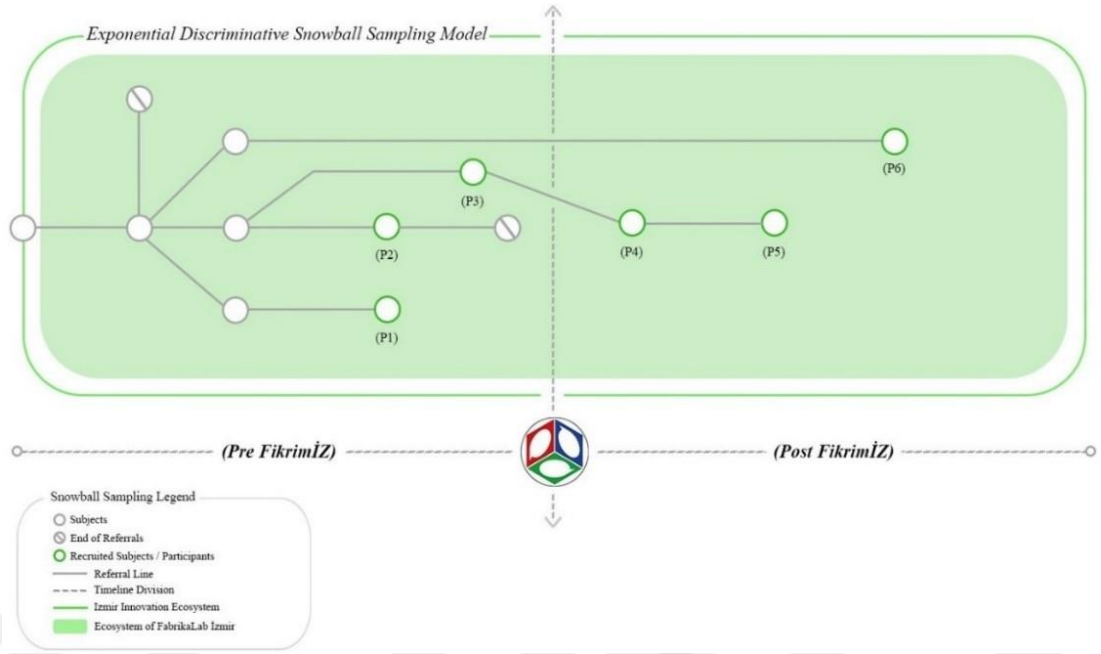


Figure 8. Exponential discriminative snowball sampling process.

On 24 th of February 2023, an academician from TU Delft University who was an active participant and a director for the development project of the selected lab under the municipality, an ex supervisor of FabrikaLab İzmir, now working as urban designer at Izmir Metropolitan Municipality, an ex design and event coordinator of the selected lab, a lecturer from İzmir Kavram Vocational School, the current supervisor of FabrikaLab İzmir and the current software expert of it have been reach via e-mail to collect the data regarding the research question and the investigation on the overall ecosystem. After the selection process under the snowball sampling, it has been obsevered that the overall distribution of each participant had the potential to be categorized into different timelines. While considering the establishment of FikrimİZ divison as the main timestamp whiched defined as a new operational body within the organizational structure, each participant has been distributed to two main timelines described as *pre-FikrimİZ* and *post-FikrimİZ*. This way, it has become possible to identify and track how each selected participant were distributed on the overall system and service scheme of the selected case as well as their contributions to the whole ecosystem from different perspectives on an actor-based level. Following figure visualizes the distribution process on to the mentioned timeline.

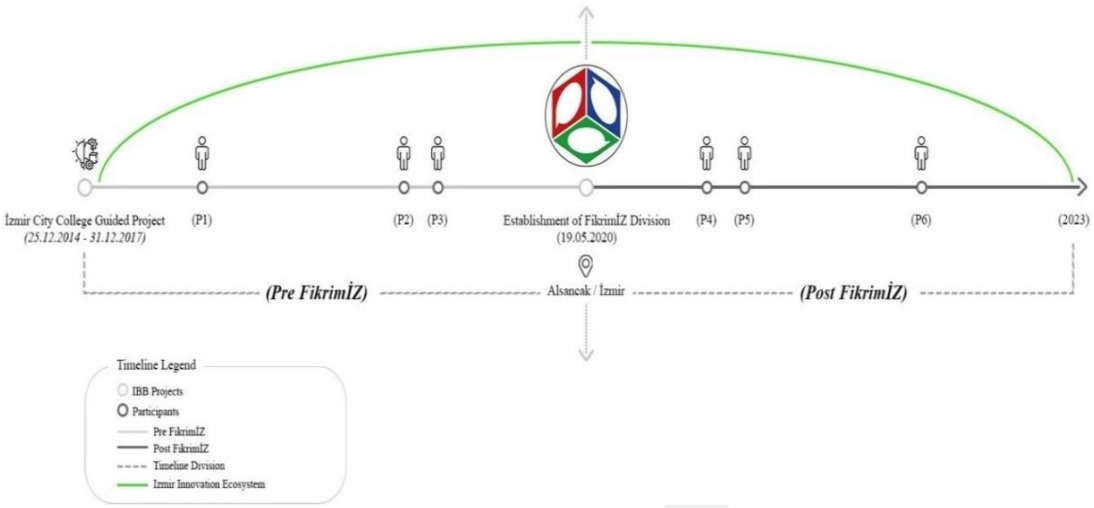


Figure 9. Distribution of participants on two main timelines.

The distribution of each participant on the defined timelines related to the establishment of FabrikaLab İzmir, presents the overall view and the positioning of each selected professional actor within the given ecosystem model. It is important to mention that, for both timelines the inclusivity of the previously analyzed innovation ecosystem of İzmir is apparent, thus making the total structure a purposely defined system model dedicated to realize innovative outcomes outputs.

- *In-depth Interview*

To identify the data and proceed with the methodology, under the snowball sampling process an in-depth interview format was defined via the revisions and feedback from the initial pilot survey process in terms of formating of questions and shape up the general structure of the interview and the questionnaire (Appendix. B). Since snowball sampling process has referred to varied participants who have been distributed into two main timelines, participants were asked to answer the questions according to their own experiences and time periods which they have been a part of the selected ecosystem. This allowed methodology to identify how each actor has become a part of the selected case via different occupational backgrounds. Each participant were informed about the theoretical background of the study and the overall scope of the dissertation before the interview started to make them become used to the terminology regarding openness ideology and fabrication processes. Due to scheduling conflicts and distancing, a hybrid approach was conducted during the application of each interview. Each three participant distributed on the timeline depicted for the period before the establishment of FikrimİZ division were interviewed online through zoom meetings platform. On the other hand, each

participant from the current timeline after the establishment of the division were interview face-to-face, since their actor-based roles and responsibilities regarding the utilization of the ecosystem were accessible during that time. Each participant were questioned approximately 40-50 minutes and with their consent each session were recorded for further analysis of the findings. The questionnaire has been divided into six main categories which define the overall flow of the interviews. Questions were specifically focused on the FabrikaLab İzmir and the surrounding innovation ecosystem to understand the overall utilization of OD framework for fabrication. Following presents each topic of the provided question sets to participants.

- *Infrastructural Capabilities:* Focuses on the overall technical equipments and spatial capabilities regarding the usage and utilization of the lab itself.
- *Networking:* Focuses on both the internal and external partners and collaborators of FabrikaLab İzmir to map and identify the reach of connection with users, collaborators, experts etc.
- *Services:* Section was added to the questionnaire to identify what kind of services does FabrikaLab İzmir get externaly to sustain their own service and system delivery.
- *Events:* Focuses on examining how FabrikaLab İzmir comes together with users, participants and citizens and what kind of events have been conducted under their management to diffuse the culture of design and fabrication.
- *Participatory Approaches:* Section was defined under the category of *events* to further investigate and understand which kind of participatory approaches (co-creation, co-design, participatory design) have been applied throughout different events and organizations. Each three sub-term were derived from the foundational aspects of OD framework to further investigate and understand how FabrikaLab İzmir conveys and utilize each mentioned aspect within their event types.
- *Open Design:* Final categorization focuses on the usage and integration of OD within the lab and the related ecosystem to identify if the framework has become a part of the selected case and related operations under the structure of its overall service delivery.

While generating each question set the previously defined essential drivers of OD in fabrication processes and the fab labs ecosystem components were reconsidered to

shape the structure of the interview. This way, related to the proposed research question, the overall analysis was able to understand how the ecosystem of FabrikaLab İzmir operates.

The figure below provides an initial attempt on creating the connection between two main spectrums and summarizes the evident influence of essential drivers of OD on fabrication processes. These drivers will be investigated on the following sections to further explain how OD is practiced within fab labs as well as how they have been correlated with the provided components of fab labs ecosystem.

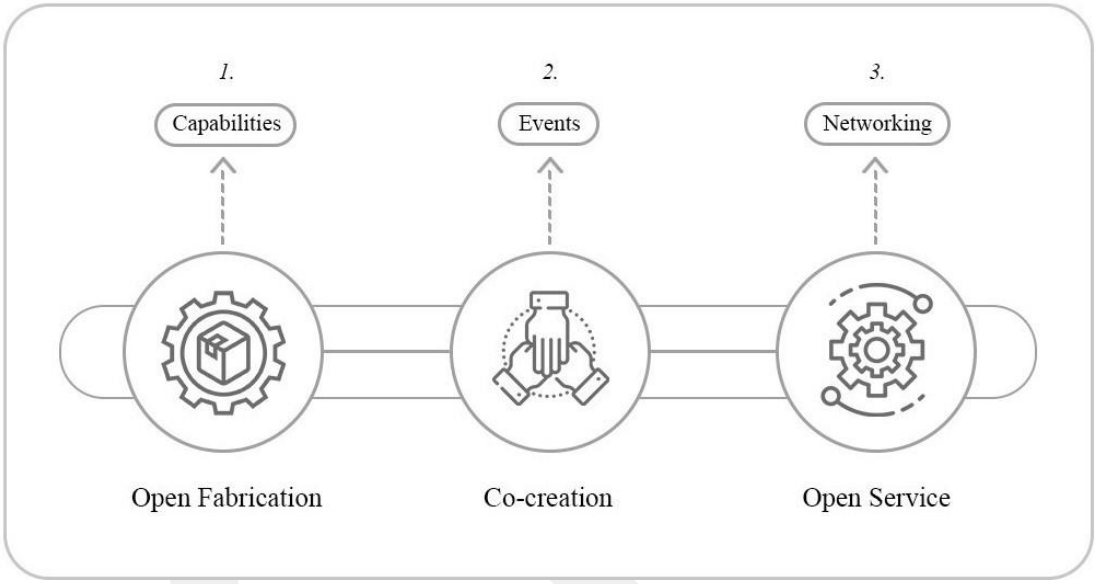


Figure 10. Essential drivers of open design within fabrication processes.

4.3. Case Study: FabrikaLab İzmir

4.3.1. Analysis of National Context

As a preliminary analysis, following section introduces the contemporary positioning of fab labs in Türkiye. Derived from the information presented by Fablabs.io, selected organizations provide essential and necessary information in terms of their components within their respective ecosystems. As a first step, the current distribution of each 17 fab labs in the geographical section were defined to present the physical framework. As a second step, each case was analyzed according to their corresponding tools on the essential drivers of OD. This enabled this preliminary phase to understand the overall process of the implementation of openness ideology within each ecosystem. Then, research phase continued with the matching process of each essential driver with the ecosystem components of fab labs.

Data derived from the Fablabs.io's archive on the operational fab labs around the globe, presents that there are currently 17 operational fab labs within the geographical borders of Türkiye. Following figure showcase the overall geographical distribution of each fab lab within Türkiye.

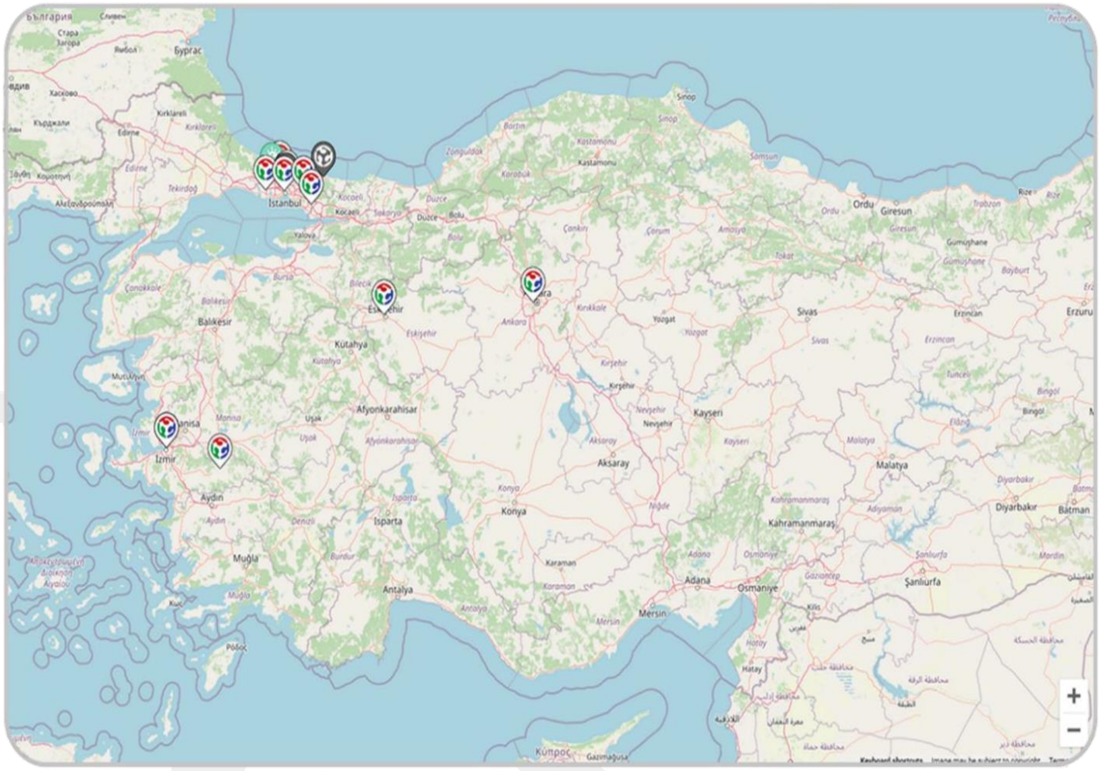


Figure 11. Contemporary map of fab labs in Türkiye (source: fablabs.io, 2022).

