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Fab Labs to Fab Cities: Exploring Innovative Urban Spaces in İzmir

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Abstract

This study focuses on fabrication laboratories (fab labs) that provide user-oriented innovative urban spaces to meet advanced technologies and city dwellers who can share their knowledge in solving local problems. The aim is to explore the potential of fab labs as a part of smart city initiatives to develop the fab city by creating a network for collective knowledge and technology-enabled production in collaboration with local communities, companies, NGOs, and institutions. The opted methodology is to examine several fab labs as innovative and creative spaces in İzmir to evaluate their potential role in the development of the fab city. Fab labs might improve the organizational gap between local governments and inhabitants in developing innovative and sustainable solutions. This paper fulfills the lack of systematic research on fab labs; how they relate to smart city initiatives, evolving into fab cities, and obtaining and implementing the know-how of fab cities' global knowledge.

Keywords: *Smart city, fab city, fab lab, participation, innovation, İzmir*

Fab Laboratuvarlarından Fab Şehirlere: İzmir'de Yenilikçi Kentsel Mekanları Keşfetmek

Öz

Bu çalışma, ileri teknolojileri yereldeki problemlere karşı çözüm üretme konusunda veri paylaşımı yapabilen kent sakinleriyle buluşturmak üzere "kullanıcı merkezli inovasyon ortamı" sağlayan üretim laboratuvarlarına (fab lab) odaklanmaktadır. Çalışmanın amacı, yerel topluluklar, şirketler, STK ve kurumlarla iş birliği içinde kolektif bilgi ve teknoloji destekli ürün üretimi için bir ağ oluşturarak, akıllı şehir girişimlerinin bir parçası olan üretim laboratuvarlarının potansiyelini keşfetmektir. Araştırmada tercih edilen yöntem, İzmir'deki yenilikçi ve yaratıcı mekanlar olan üretim laboratuvarlarından örnekleri incelemek ve İzmir'i Üreten Şehre (fab city) dönüştürme potansiyellerini değerlendirmektir. Üretim laboratuvarları, yenilikçi ve sürdürülebilir çözümler geliştirerek, yerel yönetimler ve kentliler arasındaki kurumsal boşluğu iyileştirebilir. Bu makale, üretim laboratuvarlarının akıllı şehir girişimleriyle nasıl ilişkili olduğunu, üreten şehirlere nasıl evrildiğini ve Üreten Şehirler (Fab Cities) küresel bilgi ağının nasıl elde edildiğini ve uygulandığını inceleyerek sistematik bir araştırma eksikliğini gidermektedir.

Anahtar Kelimeler: *Akıllı şehir, üreten şehir, üretim laboratuvarları, katılımcılık, inovasyon, İzmir*

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1. Introduction

In the burgeoning world of the modern era, many advancements in production and design processes have gained momentum with the high-speed travel of industry, technology, and information. With this jump created by the Industrial Revolution, the economy changed irrevocably which brought the producer and the consumer to become separated into visible and invisible economic circles (Toffler, 1980). Especially after the developments that occurred in the 19th and 20th Century which are the technological advancements such as "innovations in the mechanic arts", "mass-production", or more recently the "worldwide information superhighway" has caused breaking points in the historical process of these economic circles (Marx, 1999). Between the Great Depression and the Second World War, mass production carried its popularity with a vast array of products. These products were initially designed for the general marketplace and lacked the diversity and customization that small-scale production was promising their target consumers. While production was incorporating the new technological advancements, which have been gained throughout the war, the post-war industry was facing new demands from consumers; design and innovation (Sparke, 2013).

Makers, creators, and innovative-minded people who are in invisible circles have realized the economic gap since the early 20th Century. The action of 'Do It Yourself' came to the fore by these people who make and create on their own or with others for both their own needs and others. This rapidly spreading action culture has turned into a 'Maker Movement' in time. The maker environments such as maker spaces, hackerspaces, and fab labs are meeting and co-working points for the maker community. They come together, share their knowledge, learn with others, develop their skills, and collaboratively work. The Maker Movement Manifesto highlights the significance of 'making' that is claimed as an inference of being human (Hatch, 2013 as cited in Bingöl, 2019). In this manifesto, the culture of the maker community is revealed with nine titles: "make, share, give, learn, tool up, play, participate, support, and change". These nine characteristics show how maker culture has the intention to develop the ability and capability of people to produce. What is focused on in these nine characteristics is not money or profit-making but rather the development of the ability and capability of people to produce and change. In this regard, the maker culture may have the potential to bring back the "prosumer" as a powerful actor in the social, economic, political, and environmental dimensions of the city by closing the gap between consumer and producer through collaboration that is different from the common separation of consumer and producer in the industrial age. Thus, maker spaces have the potential to contribute to the local economy by supporting entrepreneurs, production, and manufacturing spaces in cities. This inclusive "networked society" mode of production has superseded and altered the ways of Fordist industrialism and manufacturing (Toffler, 1980; Baum et al., 2007).