As well as presenting the current distribution of each fab lab, Fablabs.io provides sufficient information regarding each lab's capabilities in terms of fabrication and design-based knowledge dissemination. This way, the identification of how each lab have been utilizing the openness ideology and OD approach within their organizational structures has been realized. To realize this identification, section utilizes the previously defined essential drivers of OD, specifically within fabrication processes. Each case was re-considered through the lens of open fabrication, co-creation and open service capabilities, in accordance with their provided services for manufacturing alternatives referring to varied fabrication tools and technologies. For co-creative approaches, each case has been analyzed in order to identify their provided events to users and participants. When it comes to understand the total communication and information distribution, each lab's networking capabilities with stakeholders and other organizations were identified regarding the open service driver within the framework.

To understand the overall ecosystem and its operational structure of each selected case, each lab's features were matched and unified with the previously defined components of fab labs ecosystems. Through this approach, each lab's features and provided opportunities were categorized under capabilities, events and networking components.

To explain the overall contextualization and positioning of each fab lab, following table presents the distribution of each essential driver of each component through the lens of previously mentioned categorization within the fab labs in Türkiye. Furthermore, table also consider and identify each lab's tools as their fundamental operative aspect within the layer of OD approach as the core driver within the mentioned ecosystems.

Table 9. Essential drivers of open design in fab labs in Türkiye.

Fab Lab Ecosystem in Türkiye		**Essential Drivers for Open Design**		
Labs	*Available Tools*	*Open Fabrication*	*Co-creation*	*Open Service*
FabLab İstanbul	*Technical Infrastructure *Learning& Knowledge Sharing	*Machineries *Tools *Additive Technologies	*Hackathons, *Workshop *Training Programs	*Development Agencies *Government *Universities
Inno Fab Lab	*External Knowledge	*Machineries *Tools *Additive Technologies	*Hackathons, *Workshops *Training Programs.	*Manufacturers *Foundations
FabLab Odemis	*Not Found	*Machineries *Tools *Additive technologies	*Not Found	*Foundations

Table 9. (Continued). Essential drivers of open design in fab labs in Türkiye.

Open-Fab	*Technical Infrastructure *Learning& Knowledge Sharing	*Machineries *Tools *Additive Technologies	*Hackathons *Workshops, *Seminars *Training Programs	*Development Agencies *Government *Universities *Manufacturers *Foundations
Işık Fab Lab	Not Found	*Machineries *Tools *Additive Technologies	Not Found	*Universities *Foundations
Maker Atölye	*Technical Infrastructure *Learning& Knowledge Sharing	*Tools *Additive Technologies	*Workshops *Seminars *Training Programs	*International Alliances *Foundations
Atölye	*Learning& Knowledge Sharing	*Machineries *Tools *Additive Technologies	*Workshops *Seminars *Exhibitions *Training Programs	*International Collectives *Foundations
Anadolu FabLab	*Technical Infrastructure	*Machineries *Tools *Additive Technologies	*Workshops *Training Programs	*Universities *Foundations

Table 9. (Continued). Essential drivers of open design in fab labs in Türkiye.

FabrikaLab İzmir	*External Knowledge *Learning& Knowledge Sharing	*Machineries *Tools *Additive Technologies	*Workshops *Seminars *Exhibitions *Training Programs	*Municipalities *Foundations
Fabutopia	*External Knowledge *Learning& Knowledge Sharing	*Machineries *Tools *Additive Technologies	*Workshops *Seminars	*Foundations
Collaboration Space	*External Knowledge *Learning& Knowledge Sharing *Technical Infrastructure	*Machineries *Tools *Additive Technologies	*Workshops *Training Programs	*Universities *Foundations
Atölye 4x4	*External Knowledge *Technical Infrastructure	*Machineries *Tools *Additive Technologies	*Workshops *Training Programs	*Foundations
Dijital Çağ Atölyesi	*Technical Infrastructure	*Additive Technologies	*Workshops *Training Programs	*Universities *Foundations
IdeaLab Hisar School	*Technical Infrastructure *External Knowledge	*Machineries *Tools *Additive technologies	*Workshops *Training Programs	*Elementary, Middle and High Schools *Foundations

Table 9. (Continued). Essential drivers of open design in fab labs in Türkiye.

Atölye Ankara	*Technical Infrastructure	*Machineries *Tools *Additive Technologies	*Workshops *Seminars *Exhibitions *Training Programs	*Development Agencies *Government *Foundations
FabLab Iztech	*External Knowledge *Learning& Knowledge Sharing	*Machineries *Additive Technologies	*Workshops *Training Programs	*Universities *Foundations
FabLab Gaziantep	*Technical Infrastructure	*Machineries *Tools *Additive Technologies	*Workshops *Training Programs	*Universities *Foundations

4.3.2. Analysis of Internal Structure of FabrikaLab İzmir

Following section ventures through the internal structure and the organizational environment around the total service delivery of FabrikaLab. The overall structure has been analyzed under three main categories; organizational structure to provide the basic introduction of the chain of command, technical infrastructure to provide a concise idea about the organization's main utilities within a service delivery approach and lastly networking capabilities to understand FabrikaLab İzmir's connections and collaborators for varied projects. Each three categories were shaped accordingly from the analysis of preliminary research and prior contributions from academic literature as well as utilizing the individual observation during the initial field study.

1) Organizational Structure

The current management team on the selected organization emphasizes that, the integral organization and the distribution of individual responsibilities follows a non-hierarchical approach, since each team member has well equipped in terms of management capabilities and the overall skills when it comes to utilizing

infrastructural capabilities like machineries and fabrication tools. However, when considering the given analysis from a wider scale, other management bodies emerge to present the main structure of the chain of command. Placed under the main body of İzmir Metropolitan Municipality Senior Management, FabrikaLab İzmir operates under the management of Vocational Factory Branch Manager to further identify its positioning within the bigger picture. Derived from the organization's public website, the overall organizational model also identifies the positioning of FabrikaLab İzmir under two main committees of Innovation & Project and Technical Consultation. Following figure present the overall structure of the organization and how the main chain of command has been distributed between each branch.

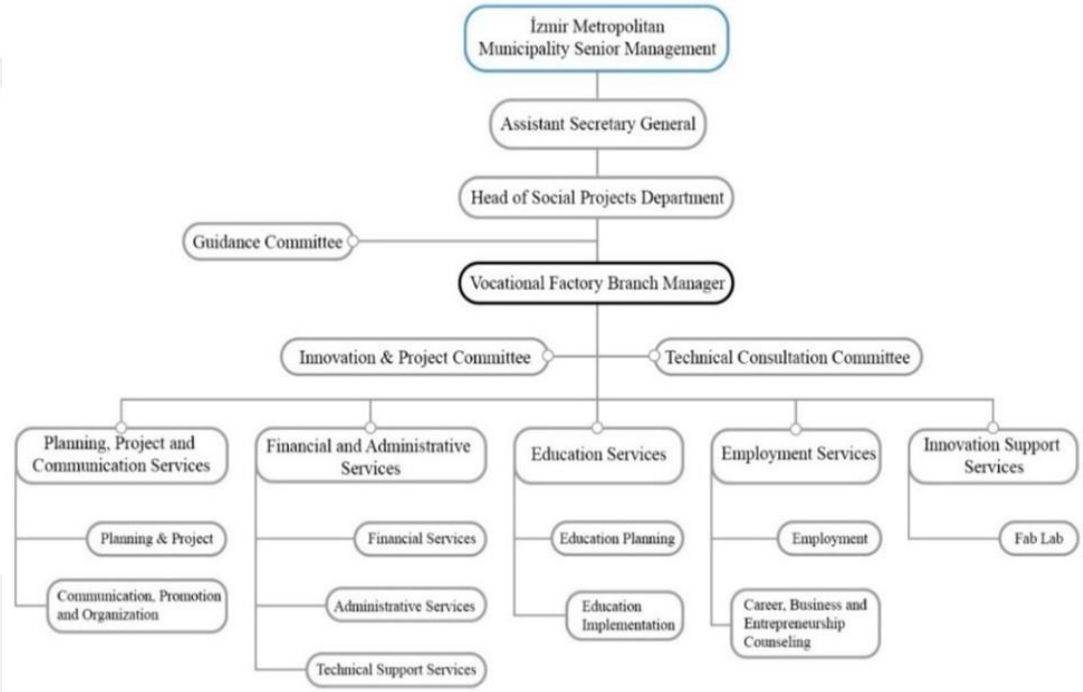


Figure 12. Organizational model of FabrikaLab İzmir.

2) Technical Infrastructure

Preliminary field study shows that there are multiple and varied tools for fabrication purposes within the infrastructural capabilities of FabrikaLab İzmir. Individual observation and the initial discussion with the personnel of the selected area have shown that the usage on 3D printing, CNC routers and laser cutter is evident as well as the usage of wooden and metal materials as the main material inputs for prototyping purposes. (Bingöl, 2019) emphasizes the wide range of equipment selection on FabrikaLab İzmir's infrastructure by presenting the following list of fabrication tools on her dissertation work.

- 3D printers.
- CNC router.
- Laser cut.
- Robot arm.
- Computer aided sewing machines.
- Robot design & training kits

Organization's main website and the current personnel have also been emphasized that, within these infrastructural spectrums, the main goal is to provide user with convenient usage and learning experience in terms of fabricating and realizing new outputs. Occupational health and safety measures were also considered as one of the most important aspects when it comes to the interaction between each user and provide tools within the spatial distribution of the lab.

3) Networking Capabilities

In terms of networking capabilities and connections with other organizations outside of the lab's ecosystem, İzmir FabrikaLab offers multiple and varied options when it comes to collaborating for desired outcomes. Lab's unique characteristic of providing manufacturing and fabrication equipment allows the organization to reach out and connect with institutions like technoparks, universities, co-working spaces, technology transfer offices (TTO) etc. Since one the lab's main mission was to diffuse the culture of making and sharing design-based language, its significance depends and relies on these connections. Previous research conducted by (Bingöl, 2019) as her dissertation work, provides sufficient information regarding the networking capabilities of the selected case. Following figure was adapted from the selected preliminary research to identify the overall networking spectrum of the lab.

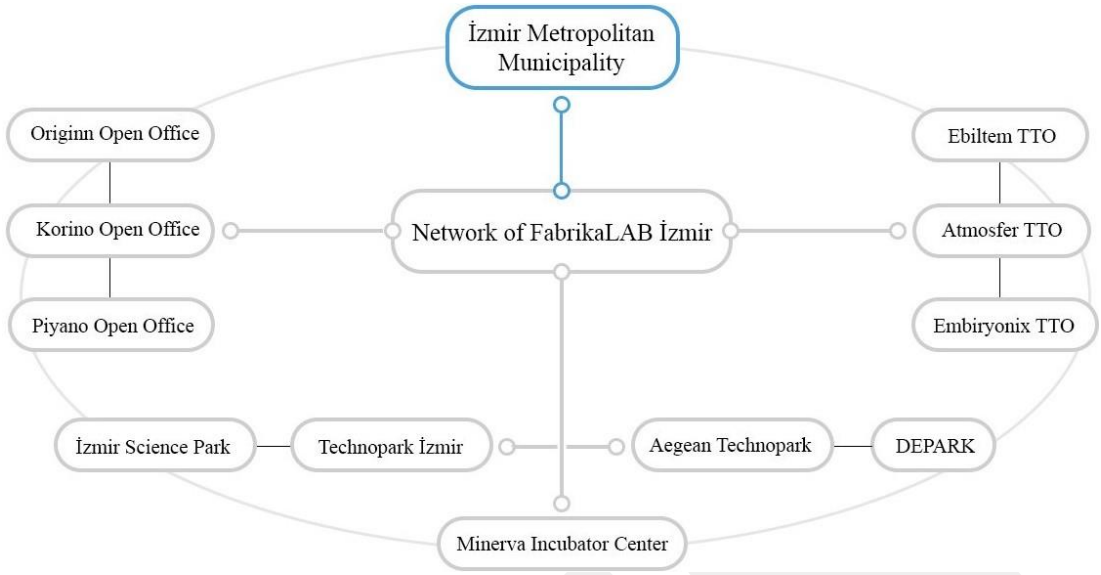


Figure 13. Network of FabrikaLab İzmir. (Source: Bingöl, 2019, p.35).

As it can be observed from the figure, the spectrum of reach of FabrikaLab İzmir spans between multiple and varied institutions, which can be considered as provided spaces to users and participants for creating new and desired outcomes through collaborative practices. Since vocational and educational training programs are essential practices for the selected organization, collaborations between TTOs and universities play a crucial role when it comes to reach participants from different education levels and age spectrum. On the other hand, it is possible for the lab to reach out and connect with entrepreneurs through techno parks and incubator centers, since one of their main goals was to establish a strong culture of providing creative spaces where design and project development processes meet. Open office spaces can also be considered as vital connections for practicing co-creative approaches with users who are utilizing the provided tools for creating and fabricating. This way, lab can diffuse the integral design-based knowledge and enlarge their user spectrum on a wider level. From an organizational standpoint each networking capability not only provide FabrikaLab İzmir with multiple options when it comes to defining their user and participant profile, but also enable them to utilize alternative ways on providing their main service capabilities for educative purposes on citizens for making, fabricating and realizing new outputs.

4.3.3. Analysis of In-depth Interviews

Following section explores the overall findings derived from the in-depth interviews and their analysis in accordance with the answers of each participant. To understand the status of the selected ecosystem of FabrikaLab İzmir and how it operates, the

general structure of the interview questions was organized in accordance with the previously presented ecosystem components and essential drivers of OD framework. This organization formed the overall question sets and became integrated to the format of the questionnaire (Appendix. B).

Within the scope of this analysis, each question set systematically explores the given answers focused on FabrikaLab İzmir's *infrastructure*, *networking*, *services* which they receive from both on internal and external bodies to sustain their own service deliveries, *events* which they organize, *participatory approaches* to examine which type of design approaches do they emphasize during varied events and as a last unit *open design* to understand to what extend they utilize the general framework for delivering innovative outcomes. Following section focuses each question sets and their sub-categories to extend the analysis process according to participant's answers and perspectives towards the overall framework.

4.3.3.1. Infrastructure

Infrastructure question set has been divided into five main sub-questions to allow participants to identify technical capabilities, their utilization stages, their contributions to project and design development phases, their usage and preference frequencies within fabrication processes. Following section mentiones each sub-question set and related answers from the participants in a descriptive approach.

1. Technical Capabilities

To analyze and understand the overall technical infrastructure of the selected ecosystem, participants were asked to state multiple technical attributes which belong to the total structure of FabrikaLab İzmir. Within this scope every potential tool and method which are accessible for users to utilize for fabrication process were considered as viable answers. Following list presents each capability, which were proposed and mentioned by participants during the interviews.

- *Robot arm*
- *Hand tools*
- *Sandpaper*
- *Sewing machine*
- *Cutting tables*
- *Storage units*
- *Spray paint*

- *CNC*
- *Circuits (Arduino and Raspberry Pi)*

Participants also stated that besides from conventional manufacturing tools, if it is a necessary phase, it is also possible to focus on assembly processes for certain products within the environment.

2. Utilization Stages

After investigating the technical capabilities of the selected ecosystem, participants were asked to determine specific phases on project and design development process, which they have considered as adequate to utilize and use each mentioned capability. Following list presents multiple stages which proposed and defined by each participant during the interviews.

- *Design workshops*
- *Prototyping*
- *Material manipulation*
- *Outer shell design*
- *Product development stages*
- *Product testing*
- *Project optimization*
- *Educative workshops (both for user and personnel)*

Participants also suggested the importance of communication between multiple participants within the ecosystem, since it directly effects the selection of adequate fabrication methods and approaches when it comes to certain stages of design and project development.

3. Contributions of Technical Capabilities to Project & Design Development Processes

In terms of analyzing the overall contributions of each technical capability to the development of new projects and design proposals, answers of each participant provided varied perspectives. For instance, P3 stated that most of the applicants to the organization has developed their projects and gained positive results in terms of realizing their goals and outputs. Furthermore, FabrikaLab İzmir even provided such outcomes with its technical capabilities, for works dedicated on academic development as well. P3 opened this statement by proposing a prior example; *"a graduate student came to our facility and printed a model on a one-to-one scale*

within the scope of his research, then he fabricated a product to be used in real life scenarios." Similarly, P2 suggested that these kind of applications and positive outcomes also enable this selected ecosystem to enlarge its scope of operations and allows the organization to reach even more users and participants. According to them, this is related to the utilization of varied technical tools and equipment for users who were preparing their own projects for design competitions, exhibitions and graduation projects. Related to this fact, P2 states that "*The products and design outputs which have been realized within the lab contributed to the promotion of FabrikaLab İzmir and led to its recognition among citizens. It helped the organization to reach more people, both end-users and academics."*

4. Usage Frequencies

Even though multiple and varied technical capabilities are accessible for every citizen and user within the ecosystem of FabrikaLab İzmir, their usage frequencies may differ according to date, time periods, user types and their demands according to project descriptions. Within this scope P2 mentioned that *"these technical capabilities were used periodically within the framework of group or individual applications, and they were prepared to be used after the application process resulted."* Within this perspective P3 mentioned the general service flow related to the usage frequencies of provided technical infrastructure. Participant states that, *"in general, it is possible to summarize the process as the following: project application, interview with users and as the last part, the development of the project itself.*

P5 considered the issue from the organizational perspective and mentioned that the overall usage frequencies depend heavily on educational periods, especially for student user groups. According to the participant's statement, it is possible to observe user activity when designated participants and applicant have the spare time to focus on both individual and collaborative projects. P5's statement was designated as follows *"rather than focusing on the frequency in terms of usage, we can say that applications and usage scenarios intensify or weaken within a periodical context. Generally, when students have homework, individual submissions or school projects they apply and utilize these technical capabilities. On the other hand, when they have the spare time or a specific period where they are allowed to focus on their own ideas they can also come here and start using varied tools. This usually happens after their exams are over or within the summer vacation."* Within this perspective, it is possible to mention that the usage frequencies may differ according to user's

spare times and extracurricular activities as well as if it is possible to observe a task-based attitude to develop and submit varied projects.

5. Preference Frequencies

As the last part of the sub-questions dedicated to analyzing the technical capabilities of FabrikaLab İzmir, preference frequencies according to participants was design to understand the selection preferences of technical equipment and methods for realizing new outputs and fabrication processes. Each participant was asked to list related technical capability starting from the most preferred ones to the less utilized within the ecosystem for usage and utilization phases. Following list was created in accordance with the preference sequence, stated by participants during the interviews.

- *3D printers*
- *Lazer cut*
- *CNC*
- *Robot arm*
- *Circuits (Arduino and Raspberry Pi)*

Even though there are multiple tools and machineries within the ecosystem of the selected lab, given list showcases the most preferred ones when it comes to realizing new and innovative outputs according to participants.

4.3.3.2. Networking

Networking question set has been divided into five main sub-questions to allow participants to identify networking scope of FabrikaLab İzmir and its reach within the total ecosystem of İzmir, participant's personal opinions about prior or ongoing collaborations, FabrikaLab İzmir's projects scopes and types through different collaborations, the overall contribution of this networking structure to design and project development phases and as the last question, participants were asked to designate actors from different professions who they have collaborated within the scope of these networking. Following section mentiones each sub-question set and related answers from the participants in a descriptive approach.

1. Networking Scope

To understand the overall reach and the influence of FabrikaLab İzmir as an organization within the emerging innovation ecosystem of İzmir, participants were asked to define certain ecosystem structures as actors or other organizations which

the selected lab has collaborated or contacted during its operational time period. Within this scope, P1 mentioned a prior collaboration between FabrikaLab İzmir and Yaşar university for its development and establishment as a fully functioned fabrication space. Academic consultancy has been emphasized during this interview and how it is possible to observe the influence of educative purposes and structures on fabrication processes as well. While mentioning a smilar perspective on academic collaborations, P3 described a personel observation regarding the user population from different universities. Participant stated that, eventhough in the ecosystem of FabrikaLab İzmir they were expecting to see more students and user groups from disadvantegeous group in terms of income and relatively from state universities from İzmir; they have encountered more students from both Yaşar University and İzmir University of Economics. P3 stated the following as a personal observation, *"personally, when I think about socioeconomic welfare and related factors, i can say that the students and academic staff of İzmir University of Economics and Yaşar University have used our field more than other state universities. I expected to observe more students and users who may have difficulties in accessing this type of equipment, but in reality these two universities were constantly utilizing our space."*

Regarding the collaborations with Non-governmental organizations (NGO), P5 stated that eventhough FabrikaLab İzmir never had a direct collaboration with these kind of organizations, under the governance of FikrimİZ they are trying to alter their own organization into a fabrication space which is designed to promote social entrepreneurship. Within this scope P5 stated the following, *"we are in contact with non-governmental organizations (NGOs) and in the process of turning this field into an entrepreneurship center under the governance of FikrimİZ division. In this sense, we organized workshops with several NGOs and discussed with them what kind of services we can provide besides from fabrication tools and methods."*

2. Personal Opinions

For the second part of the networking set, participants were asked to state their individual opinions regarding the overall networking structure of FabrikaLab İzmir and how it has been effecting the total fabrication and production processes. Regarding the question, P2 explained that in terms of socialization and building connections with other actors within the ecosystem has resulted into positive outcomes. Specifically focusing on knowledge diffusion regarding technical and design knowledge, participant suggested that these type of connections facilitate the

creation of an interdisciplinary environment. From a similar approach, P3 emphasized the main mission of the lab in terms of providing an openly accessible space for the public and mentioned that the overall networking structure allows this goal to become realized for varied projects. Furthermore, participant also explained the importance of these connections regarding the Lab's recognizability as an organization.

From a contrasting perspective, P5 mentioned several aspects which can be considered as obstacles when it comes to fabricating innovative outcomes through collaborations and connections. Participant mentioned that the overall supervision of the municipality can sometimes become a slowing factor for FabrikaLab İzmir to act in an agile and rapid manner for demands or goals. P5 further explained the situation by emphasizing that they have been delivering a public service and to a certain extend this may limit their delivery methods when building up new connections. Participant also higlighted the financial aspects within the ecosystem for material and tool supplies and mentioned that the economic situations revolving around the country can cause uncertainty on management level.

3. Project Scopes

After listening each participant's individual and personal opinions of the overall networking structure of FabrikaLab İzmir and its potential on innovative outcomes on different levels, each participant was asked to describe varied project scopes and types within the selected ecosystem. Following table presents each mentioned and described project type from participant during the interviews.

Table 10. Project scopes.

Participants	**Years Active in FabrikaLab izmir**	**Current Status**	**Project Scopes**
P1	2014-2015	*External*	• *Design workshops*
P2	2018-2020	*External*	• *Design workshops*
P3	2018-2020	*External*	• *Student projects* • *Personnel training programs* • *Research & development projects*

Table 10. (Continued). Project scopes.

P4	2022- continues	*Internal*	• *Student projects* • *Graduation projects* *Competition projects*
P5	2017- continues	*Internal*	• *Exhibition projects* • *Entrepreneurship projects* • *Competition projects* *Graduation projects*
P6	2022-2023	*External*	• *Urban transformation* *Design workshops*

Within these varied scope of project types and operations, P2 mentioned that there have been several training courses regarding software programs and coding workshops, created specifically for disadvantegous participants from elementary and middle schools. Similarly, P4 also emphasized that there have been multiple workshops currated as a collaborative approach with NGOs focusing on young and women population of İzmir.

4. Contributions of the Networking of FabrikaLab İzmir to Project & Design Development Processes

For the following part, each participant was asked to realize if there were any contributive aspects for the development of new projects, via each designated networking aspect. P3 emphasized the cruciality of knowledge distribution within the ecosystem through the mentioned networking structure. According to the participant's experience, it was also important to learn new skills and knowledge form participants and users while utilizing the space as well. P3 opens the discussions by stating that, *"Within our networking structure, we did not necessarily play the role of instructors, on the contrary we also had the opportunity to learn new things and gather information related to new technologies from users and participants. The main idea was to guide users on their fabrication processes while allowing them to teach us new methods as well."*

Even though FabrikaLab İzmir's external networking structure allow the

organization to reach wide range of participants and actors, its internal networking system may suggest a contrasting perspective related to the issue. For instance, P4 explained that operating as a public organization under the municipality, there is a high chance of falling a short on providing the most efficient and consistent service delivery to users. Furthermore, since as public organization, FabrikaLab İzmir has certain limits when it comes to working hours and operations. This restrains the overall service and system delivery, thus directly effecting the realization of innovative outcomes.

5. Occupational Types

As the last question part of networking set, each participant was asked to define multiple and varied occupational background which belongs to other actors outside of the selected organization. To examine the overall distribution of each actor surrounding the overall ecosystem model of FabrikaLab İzmir and identify their contributions to collaborative approaches on different projects and fabrication phases, proposed question aimed to understand the total networking structure via actor-based roles. Following list was created according to each mentioned occupational type from participants.

- *Academicians*
- *Industrial designers*
- *Architects*
- *Interior architects*
- *Engineers*
- *Makers*
- *3D modelling specialists*

4.3.3.3. Services

Services question set has been divided into five main sub-questions to allow participants to identify what kind of services FabrikaLab İzmir recieves to sustain its own service delivery methods, how often these service types are needed for project and design development phases, which service types are crucial on these mentioned phases, their contributions to the overall processes and lastly to identify related actors surrounding the selected ecosystem, participants were asked to identify several occupations related to service deliveries. First three sub-question set were given below as one section, since asnwers from participants were interconnected with each

other and revolved around common mediums. Following section mentions each sub-question set and related answers from the participants in a descriptive approach.

1. *Service Types / Usage Frequencies / Crucial Service Types for Fabrication Processes*

As an initial approach, participants were asked to identify certain service types which FabrikaLab İzmir has been receiving for its own system and service delivery structure. Following table was created according to each mentioned service type from participants.

Table 11. Service types.

Participants	**Years Active in FabrikaLab izmir**	**Current Status**	**Service Types**
P1	2014-2015	*External*	• *Informal education.*
P2	2018-2020	*External*	• *Personnel training programs on machinery usage, software programs and occupational health and safety.* • *Maintenance services.* • *Material supply.*
P3	2018-2020	*External*	• *Maintenance services.* • *Material supply.* • *Training programs.*
P4	2022-continues	*Internal*	• *Tool and equipment supply.* • *Material supply.* • *Maintenance services.*

Table 11. (Continued). Service types.

P5	2017- continues	*Internal*	• *Material supply.* *Maintenance services.*
P6	2022-2023	*External*	*Material supply*

In terms of the usage frequencies of these mentioned services, participants provided different examples of usage types and demands during fabrication processes within the ecosystem. For instance, P2 explained that whenever there is a technical issue with any of the machinery and equipment within the lab, the demand on maintenance services become significantly higher. Moreover, P2 also emphasized the importance of planning the annual budget for material supply for the lab and how they save and collect every unused material to sustain their service delivery.

For organizing different events such as workshops and maker trainings within the ecosystem for users, P3 explained that there was a significant demand on lecturers, who have been specialized on design mediums and topics. Machinery experts were also mentioned during the interview, since usage of such equipments like CNCs, laser cut and robot arm may create complex processes on utilization during varied events. A related example was proposed by P6, who were an active user for a specific type of project within the ecosystem. According to participant's own experience, during three dimensional modelling their team was able to meet with a design expert to optimize each and every modelling asset to facilitate the fabrication phases of the designated product. P6 also emphasized the importance of material supply, specifically on filaments for 3D printers when it comes to prototyping and the realization of their products.

When it comes to identifying crucial service types for fabrication processes within the selected ecosystem of FabrikaLab İzmir, participants described their perspectives through different levels. P1, for example approached the given issue from a wider perspective and suggested that a fabrication space should be a flexible field, which can provide immediate response to ongoing situations revolving around its ecosystem through multiple services and facilitating factors. P1 explained the given opinion by stating that, *"one of the strengths of such organizations should be the capacity to plan and act in a more flexible way, so they can become spaces that can show agile and quick reactions and produce solutions even for unplanned*

situations."

P2, P3 and P5 approached the question from a practical perspective and explained that the material supply was the most crucial service type when it comes to fabrication processes. Both participants also emphasized the importance of maintenance services, however they have also mentioned that, on a daily basis if the personnel is capable of intervening with related technical issues they resolve the problem on their own.

Different than the previously mentioned aspects, P4 considered the issue while focusing on the social influence of the lab and explained that the integral management of lab's website from the municipality is a crucial aspect for promoting their services and capabilities. The usage of social media has been emphasized during the interview as well and it has been mentioned that they consider these two channel as their main mediums on communicating with users and participants.

2. Contributions of Received Services to Project & Design Development Processes

For the next part of the given question set, participants were asked to consider the overall contribution of different service types on project and design development phases. Within this scope P2 explained that each service recieval facilitated the ongoing process of fabrication within the space both for users and their own service structure. Similarly, P3 also suggested that previously defined service types have affected the overall process in a positive manner. According to P3 it is also possible to mention the importance of building connections with experts and instructors outside of the organization. P3 opened the issue with the following statement, *"since subject types and scopes of every event type may vary, we needed the aid from academics and experts from different fields to facilitate the educative processes within the lab. Sometimes it is vital to reach and collaborate with people who can be considered as professionals on their own specialized areas. On the other hand, I personally remember that we even had participants who were high school graduates and they took the role of instructors within the environment to share their knowledge and abilities."* Participant further explains that this type of applications corresponds with the mission of FabrikaLab İzmir and if they have tried to provide such an approach without the guidance of such experts, they would ultimately fail in terms of delivering and efficient service to the public.

Similarly, P5 contributed on the subject by mentioning a previous event, where FabrikaLab İzmir has received the knowledge and guidance of various experts from

the field as an example. According to the participant, back in 2020 there was a specific event dedicated for social and food entrepreneurship and the responsible team in the lab did not have any qualified personnel to manage and lead such an event type. Because of this they have connected with other actors from the field to proceed with the event and establish the overall scope of it.

From a different perspective, P4 suggested that eventhough the overall service recievals have affected the lab in a positive way and allowed personnel to proceed with each task, FabrikaLab İzmir could provide more and new opportunities to its users in terms fabrication. Participant strongly believes that the overall ecosystem does not fully present its capabilities to users and there is a strong potential waiting for its utilization. P4 stated the following within the scope of these explanations, *"Services we receive allow us to manage the contemporary status within the lab, but the main question is, can better work be done with better materials? Or can users come here and build new and better prototypes? I think it can happen. For example, if we had a 3D printer that can work with metal, we would receive different applications for prototype production. Project variations would have developed and different scopes of work could have produced. These can be considered as small yet important details and if we can manage to solve these kinds of issues, we will get more efficient and positive outcomes in the future."*

3. Occupational Backgrounds

As the last question part of services set, each participant was asked to define multiple and varied occupational background which belongs to other actors, who has been delivering the previously defined service types. Like networking part from the interview, proposed question once again aimed to understand the actor-based roles, when it comes to service deliveries. Following list was created according to each mentioned occupational type from participants.

- *Academicians*
- *Industrial designers*
- *Architects*
- *Suppliers*
- *Stationers*
- *Social entrepreneurs*
- *Software experts*

- *Maintenance personnel*

4.3.3.4. Events

Events question set has been divided into five main sub-questions to allow participants to identify what kind of events FabrikaLab İzmir organizes to diffuse and distribute design-based knowledge, how often they plan and organize various events, what kind of role(s) do participants own during related events and activities, which actors do they connect with, specially during preparation phases of each related event and lastly participants were asked to discuss to what extend do these events contribute to projecr and design development phases within the lab's ecosystem. Following section mentiones each sub-question set and related answers from the participants in a descriptive approach.

1. Event Types

As an initial approach, participants were asked to identify certain event types which FabrikaLab İzmir has been organizing for its participants and different actors surrounding the ecosystem. Following table was created according to each mentioned event type from participants.

Table 12. Event types.

Participants	**Years Active in FabrikaLab izmir**	**Current Status**	**Event Types**
P1	2014-2015	*External*	• *Design workshops*
P2	2018-2020	*External*	• *3D printing workshop* • *Furniture design workshop* • *Parametric design and 3D modelling workshop* • *Social and food entrepreneurship programs*
P3	2018-2020	*External*	• *3D printing workshop* • *Coding workshop* • *Arduino prototyping*

Table 12. (Continued). Event types.

P4	2022- continues	*Internal*	*Design workshops*
P5	2017- continues	*Internal*	• *3D printing workshop* • *Robot arm workshop* *Arduino prototyping* • *workshop* *Social and food entrepreneurship programs*
P6	2022-2023	*External*	• *Promotional gatherings* *Design workshops*

2. Organization & Planning Frequencies

For the second part of the events section, participants were asked to identify how often they plan and organize events within the ecosystem of FabrikaLab İzmir, in terms of frequencies and scheduling. Within this scope, P2 explained that it is not viable to propose a certain frequency when it comes to planning and scheduling various event types. P2 stated that there were multiple events they have organized and managed, but it would not be possible to mention a certain period. On the other hand, P3 mentioned that they have been organizing various events on each weekend within the lab and if it becomes necessary, they have been utilizing certain time frames after the working hours for planning as well. From a different perspective, P4 stated that it would not be possible to suggest a pattern related to planning and organizing event within the lab. However, after the establishment of Fikrimİz Division there have been certain educational modules ready to be implemented for upcoming events. Furthermore, P4 also explained that every two weeks each personnel of FabrikaLab İzmir organize certain workshop according to their original occupational backgrounds and expertise. P5 stated that eventhough there is not a certain scheduling system for organizing events, every Wednesday and Friday there are multiple workshops within the lab's ecosystem.

3. Participant's Role(s) During Events

To understand each participant's role during these mentioned event types within the ecosystem, participants were asked to identify their own responsibilities during the application process of each event type. Following table was created according to each mentioned role owned by the participants.

Table 13. Participant's roles.

Participants	**Years Active in FabrikaLab izmir**	**Current Status**	**Participant's Roles**
P1	2014-2015	*External*	• *Organizer* • *Instructor*
P2	2018-2020	*External*	• *Technician* • *Organizer* • *Instructor*
P3	2018-2020	*External*	• *Event Coordinator* • *Technician* • *Instructor*
P4	2022- continues	*Internal*	• *Technician* • *Instructor*
P5	2017- continues	*Internal*	• *Event Coordinator* • *Instructor*
P6	2022-2023	*External*	• *Academic consultant* • *Strategist* • *Instructor*

4. Occupational Backgrounds

As the last question part of events set, each participant was asked to define multiple and varied occupational background which belongs to other actors, who have been a part of planning processes of various events with the lab. Given question set was proposed to participants specifically to contribute the overall identification of networking structure of FabrikaLab İzmir. Following list was according to each mentioned occupational type from participants.

- *Academicians*
- *Industrial designers*
- *Architects*
- *Interior architects*
- *Engineers*
- *Stationer*
- *Suppliers*
- *Maintenance and repair personnel*
- *Municipality personnel*
- *Makers*

5. Contributions of Events to Project & Design Development Processes

Following question was proposed to participants to make them evaluate the overall contributions of various events to project and design development phases within the ecosystem. Given question aimed to understand how events and various activities played a crucial role for the development of new design proposals and solutions. Participants approach the issue from different perspectives according to their own experiences and observations. P1 mentioned that, when considered in an informal way, educative processes within workshops and knowledge distribution were an influential aspect for participants to proceed with their own specializations for the future. Within this scope P1 mentioned the following statement as a reference to personel experience, *"according to my own observation, each and every student in our workshop group was able to carry on with their education and academic development through our influence, regarding workshop scope and topics we have covered with them".*

From a different perspective, P2 explained that as a fabrication space, FabrikaLab İzmir should become connected to more and varied participants when it comes to events and various activities. Participant mentioned that since the given ecosystem provides a public service, the responsible team is limited to working hours within the day and this prevents FabrikaLab İzmir to present its full potential for organizing events and participatory activities. Furthermore, P2 also emphasized the importance of user variety and mentioned that *"organizing events is a good factor for attracting participants and users however, such an ecosystem should not limit their participant profile soley as students but should also contain designers, entrepreneurs and*

industrialist who are actively working in the private sector as well."

In terms of reaching wide variety of participants, P3 explained that through different events, industrial designers and makers started to utilize the ecosystem of FabrikaLab İzmir even more.

Participant also highlighted that, each event that they have been organizing within the space, allowed every participant to aid eachother when it comes to project and design development phases.

On the other hand, P4 approach the issue from a contrasting perspective and explained that, in terms of creating tangible innovative outputs it is not viable to consider a significant contribution of events and activities. Participant further explained that events and various collaborative approaches allowed users to understand what kind of approaches they should consider for fabrication and manufacturing. According to the participant, the real contribution of these mentioned event types is the possibility to teach users on design and fabrication methods.

4.3.3.5. Open Design

As the last part of the in-depth interview, OD question set were discussed with each participant to finalize the overall methodological approach. Before proposing each sub-question set of the designated part, participants were informed with the overall nature of the term OD and its framework regarding design-based development for innovative outcomes. The aim of the study has been emphasized through this brief informative stage to allow participants get an efficient approach on the overall scope of the research. Initially, each participants were asked if they had a prior knowledge on OD framework and its general scope. Following this question, each participant were asked to re-consider their spent time within the ecosystem of FabrikaLab İzmir and if they had a prior experience on project or design development stages, which can be considered as a related practice of OD approach. As the third question, participants were asked to explain to what extend do they consider FabrikaLab İzmir have made various project and design creations publically accessible and which channels they have utilized to distribute each output. Vice versa, as a contrasting yet a complimentary question, participants were asked if the selected organization has ever utilized open source design components and if so, from which data bases or platforms they have reached to utilize these assests. As the final question of the given part, participants were asked to consider each ecosystem component, essential driver of OD and related questions so far during the interview. Furthermore, they were

asked for them to rate the importance of OD within project and design development stages for innovative outputs within a scale of 1 to 10. Following section provides the analysis of each answer as a total explanation since each sub-questions were in a complimentary structure.

Participants were asked if they had any previous knowledge or information regarding OD framework. Each participant stated their own personal experiences and individual observations towards the topic. P1 explained that, it was actually the main focus area of the participant within academic research during master thesis. Similarly, P3 explained that OD framework was one of the research areas of participant during master thesis research. Furthermore, participant also explained that throughout professional practices and becoming an actor within the fabrication ecosystem, provided the opportunity to enhance the knowledge regarding OD approach. As a person graduated from a design-based education system, P2 explained that, during the education process the overall name of the design approach was not defined as OD but it was still possible to understand the fundametal aspects of the framework. On the other hand, P4 and P5 explained that they had no prior knowledge and information regarding the framework and stated that, now they have realized they have actually been utilizing this approach within the ecosystem of FabrikaLab İzmir for a significant amount of time. Lastly, for P6 it is possible to state that the participant had a prior knowledge about the framework but only limited to previously conducted research and activities as an individual effort.

Following these explanations, participants suggested certain scenarios which they considered as related practices of OD framework. These instances could be a part of a project development stage or any practice from various events and activities within the ecosystem. Rather than approaching the issue exclusively to the selected space, P1 explained that, even though it is not possible for the participant to refer any practice within the ecosystem, P1 utilizes the given framework for individual research and practices. Within the question's scope, P2 suggested that since their main goal is to guide users through fabrication tools and manufacturing techniques, it is possible to consider the overall service delivery of FabrikaLab İzmir is related to OD framework. According to P2 the main decision makers were the users only within the space and the responsible team was there to guide them when necessary. From a similar perspective, P3 also mentiones the main service delivery structure of FabrikaLab İzmir and underlines the thematic influence of OD framework in every

operational act. According to the participant, OD was not the main topic of executive processes within the lab, however it was definitely the main influential factor for service delivery methods. From a contrasting approach, P4 and P5 did not mention any project or design development phases related to OD and both stated that, they did not remember any activity which can be considered as a relative practice to the overall framework. As a user who was utilizing the ecosystem of FabrikaLab İzmir, P6 considered their own projects as an implementation of OD and suggested that the spatial factors related with the environment have facilitated the development processes even further.

For the next part of the interview, a certain question was proposed to participants to make them consider to what extend FabrikLab İzmir have transformed innovative design and project outputs into openly accessible assests for public. In terms of personal opinions and observations, P2 suggested that it is not possible to mention such instance since participant did not witness any related practice. Similarly, P3 also could not suggest a rate in terms of usage on openly accessible design components within the ecosystem of FabrikaLab İzmir, however participant mentioned that they have been trying to present several outputs via organizing exhibitions for public to attend. On the other hand, P4 strongly emphasized that such practices would not be possible within the overall service structure of FabrikaLab İzmir. Participant explained that, since mots of the users individually apply to FabrikaLab İzmir with their own personal ideas regarding project or design development, the intellectual property rights do not allow them to alter related components into publicly accessbile materials. P5 agreed to this argument from a similar point of view and contributed to the overall discussions by explaning that, so far it is not possbile to observe such an approach within the given ecosystem. P6 approached issue while mentioning their own project and the emerging ecosystem of innovation of İzmir. According to the participant, they have been developing a mobile app with İzmir Metropolitan Municipality to share their design-based knowledge and project outputs with the public. P6 further explained that, this collaboration actually aims to realize a smart community where each user can be considered as decision makers for design to develop and integrate within the society. P6 also added that, they have also shared their project development stages with the public on an urban scale with the help of design boards and posters within an exhibition structure.

For the following sub-question, participants were asked if they can define certain

channels and platforms which FabrikaLab İzmir has been utilizing to share design-based knowledge, information and intellectual outputs for other users and citizens to utilize. Following list was created according to each platform type which have been suggested by the participants.

- *FabrikaLab İzmir website*
- *Published catalogues*
- *Dutch Design Week exhibition*
- *Good Design İzmir exhibition*
- *Documentary*
- *Social media (instagram and facebook pages)*
- *Mobile application*
- *Project website*
- *Scaled models for exhibitions*
- *Design boards and project posters*

After the listing process, participants were asked to reconsider the provided question from the other way around and they were asked to identify certian design and material components which have been utilized within the ecosytem as openly accessible assets for development processes. Within this framework, P2 explained the usage of model pieces and visual materials like blueprints for prototyping purposes. According to the participant it is possible to detect a certain usage within this frame when it comes to student user groups within the lab. P2 agreed on this comment and also emphasized that, within the lab this approach has been a common practice between users so it is once again possible to mention the OD approach within this procedure. On contrary, P4 explained that it has been never been observed this kind of a usage within the lab, since most of the projects are already close to maturing and users only come to the lab to utilize certian fabrication tools for production. P5 also contributed to this comment by suggesting that FabrikaLab İzmir has already been equiped by certain fabrication tools and manufacturing equipments, thus for users it is not particularly necessary to utilize openly accessible model components or pieces. P6 considered their own experiences regarding the issue during project and design development stages and explained that, to improwe certian 3D models they have utilized multiple model pieces and software assets as a team during the whole process.

Similar to previously given listing process, participants once again were asked if they can define certain channels which they have been utilizing to download information, design components and intellectual outputs to utilize during project or design development stages. Following list was created according to each channel type which have been suggested by the participants.

- *GrabCAD*
- *Thingiverse*
- *ThinkerCAD*
- *Youtube*
- *Academic databases*

As the last question of OD set, participants were asked to rate the importance of OD framework on project and design development phases from 1 to 10. Following table provides each participant's answer in terms of rating.

Table 14. Participant's rating.

Participants	P1	P2	P3	P4	P5	P6
Rating	*9*	*10*	*10*	*8*	*8*	*9*

4.4. Evaluation of Key Findings Through Ecosystem Units

The following evaluation section aims to consider the findings within the scope of the main research question. Since the overall findings provided sufficient information regarding the overall working dynamic of FabrikaLab İzmir, given section seeks to answer the main research framework through OD within fab labs ecosystem. To proceed with this evaluation, following part utilizes the previously defined essential drivers of OD within fabrication processes and the main ecosystem components of fab labs. Within the lens of this utilization, the findings were also re-considered in accordance with the mentioned scope and each answer of participants were evaluated. Following proceeds with re-stating the overall research question and the main goal of the dissertation to reconsider the connection between findings and the previously defined research framework. Within this scope, evaluation part presents both a qualitative and descriptive summarization towards each key finding.

As mentioned within the first chapter, given dissertation approaches OD drivers with respect to the overall dynamic of fab lab ecosystems and aims to identify "*How Open Design Operates in the Fab Lab Ecosystems?"* Referring to this goal, literature review and the analysis of preliminary research on the third chapter has enabled the

research to signify the essential drivers of OD framework for fabrication processes as: *open fabrication*, *co-creation* and *open service*. This classification has enabled this research to provide an evident connection between each previously defined ecosystem components of fab labs ecosystems which designated as: *capabilities*, *events* and *networking*. Through this connection, given section aims to reflect the evaluation of each driver in respect to the ecosystem components from selected key findings from the fourth chapter. Within this approach, to further evaluate the main operational dynamic of OD within fabrication processes, each essential driver and component were considered to act in unison and designated as *"ecosystem units"*. Considering the selected ecosystem of FabrikaLab İzmir as the main case study of this research, following section will higlight the crucial thematic aspect through each participant's answer to given questions within in-depth interviews.

4.4.1. Ecosystem Unit 1: Capabilities

First unit refers to the key finding from the *infrastructure* question set of in-depth interview, which proposed specifically within the ecosystem of FabrikaLab İzmir. With the examination of technical capabilities of the selected environment, this section ventures through participant's own statements and re-considers the overall findings within the perspective of OD framework.

Considering open fabrication as one the main drivers of OD within fabrication stages, participant's individual statements provided varied perspectives regarding the examination of the operational potential of OD within the ecosystem**.** As stated by the participant (P5), it has been highlighed that the beneficial aspects of these mentioned technical capabilities mostly utilized by student groups, *"most of the time, when students come to our facility, they are already finished up their design and project proposals. When it comes to prototyping phase, they mainly utilize this process to identify potential errors which they can encounter for future development and to test the overall product and related outputs."* Regarding the case study findings, in terms of discussing the overall contribution of technical capabilities within the ecosystem of FabrikaLab İzmir, participants emphasized the importance of these fabrication methods on prototyping phases. One of the most significant contributions of each technical capability and utilities which FabrikaLab İzmir provides to its users, is the ability to test and identify necessary improvements on new outputs before the realization of the final products. Within this scope it is evident that, user groups like students have been utilizing the overall technical

capabilities of the lab for improving their homeworks, term projects and individual practices. Moreover, while evaluating the contributive aspects of these technical capabilities to fabrication processes, it is also possible to emphasize the importance of knowledge sharing between each actor for project development and improvement on prototyping stages.

Following this evaluation, the process of identifying the significance of technical capabilities on the main operational aspect of OD within the ecosystem continued with focusing on the participatory aspects on project development phases. While users are utilizing the overall infrastructural aspects, some participants also mentioned the importance of their intervention and guidance on the overall process. As mentioned by the participant (P3), it is important to signify the contribution of project optimization on prototype development phases and the guidance which they provide on users to make them able to select the most efficient technical capability for prototyping. As a similar explanation from another participant (P4), the importance of their guidance on users to start utilizing provided technical capabilities is evident within the ecosystem and stated that "*nearly in all prototyping phase users refer to these technical capabilities to visualize, improve and fabricate their desired outputs."* Since open fabrication refers to the openly accessible fabrication tools and manufacturing capabilities, whether digital or tangible for users to alter and manipulate (Phillips et al, 2013), it is possible to suggest an initial integration of open fabrication within the overall infrastructure of the selected ecosystem. Regarding this evaluation, when it comes to the visualization and the realization of varied project outputs, it is crucial to emphasize that FabrikaLab İzmir has been providing its main infrastructural aspects to multiple participants within an efficient approach.

4.4.2. Ecosystem Unit 2: Events

Second unit refers to the key finding from the *events* question set of in-depth interview, which specifically proposed to understand the overall structure within the ecosystem of FabrikaLab İzmir. Given section aims to analyze the selected key findings in relation with the co-creation driver of OD framework within fabrication processes. Regarding a collaborative approach, participants referred to the main contributive aspects of each and every different event within the ecosystem. As explained by the participant (P1) in a broader perspective, the issue has been considered towards the influential factors of events and co-creative acts on users and

how they have the potential to let users to develop different professional skills and attributes. Participant further explained the crucial factor of inspiring others to continue developing their individual skills regarding fabrication and generation of design-based knowledge, *"As a matter of fact, these kinds of events change into inspirational aspects for participants. This way when a person attends to a workshop dedicated to robot arm usage for example, they can gather new ideas and continue build on it to extend their capacity in terms of manufacturing and design knowledge."* Within this scope, it has been realized that the focus on attracting wide variety of users from different occupational backgrounds should be one of the main goals of fab labs ecosystems. Referring to the case study findings, this initial evaluation explains that fab labs ecosystems should become the main driver of providing individual motivation for gaining new skills and attributes through events and collaborative activities.

As a new perspective towards the given issue, which proposed by the participant (P2), as a public facility FabrikaLab İzmir could not provide sufficient event types and co-creation processes since the working hours is limited. Since the responsible unit is limited to a tight schedule, the selected ecosystem still can not present its full potential when it comes to co-creative aspects as a fabrication space. Within this sense, participant states that *"organizing events is just a starting point, in other words they are not enough to connect with varied participants or users. The necessary thing to do is to make FabrikaLab İzmir a more accessible and a flexible space for everyone for different event types and activities."* Considering this key finding, it is viable to suggest that as an ecosystem model, it would be beneficial for FabrikaLab İzmir to become a common ground between citizens and participants through a more flexible service delivery method.

It is also possible mention several positive aspects when it comes to the integration of co-creation driver within the given ecosystem. As an example stated by the participant (P3), the importance of knowledge sharing and distribution to facilitate the co-creative processes has been emphasized and participant further stated that different actors from other professions have enabled them to experience more efficient project and design development phases within the ecosystem. To elaborate on this statement, participant stated the following, *"Since participants from professional areas and the sector are more efficient on utilizing design and manufacturing software, they were guiding us to produce new and innovative outputs*

through their prior experiences." Considering this key finding within the light of the definition of co-creation, which has been signified as a bridge between employees and external participants which allow them to collaborate within a two-way spectrum for developing new outcomes Prahalad, and Venkatram, (2000), FabrikaLab İzmir has been considered as an efficient example within this scope. Referring to the participant's statement and the general findings of the case study, FabrikaLab İzmir has been collaborating with external actors from various backgrounds, thus as a public service they have realized the contributive aspect of the co-creation driver within their own service structure.

To evaluate the overall utilization of OD framework through events and co-creative approaches within the selected ecosystem, following section highlights several key findings regarding the "*participatory approaches"* question set from the in-depth interview. Participatory approaches question set was divided into three main sub-questions to understand how FabrikaLab İzmir has been utilizing design approaches of participatory design, co-design and co-creation within different event and activity types. Since each mentioned design approach have been identified as the foundational pillars of OD framework, given section acted as a vital part on understanding FabrikaLab İzmir's attitude toward the utilization of each approach as an organization. Within this scope, given section considered as a complimentary question set for *events* part, since participatory approaches demand a collaborative approach through varied users and participants on both theoretical and practical levels. Participatory approaches section aims to understand how often do FabrikaLab İzmir and participants utilize each identified design approach on varied events, participant's personal opinion towards the utilization of these approaches on various practical activities and lastly participants were asked to explain to what extend do they consider these approaches beneficial on project and design development phases.

As an initial approach, participants were asked to identify how often they utilize and integrate participatory approaches for events and planned activities. One of the participants (P2) considered the issue from a managemental perspective and explained that eventhough they had positive intentions to integrate these kind of approaches to every event and organization, they could not manage the process because of limitations related to organizational structure and overall service delivery type. According to the participant, being a part of a public service structure limits these kind of approaches in a significant way. Within this scope participant

mentioned the following, *"as a team we were in favor to utilize these kind of approach for every event we have planned, however just like i have mentioned before because were were a part of a public service, our working hours and management type limited us to realize every single goal and idea we had in our minds."* Considering this finding, in terms of utilizing participatory approaches for OD to operate within the selected ecosystem, FabrikaLab İzmir and its goal towards implementing these kind of design methodologies for their respective event types, still demand certain imporevements and re-arrangements. Since the given ecosystem presents a public service, the upper management within İzmir Metropolitan Municipality has the potential play a vital role in terms of providing a flexible fabrication space.

When it comes to knowledge sharing during events and collaborative acts, regarding these mentioned design approaches. Participant (P3) also referred to the "maker movement" and explained that participatory approaches should be the essential components of fabrication spaces to further develop innovative outcomes. Participant further highlighted the organizational culture of FabrikaLab İzmir and how it has approached the issue as an openly accessible space by stating the following, *"one of the most important feature of FabrikaLab İzmir was its ability to welcome varied users and participants from different age, gender and occupational backgrounds."* With this statament participant also point out the fact that, FabrikaLab İzmir have been trying to embrace such design approaches as a service delivery structure. Furthermore, participants also considered the current organizational approach on events within the participatory design framework. According to the participants who were and still a part of the responsible team within the lab, they prioritize the dialogue between responsible team and users to create an environment where knowledge transfer is a necessary method for learning processes. Regarding the academic literature, the maker movement has the potential to bring multiple actors and participants together to foster the creation processes through knowledge sharing and learning (Hynes and Hynes, 2018). Thus the given evaluation and the key finding related to the status within FabrikaLab İzmir, contributes to this nature via its institutional culture on events and collaborative acts.

The interview proceeded with participant's descriptions of personal perspectives towards participatory approaches on events and overall fabrication processes to further evaluate the operational aspect of OD framework regarding actors's

approaches towards the issue. According to the explanation provided by the participant (P2), most of the users provided positive returns and showcased enthusiastic behaviour regarding the utilization of participatory methods within workshops and other events. Participant further explained that, participatory approaches allowed them to create a bond between them and their user groups to further develop new and innovative outputs within various scopes. Participant also mentioned the influential factors within the ecosystem caused by these approaches and proposed a metaphor by explaining how maker culture and design-based development can become infectious components between multiple users. Referring to the given explanations, participant stated the following to further elaborate on the issue, *"when a user leaves our facility in a satisfied way, they also influence their other friends and potential participants to come and join the overall process which we heve been trying to deliver. This way we can suggest that fabrication culture and knowledge becomes and infectious virus, this is what we aim as an organization actually."* From a similar scope, participant (P3) also emphasized the importance of collaborative efforts on project and design development procedures within the ecosystem. Participant explained that, as a personal point of view it is suitable to consider participatory approaches as vital methods within such spaces. Within this frame, Participant suggested the following statement, *"eventhough a user applies to our facility with and individual project, along the way of development he or she has to meet and come together with people from different occupations. I believe that, for interaction and knowledge sharing these kind of approaches are very beneficial."* Regarding this key finding and the OD framework, the potential of fab labs on knowledge sharing and distribution is evident since it has been stated that, OD allows democratic and transparent methodologies and approaches for knowledge generation and distribution Wolf et al (2014). Within the scope of this evaluation, it is possible to acknowledge that FabrikaLab İzmir has been trying to implement both design-based konwledge generation and distribution regarding fabrication processes.

Interviews proceeded from a contributive perspective to the preivously mentioned opinions and the importance of participatory approaches on various activities and pre-defined event types has been emphasized. As suggested by the participant (P4), various professions and actors from different occupational background can contribute to design and development processes in a significant way. Participant elaborated further by stating that, *"being involved in design processes or letting other*

participants from different professions to take part in the total flow is a crucial factor which improves the overall design output and elevates it into a higher level." Similar to the given perspetive, an another participant (P5) contributed to the overall discussions by emphasizing the cruciality of participatory approaches on knowledge sharing and distribution among users. Participant also explained that these approaches allow them to evaluate the ongoing dialogue between them and their users to understand how they can guide and help them for design and development in a much better approach. Considering these findings, in FabrikaLab İzmir there is a constant focus on implementing such approached within various event types to elevate the overall fabrication processes regarding prject development.

For the last question of participatory approaches set, participants were asked to evaluate the beneficial aspects of these given approaches on project and design development phases. Regarding the question, participants explained that such approaches should be considered as integral components of fabrication spaces rather than complimentary aspects as interventions to events and various collaborative acts. A stated by the participant (P1), *"it is a necessity to develop these approaches as indispensable tools within such fabrication ecosystems. These kind of participatory approaches carries two different mediums, one of them is cultural and the other one is practical. Because of this nature, fabrication spaces should be transformed into a social crossroad where every other participant can come together to work on design projects and innovative interventions."*

From a more practical perspective in terms of operations and service delivery methods, participants explained that participatory approaches allows the opportunity for users to distribute design-based knowledge between each other. According to the participants, whenever there were multiple groups within the ecosystem working simultaneously, as responsible personnel they were tyring to get these groups together to make them get to know eachother. Referring to an individual observaion, participant (P2) stated the following while referring to this dynamic, *"we have observed such instances between multiple groups and this makes us very satisfied, since we can observe that with the help of such design approaches participants can come together and educate themselves."* Referring to this practical approach other participants also contributed from a similar aspect and mentioned that, as a team they have been trying to educate and guide users via these mentioned approaches on various events and activities. Participants also explained that, within the lab they

were aiming to make users get used to fabrication tools and manufacturing equipment via participatory approaches.

Even though the general perspective towards participatory approaches is positive, it has been higlighted that the overall innovation ecosystem of İzmir is still not yet efficient enough to fully integrate this nature and design methods to its own procedures during the interviews. As explained by the participant (P3), these kind of approaches are strongly effective and beneficial however, participant also stated that since İzmir is still in a development process these kind of design approaches are yet to become completeley integrated to organizational structures and applications.

Considering co-creation as one the main drivers of OD framework which signifies constant participation of users on creation processes (Fleischmann, Hielscher and Merrit, 2016), it is viable to state that the selected ecosystem of FabrikaLab İzmir presents significant yet initial attempts on providing varied event types to integrate this driver to their own fabrication procedures. However, it is also important to state that since FabrikaLab İzmir has defined as a publically accessible space, its overall service delivery is limited to certain time period, procedures and operational regulations. This key finding respresents the demand on transforming the selected ecosystem into a more flexible space, where different actors from different proffesional backgrounds can meet and collaborate together for new outputs and solutions.

4.4.3. Ecosystem Unit 3: Networking

The third and the last unit refers to the key finding from the *networking* question set of in-depth interview, which specifically proposed to understand the overall networking spectrum of FabrikaLab İzmir according to the answers gathered from the participants. Regarding the OD framework, following section considers the third essential driver designated as *open fabrication* as the main influential aspect to proceed with the evaluation. Within this consideration, participants approached the proposed questions on varied perspectives. To proceed with an efficent method on evaluting the key findings related to the selected unit, participants were asked to consider the overall networking structure of the ecosystem both internally and externally to allow the reserch to estimate the openness within the service structure. Through this scope, as mentioned by the participant (P3), İzmir Metropolitan Municipality has effected FabrikaLab İzmir in terms of expanding and enhancing its range and influence. Furthermore, participant also focused on municipalities from

other cities which have visited FabrikaLab İzmir to examine its service structure by stating, *"Other municipalities outside from İzmir visited us to learn about our working principles and system."* In terms of knowledge diffusion, participant's statement emphasizes that there was a constant information distribution among different organizations regarding service and system deliveries. Continuing with the evaluation on internal dynamic for management and operational steps, a key finding gathered as an answer from other participants presents a significant issues in terms of communication between individual departments within the overall ecosystem. As a user who utilized the provided ecosystem of FabrikaLab İzmir, (P6) approached the issue while presenting personal experiences regarding their own collaboration. According to the participant, the collaboration between their team and the lab's has enhanced their bond and solidified future possibilities for coming together again to develop new and different projects. Furthermore, Particpant also explained that, their collaboration also enabled the communication between Kaşıyaka Municipality and FikrimİZ Division, thus the overall ecosystem of FabrikaLab İzmir. According to participant's statement when they first initated their collaboration, it was possible to observe the lack of communication between two management bodies. Participant further explained that the personnel of Karşıyaka Municipality did not even acknowledge the personnel who is responsible within FabrikaLab İzmir. Within this sense, participant stated the following, *"if we consider İzmir Metropolitan Municipality and Karşıyaka Municipality as two separate institutions, the employees of Karşıyaka Municipality were not aware of FikrimİZ, Vocational Factory and therefore FabrikaLab İzmir, which is a space, governed under İzmir Metropolitan Municipality. They learned about it after I presented the project".* Through this statement, it is possible to suggest that varied connections and collaborative acts within the respective networking of FabrikaLab İzmir was able to strengthen the contemporary status of management capabilities in terms of communicative aspects. On the other hand, it is also possible trace the lack of communication between two main operative units.

Considering the external networking reach of FabrikaLab İzmir, Participants focused on FabrikaLab İzmir's indirect connection with NGOs and how it has provided necessary aid and guidance when it comes to reach and influence young unemployed and women population in İzmir. According to a stament of the participant (P4), FabrikaLab İzmir with its mission and vision has influenced multiple disadvantegous

groups when it comes to gaining new skills and attibutes via learning new ways on fabrication and manufacturing. Within this answer, FabrikaLab İzmir's ability to make varied participants gain new occupational skills has also been emphasized. Referring to OD and its main foundational framework, this statement also allowed this research to signify the ongoing participatory approaches within the general networking capabilities of FabrikaLab İzmir. Regarding the open service approach, application of this kind of a transprent method on service delivery signifies the main ideology of fabrication processes within the selected ecosystem of FabrikaLab İzmir.

Considering the contributive aspects of the current networking structure of the ecosystem, participants also provided several perspectives in terms of how varied colaborative acts can be considered as complimentary components for OD framework operate on project or design developments stages. Within this scope, Participants mentioned that, to discuss such an attitude the overall aim and organizational structure of the lab should be designed accordingly with the OD framework. Furthermore, participants suggested that with the help of these collaborations and provided accessibility to users, selected lab becomes more than just a fabrication space and can be considered as a "gathering point" for every actor within the ecosystem. As mentioned by the participant (P2), the overall networking structure of FabrikaLab İzmir was significantly helpful for fabrication and manufacturing processes by stating *"We observed that we could help people come together and produce since our lab was an open and accessible space. Moreover, when necessary, we provided training to our users and shared our knowledge with them."* Participant also highlighted that, with this approach user from different age and occupational groups were able to utilize the space. Similar to the key findings from the participatory approaches section, knowledge sharing and distribution have been stated once again. In terms of knowledge generation and diffusion, FabrikaLab İzmir consider the issues as one of their top priority goals for their fabrication and manufacturing processes with varied connections.

Similar to previously defined constraints from the first two ecosystem units, FabrikaLab İzmir's overall service delivery type once again emphasized through a management perspective. Because the general delivery method of the selected ecosystem is public, participants mentioned that this nature can also act as an obstacle for building new connections, thus effecting the total possibility of proposing new collaborative practices with other actors. As explained by the

participant (P4), this situation by mentioning the following, *"since we must provide a public service, as a team, we cannot give outputs which we can consider as innovative or new. This situation blocks many things in terms of achieving innovative outputs."* Participants further explained that their service delivery goals and the demand from participants or users don't match in terms of fabrication methods or projects scopes. While relating this issue to the internal networking structure, participants also mentioned that because of this situation, they have not been able to analyze projects according to their social and innovative impacts.

Following briefly re-considers and evaluates these key findings regarding the final essential driver, open service within OD framework for fabrication processes and realizes the term's main signification as the driver for the development of new design and project outputs through collaborative aspects which contains external knowledge utilization with multiple stakeholders like crowd, users, stakeholders and participants (Howard et al, 2012). Within this perspective it is viable to state that FabrikaLab İzmir main service delivery revolves around a rich networking structure with varied stakeholders and connections. It is significantly possible to trace the effects of this networking scope on seelcted ecosystem's main operational aspects as well as its events and various collaborative acts. One of the significant aspect to consider within this structure is the inclusive approach which focuses on disadvantegous groups like young unemployed and women population within İzmir. Considering OD's framework on providing democratic and transparent methods and accesibility towards design-based knowledge, it was important to evaluate on this key finding to present the contemporary dynamic within the given ecosystem. From a contrasting prespective, it is possible to consider the general management structure complimented by a public service delivery approach once again prevents FabrikaLab İzmir to transfrom itself a more flexible space in terms of enlarging it networking scope and add variations on connection profiles

4.4.4. The Ecosystem Units of FabrikaLab İzmir

After the evaluation on key findings related to each ecosystem unit, given section aims to reflect the overall picture of the respective ecosystem of FabrikaLab İzmir through each unit. Following figure represents the contemporary structure of the selected space through the signification of multiple sub-keywords which have been suggested by each participant during interviews. Considering the main goal and the research question of this dissertaiton, provided figure is a brief summary and a

representative element to show the overall dynamic of OD on fabrication processes within the selected case.

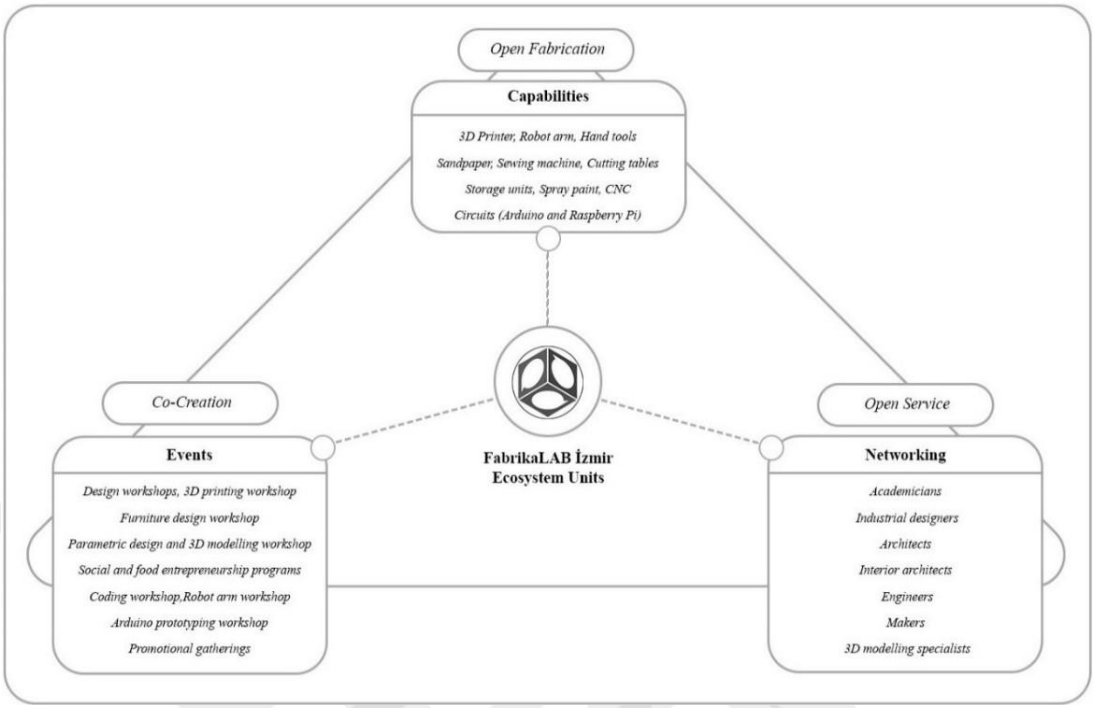


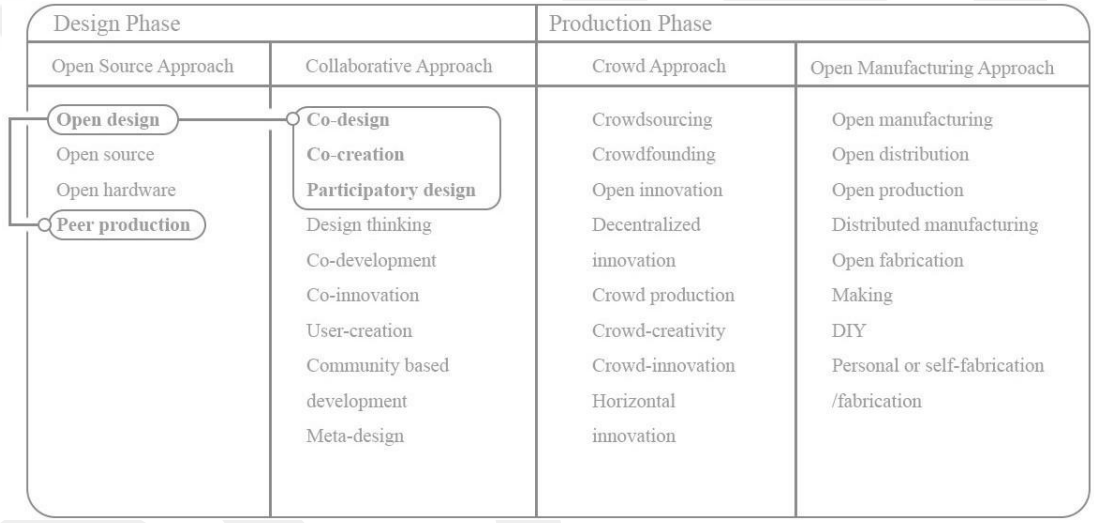
Figure 14. Ecosystem units of FabrikaLab İzmir.

Given figure and the total evaluation process contributed to the overall examination on how the selected case and its total ecosystem works and operates regarding the framework of OD. Each driver and component were contributed by multiple sub-factors through previously mentioned terms by each participant on events, infrastructural capabilities as equipments and lastly the overall networking spectrum of the selected case.

CHAPTER 5: CONCLUSION

From a contemporary perspective, OP in design research has the potential to elaborate on the shift towards closed and exclusive design processes to open and transparent methods (Aitamurto, Holland and Hussain, 2015). Within this approach it has been previously suggested that the paradigm has structured through two main aspects: *open products* and *open processes* by (Aitamurto, Holland and Hussain, 2015). To represent the consideration of this thesis on the given topic and how it has been framed to estimate a viable approach on shaping a research framework, following table has been presented to refer to the paradigm's main phases and approaches.

Table 15. Re-framing of the research (Source: Gasparotto, 2019, p.3).



As it can be observed from the table, the general approach of this thesis on the paradigm's total structure generated through the "*Design Phase*" and considered *open source* and *collaborative* approaches as the main pool of keywords to select and proceed with the overall framing. Within this scope, the dissertation proceeded with the selection of OD framework within the given spectrum. As the OD discipline within the design research field and the general structure of the OP continued to evolve both on theoretical and practical levels, the literature has designated the approach as;

> *"the state of a design project where both the process and the sources of its output are accessible and (re)usable, by anyone and for any purpose"*. (Boisseau, Omhover, and Bouchard, 2018, p.17)

Referring to this acknowledgement, Gasparotto (2019) higlighted the ongoing development on the term's overall reach within the research spectrum and how it has become a significant area to consider on designing processes and methods. Referring to the analysis from the second chapter on the framing of OD, the essential methodologies of OD designated as; *co-design, co-creation, participatory design* and *peer-to-peer* were selected within the first aspect of OP. Given designations allowed the research to proceed with the total scope of the OD approach to signify its main drivers for designing processes and how it has a potential to be implemented on service and system deliveries through a specific framing stage. Furthermore, the given framing process also contributed to the research prior to the consideration of OD through its spatiality.

To estimate the dynamic and the integration of OD within design phases, research enlarged its spectrum and referred to the maker movement to further signify certain spatial aspects of OD within manufacturing and fabrication processes.

> *"The rapid increase on the accessibility on information technologies contributed by subtractive technologies including 3D printers, has stimulated the rise of the so-called "maker movement."* (Bonvoisin, Galla and Prendeville, 2017, p.77)

On a contemporary level, it has the potential to democratize and propose equity on decision making processes for making procedures on different scales (Bonvoisin, 2016). As a result of this progression, both on individual levels of practices and large-scale projects fab labs has emerged within the spectrum to signify the evident influence of OD framework through spatial aspects such as infrastructural capabilities, manufacturing capabilities and tools.

Within the light of these previous discussions and explanations, this study aimed to understand and present the potential of OP in design and innovation ecosystems including different agents, actors, institutions, laboratories and other spatial aspects in terms of its influence on allowing new and open ways to design, create and produce innovative outputs. Contributed with the mentioned theoretical background, rather than embracing the term "design" itself only as a tool for realizing products and services through conventional approaches within the industry to meet the demands and needs of users, study acknowledged the given term as the main driver

for individuals to explore and allow them to discover their creativity to further expand the diffusion of innovative practices. Starting from the nature of openness ideology to the foundational aspects of OD processes, this research expanded its spectrum via analyzing OD through fabrication methods and tools. The scope of the research channeled its focus on understanding the dynamic of OD approach within the process of creating new outputs and artefacts, from the perspective of innovative outcomes with respect to the management of design through a certain service structure. Therefore, this study approached OD drivers through the ecosystem perspective and explored "*how open design operates in the fab lab ecosystems?".*

For the methodology part, the thesis focused on the contribution of OD processes within fabrication laboratories. The case study analyzed the process of OD within the selected fab lab ecosystem of "FabrikaLab" in İzmir, contributed by certain drivers and ecosystem components as criteria sets for the evaluation of the selected case in accordance with the OP and OD's main framework. Regarding the analysis on the third chapter, the general ecosystem components and fab labs were defined as *capabilities*, *events* and *networking* with the contributive aspects defined by The Fab Foundation, specifically The Fab Lab Network. Following this output, reconsideration of OD within fabrication processes provided the following essential drivers, *open fabrication*, *co-creation* and *open service*. Given drivers also contributed to the methodological approach of this dissertation.

Following the in-depth analysis of the literature and the data collection processes, preliminary research has been conducted as a site visit to the selected case's main ecosystem on 5 th of January 2023. Through individual observation, the overall spatial structure of the ecosystem has been determined. Within this preliminary stage, a pilot survey has been conducted on the current personnel of FabrikaLab İzmir within the site to identify the comprehensibility of the initial survey questions, which were derived and shaped from the previously defined criteria set through ecosystem components and essential drivers of OD within fabrication processes.

The snowball sampling method was utilized to enlarge the scope and reach to different actors who were and still a part of the generated fabrication ecosystem of FabrikaLab İzmir. The exponential discriminative snowball sampling method was selected as the main driver on the selection of each six participants from varied occupational backgrounds for the in-depth interviews. This way, in accordance with OD's ability to diffuse and distribute design-based knowledge, the effect of the

selected case and spatial area has been analyzed through varied participants and how they have contributed to the realization of new design outputs through fabrication.

Following this stage, an in-depth interview format has been realized to further investigate the main operational dynamic of OD within the selected ecosystem through each participant. Each participant was questioned approximately 40-50 minutes and with their consent each session was recorded for further analysis of the findings. The questionnaire has been divided into six main parts defined as, *infrastructural capabilities*, *networking*, *services*, *events*, *participatory approaches* and *open design* to implement the main criteria set derived from the main research framework. Given stage also identified and presented the status of how the ecosystem of FabrikaLab İzmir works and operates as a public service, contributed by the OP and OD frameworks through the unification of ecosystem components and essential drivers of OD within fabrication processes as "ecosystem units". Provided units were defined as, *capabilities*, *events* and *networking* specifically for FabrikaLab İzmir.

Results obtained from the case study, data gathering processes from the literature and the presented methodological steps signify that, the OD framework operates within fab labs ecosystems through three main ecosystem components which have defined on the previous sections. Considering these components as the main operational channels for OD to integrate itself to the overall structure of the ecosystem, it still requires certain drivers to fully function within various fabrication stages. Thus, this research has signified three main essential drivers of OD within fabrication processes. When these two main aspects complement each other, it has been observed that, a fabrication ecosystem has the potential to alter itself a significant space where transparent and democratic approaches are evident on design and development stages.

The selected case of FabrikaLab İzmir contributed to the realization of the general aim of this research and the overall research question by presenting its own operational aspects of its respective ecosystem. To evaluate the OD's main operational status within the case, the ecosystem of FabrikaLab İzmir shows that under the governance of İzmir Metropolitan Municipality, it has a rich and wide ranged networking spectrum with multiple actors from different occupational backgrounds. This networking spectrum directly effects the planning and the execution of varied events and collaborative activities within the ecosystem. The

case study showed that, FabrikaLab İzmir presents various event types for their users and citizens across İzmir as well as implementing participatory approaches within their activities and organized gatherings. To provide a sustainable service deliver publicly, FabrikaLab İzmir has been shaping-up its infrastructural capabilities in terms of fabrication and manufacturing tools. The case study analysis provided each capability to allow the research to further investigate the influential aspect of OD framework for stages like prototyping and project optimization phases.

As a result of the overall evaluation and the analysis regarding the case study findings, focusing on the ecosystem of FabrikaLab İzmir signified the ecosystem units as a unification of previously mentioned sets of ecosystem components and essential drivers of OD. Thus, the units belonged to the selected case has been presented on the fourth chapter and compiled with the specific findings which belongs to the FabrikaLab İzmir. First unit of capabilities aimed to investigate the open fabrication approach from the OD framework and to understand the general infrastructure of the given case through key findings derived from the participants. Second unit of events which complimented by participatory approached section, aimed to analyze and evaluate to what extend does the ecosystem of FabrikaLab İzmir welcomes varied participants to its own activities. Given unit also focused on understanding the status of integration of several design methodologies of co-creation, co-design and participatory design to build a connection with the co-creation driver of OD framework. Last unit of networking, which has been emphasized by the last essential driver of open service within OD framework, aimed to understand as a public service how FabrikaLab İzmir has structured its own networking spectrum for events and its service delivery through technical capabilities. From a brief analysis, FabrikaLab İzmir has been realized as significant ecosystem of fabrication spaces which carries each unique unit within its ow nature and institutional culture.

In terms of examining the nature of OD within fabrication processes, regarding the OP and its main structure, this research represented a contemporary perspective to given issue and signified the crucial contribution of the framework on design-based development through knowledge and information distribution. One of significant lesson learned from this research is that for OD to become integrated to such context, individual motivation and goals heavily influence the process within the ecosystem. Starting from each distributed role of actors within a service delivery instance such

as FabrikaLab İzmir's, OD demands the knowledge regarding its general nature, conceptualization and function to be utilized in the efficient way.

Considering the optimal structure of fab labs as defined ecosystems, the general space demands to be designed as a more flexible environment where multiple participants can come together to work, design, develop and fabricate as their own will and decisions. Furthermore, regarding the case study, such spaces like FabrikaLab İzmir must become much more agile and active for emerging issues within the public scene as well.

As a conclusive statement, this research acknowledges the OP's main structure of providing openly accessible design and development processes to people who has not been considered as designers. Research further signifies that; OD has the potential to be considered as a bridge and a path for them to be involved in the total process of creation and innovation. Re-evaluating OD and its operational aspects within fabrication spaces allowed this research to signify the involvement of various actors within a certain service structure to further understand the contributive aspects of the selected framework as a tool. Regarding the emerging innovation ecosystem of İzmir, there is a significant potential of altering the general structure of the city into a design-based ecosystem to fully comprehend the complementary nature of design to any given system flow. However, to provide such an effect and an alteration process, each responsible actor or citizen should carry a unique motivational attitude to allow a small drop to cause the most significant ripple within this pool of İzmir's multiple initiatives and projects. Considering the development process of FabrikaLab İzmir and its contemporary structure within this ecosystem, it carries a unique potential to integrate OD and its main methodologies to its own institutional nature. Even though the case study presented several aspects where OD is traceable and evident regarding FabrikaLab İzmir's management and service delivery structure, given space is still in development to fully comprehend this framework under the OP's main phases.

For future studies, OD and its essential drivers within fabrication processes has the potential to be investigated on different fabrication space types like maker spaces, living labs or even co-working spaces since every ecosystem has its own unique structure and service delivery methods. On the other hand, it is also possible to suggest a more narrowed down scale to re-consider the emerging innovation ecosystem of İzmir within the light of each key finding. Since FabrikaLab İzmir has

been defined as the sole fabrication space by The Fab Lab Network in İzmir and Fab Lab Ödemiş was inactive during the research period as a significant limitation, further studies have the potential to implement a comparative approach between other spaces and the selected case itself. When it comes to a practical approach, OD and its core methodology can influence citizens and non-designer participants to become the main part of decision-making processes for designing. Within this scope, there is a significant potential work and collaborate with different age groups, actors from different occupational backgrounds and especially disadvantageous groups to introduce them the design itself can be considered as a vital tool for improvement on both social and economic scales.

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APPENDICES

Appendix A: Pilot Survey Questions

Merhaba. Bu anket İzmir Ekonomi Üniversitesi, Tasarım Çalışmaları Tezli Yüksek Lisans Programı kapsamında ve Doç. Dr. Onur Mengi danışmanlığında yürütülen "Fab Lab Ekosistemlerinde Açık Tasarım: Meslek Fabrikası İzmir Örneği" çalışması için bilgi edinme amacıyla yürütülmektedir.

Kişisel verileriniz üçüncü şahıslarla paylaşılmayacak ve cevaplarınız anonim olarak değerlendirilecektir. Zaman ayırdığınız ve sorulara özenle cevap verdiğiniz için şimdiden teşekkür ederim.

Araş. Gör. Anıl Dinç Demirbilek

Aşağıdaki soruları lütfen Meslek Fabrikası özelinde cevaplayınız.

A) <u>Genel Sorular</u>

1. Yaşınız: …….....

2. Cinsiyetiniz: …….....

3. Eğitim Durumunuz: ……..

4. Mesleğiniz: ……..

3. Çalıştığınız Sektör: ……..

5. Belirttiğiniz sektörde kaç yıldır çalışmaktasınız?

……..

6. Meslek Fabrikası'nda kaç yıldır çalışmaktasınız?

……..

7. Meslek Fabrikası Fabrikasyon Laboratuvarındaki rolünüz nedir?

Rol: Tasarım yönetimi literatüründe "rol" kullanıcıların yürütülmekte olan bir iş kapsamında elde ettikleri yetkinlikleri ve görevleri tanımlamak için kullanılan bir terimdir.

□ *Eğitmen*

□ *Girişimci*

□ *Tasarımcı*

□ *Maker*

□ *Stratejist*

□ *Diğer (Lütfen belirtiniz.):*

……..

B) <u>Açık Tasarım</u>

Açık Tasarım (Open Design): Açık tasarım, tasarım bilgisinin (dijital veri, kültür vb.) ***halka/kullanıcılara açık ve eşitlikçi bir yaklaşımla paylaştırılmasına*** *ve bu sayede yeni ürün, servis ve sistemlerin geliştirilmesine imkân sağlayan bir tasarım ilkesidir. Açık tasarım kullanıcıların tasarım ve üretim süreçlerinde* ***aktif rol almalarına ve karar mercii haline gelmelerine*** *yardımcı olmaktadır.*

1. Kurumuzda ***açık tasarım süreci ile ilişkilendirilebilecek*** *olan bir projede yer aldınız mı?*

□ *Evet*

□ *Hayır*

Cevabınız evet ise,

1.2. Bu projedeki rolünüz neydi? (Lütfen açıklayınız):

……..

2. Proje ***sonuçlarına*** *bakarak,* ***açık tasarımın*** *aşağıdakilere olan katkısını nasıl değerlendirirsiniz?*

AÇIK TASARIM – PROJE SONUÇLARINA ETKİSİ					
	EN AZ	**AZ**	**ORTA**	**ÇOK**	**EN ÇOK**
Ürün Geliştirme	□	□	□	□	□
Servis Geliştirme (Girişimcilere sağlanan eğitim hizmetleri/destekleri vb.)	□	□	□	□	□
Sistem Geliştirme veya İyileştirme (Dijital modeller ve veriler için oluşturulmuş portal vb. altyapı	□	□	□	□	□

hizmetleri)					

C) <u>Alt Yapı</u>

1. *Meslek Fabrikası'nın katılımcılara sağladığı imkânlar nelerdir? (Birden fazla seçenek işaretleyebilirsiniz.)*

□ *Üç Boyutlu Yazıcı*

□ *Lazer Kesim*

□ *Bilgisayarlı Sayısal Kontrol-Frezeleme*

□ *Hassas Frezeleme*

□ *Devre Üretimi*

□ *Vinil Kesim*

□ *Diğer (Lütfen belirtiniz.):*

……..

2. *Proje **süreçlerine** bakarak, **yukarıdaki imkânların** aşağıdakilere olan katkısını nasıl değerlendirirsiniz?*

ALTYAPI – PROJE SONUÇLARINA ETKİSİ					
	EN AZ	**AZ**	**ORTA**	**ÇOK**	**EN ÇOK**
Ürün Geliştirme	□	□	□	□	□
Servis Geliştirme (Girişimcilere sağlanan eğitim hizmetleri/destekleri vb.)	□	□	□	□	□
Sistem Geliştirme veya İyileştirme (Dijital modeller ve veriler için oluşturulmuş portal vb. altyapı hizmetleri)	□	□	□	□	□

D) <u>Etkinlikler</u>

1. Kurumunuzda hangi etkinlikleri gerçekleştiriyorsunuz? (Birden fazla seçenek işaretleyebilirsiniz.)

□ *Tasarım Çalıştayları*

□ *Maker Eğitimleri*

□ *Girişimcilik Programları*

□ *Ideathon*

□ *Hackathon*

□ *Söyleşiler*

□ *Diğer (Lütfen belirtiniz.):*

……

2.Proje ***süreçlerine*** *bakarak,* ***yukarıdaki etkinliklerin*** *aşağıdakilere olan katkısını nasıl değerlendirirsiniz?*

ETKİNLİKLERİN – PROJE SONUÇLARINA ETKİSİ					
	EN AZ	**AZ**	**ORTA**	**ÇOK**	**EN ÇOK**
Ürün Geliştirme	□	□	□	□	□
Servis Geliştirme (Girişimcilere sağlanan eğitim hizmetleri/destekleri vb.)	□	□	□	□	□
Sistem Geliştirme veya İyileştirme (Dijital modeller ve veriler için oluşturulmuş portal vb. altyapı hizmetleri)	□	□	□	□	□

E) Bağlantılar (Network)

1. Meslek Fabrikası'nın bağlantılı olduğu oluşumlar hangileridir? (Birden fazla

seçenek işaretleyebilirsiniz.)

- *Eğitim Kurumları*
  - □ *Ortaokullar*
  - □ *Liseler*
  - □ *Üniversiteler*
  - □ *Diğer (Lütfen belirtiniz.):*

    ……
- *Tekno Parklar*
  - □ *İzmir Bilimpark*
  - □ *Teknopark İzmir*
  - □ *Depark*
  - □ *Diğer (Lütfen belirtiniz.):*

    ……
- *Kuluçka Merkezleri*
  - □ *Bambu*
  - □ *Classboom*
  - □ *Minerva*
  - □ *İBB Girişimcilik Merkezi*
  - □ *Diğer (Lütfen belirtiniz.):*

    ……
- *Ortak Çalışma Ofisleri*
  - □ *Originn*
  - □ *Korino*
  - □ *Piyano*
  - □ *Withco*
  - □ *Diğer (Lütfen belirtiniz.):*

    ……
- *Teknoloji Transfer Ofisleri*
  - □ *Atmosfer*
  - □ *Ebiltem*
  - □ *IEU*
  - □ *Embiryonix*
  - □ *DEU (DETTO)*

□ *Diğer (Lütfen belirtiniz.):*

……

*F) Proje **süreçlerine** bakarak, **yukarıdaki bağlantıların** aşağıdakilere olan katkısını nasıl değerlendirirsiniz?*

BAĞLANTILARIN (NETWORKLERİN) – PROJE SONUÇLARINA ETKİSİ					
	EN AZ	**AZ**	**ORTA**	**ÇOK**	**EN ÇOK**
Ürün Geliştirme	□	□	□	□	□
Servis Geliştirme (Girişimcilere sağlanan eğitim hizmetleri/destekleri vb.)	□	□	□	□	□
Sistem Geliştirme veya İyileştirme (Dijital modeller ve veriler için oluşturulmuş portal vb. altyapı hizmetleri)	□	□	□	□	□

G) <u>Hizmetler</u>

1. Dışarıdan aldığınız hizmetler var mı?

□ *Yok*

□ *Var*

Cevabınız var ise,

Ürünler

□ *Malzemeler (Lütfen belirtiniz); ……*

□ *El Aletleri (Lütfen belirtiniz): ……*

□ *Üretim Ekipmanları (CNC, 3B Yazıcı vb.)*

□ *Orijinal Ekipman Üreticileri (OEM)*

□ *Küçük Ekipman Üreticileri (SEM)*

□ *Diğer (Lütfen belirtiniz.):*

……..

Servis

□ *Tasarım Araştırması*

□ *WEB Sitesi Yönetimi*

□ *Sosyal Medya Yönetimi*

□ *Basılı / Görsel Medya*

□ *Sergi Kurulum Hizmeti*

□ *Diğer (Lütfen belirtiniz.):*

……..

Sistem

□ *Yazılım Programları*

□ *Modelleme Programları*

□ *CC (Creative Commons License)*

□ *Diğer (Lütfen belirtiniz.):*

……..

Appendix B: In-depth Interview Questions

Merhaba. Bu derinlemesine mülakat İzmir Ekonomi Üniversitesi, Tasarım Çalışmaları Tezli Yüksek Lisans Programı kapsamında ve Doç. Dr. Onur Mengi danışmanlığında yürütülen "Fab Lab Ekosistemlerinde Açık Tasarım: FabrikaLab İzmir Örneği" çalışması için bilgi edinme amacıyla yürütülmektedir.

Konuşmamız kayıt altına alınacak olup, kişisel verileriniz üçüncü şahıslarla paylaşılmayacak ve cevaplarınız anonim olarak değerlendirilecektir. Gerçekleştirilecek olan bu çalışmaya katılmayı kabul ediyor musunuz?

Yanıtlayacağınız soruların cevaplarını lütfen FabrikaLab İzmir çatısı altında gerçekleştirdiğiniz ya da parçası olduğunuz projeler kapsamında veriniz.
Zaman ayırdığınız ve sorulara özenle cevap verdiğiniz için şimdiden teşekkür ederim.

Araş. Gör. Anıl Dinç Demirbilek

Ekosistemin verimli ve detaylı bir şekilde incelenebilmesi için gerçekleştirilecek olan bu görüşme belli soru başlıkları altında gruplandırılmıştır. Görüşme sırasıyla ekosistem unsurları olarak organizasyonun alt yapısal özellikleri, bağlantıları (networking), dışarıdan aldığı hizmetleri, gerçekleştirilen etkinlikleri ve katılımcı yaklaşımları ve son olarak da temel teorik çerçeve ile ilişkilendirilmek için açık tasarım ilkesi altında gruplandırılmıştır.

A) <u>Alt Yapı</u>

1. Yapılan teorik ve ön araştırmalar kurumunuzda ***üç boyutlu yazıcı, lazer kesim, bilgisayarlı sayısal kontrol-frezeleme (CNC), hassas frezeleme, devre üretimi vb. teknik imkânların kullanıldığını göstermektedir.*** Sizin eklemek istediğiniz başka araçlar veya yöntemler var mıdır?

……

2. Proje ve tasarım süreçlerinin hangi aşamalarında bu teknik imkânlar kullanılmaktadır?

…….

3. Tüm bu teknik imkânların proje ve tasarım süreçlerine katkılarını nasıl

değerlendirirsiniz?

……

4. Bu teknik imkânlar tasarım süreçlerinde ne sıklıkla kullanılmaktadır?

……

5. Proje ve tasarım süreçlerinde en çok hangi teknik ekipmanlar tercih edilmektedir?

……

B) <u>Bağlantılar</u>

1. Yapılan teorik ve ön araştırmalar kurumuzun özellikle birçok dış paydaş ile işbirliği gerçekleştirdiğini göstermektedir. Bu bağlantıların arasında ***eğitim kurumları, tekno parklar, kuluçka merkezleri, ortak çalışma ofisleri, teknoloji transfer ofisleri vb. kuruluşlar bulunmaktadır.*** Sizin eklemek istediğiniz ve FabrikaLab İzmir'in bağlantılı olduğu başka kuruluşlar var mıdır?

……

2. Gerçekleştirilen bu işbirlikleri hakkında ne düşünüyorsunuz?

……..

3. Bu bağlantıları ve işbirliklerini hangi alanlarda projeler yürütmek için kullanıyorsunuz?

……..

4. FabrikaLab İzmir'in sahip olduğu bu bağlantıların, sizin gerçekleştirdiğiniz proje ve tasarım süreçlerine katkılarını nasıl değerlendirirsiniz?

……..

5. İş birlikleri süreçlerine en çok hangi meslek alanları ile bir araya gelmektesiniz?

……..

C) <u>Hizmetler</u>

1. Yapılan teorik ve ön araştırmalar kurumuzun dışarıdan almakta olduğu belli hizmetlerin olduğunu göstermektedir. Bu hizmetler arasında ***tasarım araştırması, malzeme alımı, web yönetim hizmeti, sergi kurulumu, sosyal medya yönetimi vb. hizmetler bulunmaktadır.*** Sizin eklemek istediğiniz başka hizmetler var mıdır?

…….

2. Bu hizmetlere yürüttüğünüz proje ve tasarım süreçlerinde ne kadar sıklıkla ihtiyaç duyuyorsunuz?

……

3. Belirtilmiş olan hizmetler arasında hangileri yürüttüğünüz proje ve tasarım süreçlerinde önemli bir etmendir?

……

4. Belirtilmiş olan bu hizmetlerin proje ve tasarım süreçlerine katkılarını nasıl değerlendirirsiniz?

……

5. Aldığınız hizmetleri göz önünde bulundurduğunuzda, en çok hangi meslek alanındaki kişiler ile bir araya geliyorsunuz?

……

D) <u>Etkinlikler</u>

1. Yapılan teorik ve ön araştırmalar kurumuz bünyesinde gerçekleştirmekte olduğunuz etkinliler olduğunu göstermektedir. Bu etkinlikler arasında ***tasarım çalıştayları, maker eğitimleri, girişimcilik programları, ideathon, hackathon, söyleşiler vb. hizmetler bulunmaktadır.*** Sizin eklemek istediğiniz başka etkinlik türleri var mıdır?

…….

2. Kurumunuz bünyesinde ne sıklıkta etkinlik düzenlenmektedir?

……

3. Bu etkinliklerde genelde rolünüz nedir?

……

Düzenlediğiniz etkinliklerin planlama aşamalarını göz önünde bulundurduğunuzda, hangi meslek alanındaki kişiler ile bir araya geliyorsunuz?

…….

4. Belirtilmiş olan bu etkinlilerin proje ve tasarım süreçlerindeki iş çıktıları açısından katkılarını nasıl değerlendirirsiniz?

…….

E) <u>Katılımcı Yaklaşımlar</u>

Katılımcı Yaklaşımlar: Katılımcıların ve diğer paydaşların (eğitmen, maker, stratejist vb.) tasarım sürecinde aktif olarak rol aldığı ve dâhil edildiği bir tasarım yaklaşım türüdür. İşlev ve sağladığı özellikler sebebiyle belirtilen yaklaşım, açık tasarım yönteminin alt yapısını ve temelini oluşturmaktadır. Bu sebeple katılımcı yaklaşımlar bu çalışma özelinde "etkinlikler" konu başlığı altında değerlendirilmiştir.

1. Gerçekleştirdiğiniz etkinliklerde, katılımcı yaklaşımlar (*participatory design,*

co-design, co- creation) ne sıklıkla kullanılmaktadır?

……..

2. Katılımcı yaklaşımlar hakkında ne düşünüyorsunuz?

…….

3. Katılımcı yaklaşımlar sizce proje ve tasarım süreçlerinde ne kadar faydalıdır?

…….

F) <u>Açık Tasarım</u>

Açık Tasarım (Open Design), tasarım bilgisinin (dijital veri, kültür vb.) halka/kullanıcılara açık ve eşitlikçi bir yaklaşımla paylaştırılmasına ve bu sayede yeni ürün, servis ve sistemlerin geliştirilmesine imkân sağlayan bir tasarım ilkesidir. Açık tasarım kullanıcıların tasarım ve üretim süreçlerinde aktif rol almalarına ve karar mercii haline gelmelerine yardımcı olmaktadır.

1. Açık tasarım hakkında daha önceden bir bilgiye sahip miydiniz?

…….

2. Burada çalışmış olduğunuz süreyi ve rol aldığınız görevleri göz önünde bulundurduğunuzda, açık tasarım ile ilişkilendirilebilecek bir proje veya tasarım sürecinde bulunmuş muydunuz?

…….

3. FabrikaLab İzmirbünyesinde oluşturmuş olan proje ve tasarım çıktıları sizce hangi oranda açık kaynak tasarım olarak kullandırılmıştır?

……..

4. Oluşturulmuş olan proje ve tasarım çıktıları hangi kanallar ve platformlar üzerinden açık kaynak tasarım olarak sunulmuştur?

……

5. Kurumunuz başka platform veya organizasyonlardan açık kaynak tasarım olarak paylaşılmış olan ürün, parça, model vb. etmenleri kullanıyor mu? Örnek verebilir misiniz?

…….

6. Kurumunuz açık kaynak tasarım ürünlerini ve parçalarını hangi platformlar üzerinden temin etmektedir?

…….

7. Diğer soru gruplarını da göz önünde bulundurduğunuzda, açık tasarım proje ve tasarım süreçlerinde sizce ne kadar öneme sahip? 1'den 10'a kadar puanlayabilir misiniz?

1. □ 2. □ 3. □ 4. □ 5. □ 6. □ 7. □ 8. □ 9. □ 10. □

Appendix C: Ethics Committee Approval

SAYI : B.30.2.İEÜ.0.05.05-**020**-*248* 05.01.2023

KONU : Etik Kurul Kararı hk.

Sayın Doç. Dr. Onur Mengi ve Anıl Dinç Demirbilek,

"Open Design in Fab Lab Ecosystems: The Case of FabrikaLab İzmir" başlıklı projenizin etik uygunluğu konusundaki başvurunuz sonuçlanmıştır.

Etik Kurulumuz 05.01.2023 tarihinde sizin başvurunuzun da içinde bulunduğu bir gündemle toplanmış ve Etik Kurul üyeleri projeleri incelemiştir.

Sonuçta 05.01.2023 tarihinde **"Open Design in Fab Lab Ecosystems: The Case of FabrikaLab İzmir"** konulu projenizin etik açıdan uygun olduğuna oy birliğiyle karar verilmiştir.

Gereği için bilgilerinize sunarım.
Saygılarımla,

Prof. Dr. Murat Bengisu
Etik Kurul Başkanı