This shows that the maker environments are part of a grander scheme than the actual space they are covering physically. The Maker Movement's power of value creation on smaller scales has been supported in the marketplace more recently in the US. Enterprises like Shapeways, ETSY, Rethink Robotics, Foxconn, Factorli, Facebook Buys Oculus VR, e-NABLE and many more have supported the maker culture in certain areas such as design, 3D printing & prototyping, sales, and robotics (Hagel et al., 2014).

The concept of innovation has been developed over three generations in Turkey and in the world (Velibeyoğlu, 2018 as cited in Bingöl, 2019). In the first generation, larger groups reach technology and knowledge from the 1960s to 1980, and information technologies and the internet changed the communication between individuals and organizations in the 1990s. For instance, through direct distance dialing, people are connected instantly regardless of the space between them. In the second generation, innovation is used by leaders and authorities to respond city's needs and necessities with the applications such as smart infrastructure, public transportation, car-sharing applications, and smart traffic solutions that reduce the density, clean energy, and lighting. This makes the concept serve for sustainability and quality of life. At last, the innovation in the third generation becomes an infrastructure and social network in cities by referring to an innovation based on a sharing economy. Innovation and creative spaces have appeared in the cities such as; design laboratories (design lab),

fabrication laboratories (fab lab), and living laboratories (living lab). These open innovation spaces have the intention to contribute to citizen participation and engagement in the innovation process.

As a continuation of the maker culture and integration of innovation, fab labs have become increased in the cities. This enhances their position in the city for the city. For example, Barcelona identifies itself as a fab city by announcing in 2014 that it will be challenged to produce everything they consume by 2054 (Fab Lab Barcelona, n.d.). Many small to medium workshops, manufacturing facilities, and initiatives are organized in a Fab City territorial prototype that is an old industrial neighborhood of Poblenou. These projects at Fab Lab Barcelona intend to put the Fab City vision into practice.

This study focuses on the fab labs that provide user-oriented innovation spaces to meet advanced technologies and inhabitants who can share their knowledge in solving local problems. They provide participatory processes to procreate design and innovation in a tangible, non-hierarchal, democratic working environment. In this regard, individual makers gain the opportunity to design and produce both individually and collectively in fab labs. The aim is to explore the potential of fab labs as a part of smart city initiatives to develop the fab city by creating a network for collective knowledge and technology-enabled product production in collaboration with local communities, companies, NGOs, and institutions. At that point, it is valuable to ask: To what extent do fab labs that organize and act in a network have the transformative potential in societal and technological challenges to create a fab city?

2. Material and Method

The opted methodology is to examine examples of fab labs in İzmir to evaluate their potential in seeking ways to produce technological innovations that can be combined with design and functionally integrate these innovations into the life of the city. Creative and productive individuals are given the chance to make production in person and they can gradually be involved in urban life with their products. In its common sense, fab labs provide the space, tools, and material to the individuals having an idea to implement it to life. In this regard, fab labs are local laboratories using technology to “make almost anything” (Gershenfeld, 2012). The idea of the fab city was facilitated by the Fab City Foundation which is a network of cities and a collective of thinkers, makers, and innovators (Fab City, n.d.). It is an urban model for self-sufficient smart cities in which citizens are empowered.

While examining the samples of fabrication laboratories in İzmir, 7 (seven) questions were prepared for the representatives of each laboratory to answer. There is a sample profile consisting of a total of 5 (five) people who are the representatives of 5 (five) fabrication laboratories in İzmir. In addition to the questions covering the basic properties of fab labs such as production capacities, legal partnership, ongoing projects, etc. in the questionnaire, it is valuable to probe the level of participation in the fab labs to understand the involvement of citizens in the design and production processes in the fab labs. This refers to probing the engagement of citizens, i.e., active engagement of citizens in collaboration with the fab lab, no active engagement of citizens.

This questionnaire has been sent out to the five fab lab representatives via e-mail, before a brief introduction of the study. Also, some of the fab labs provided personal exchanges for the matter.

The qualitative and quantitative data to be obtained from the questions will be included in this study without the aim of extracting statistics. The sample questionnaire is listed below:

1) How is the geographical impact range prediction foreseen for this fab lab?
2) How much is the production capacity of this fab lab?
3) What is the level of participation in this fab lab?
4) Is there any legal partnership formed in the making of this fab lab?
5) What is the aim of this fab lab?
6) How many people are currently working in this fab lab? What is/are their profession/s?
7) How many projects are currently ongoing in this fab lab?

3. Findings and Discussion

3.1. Smart Initiatives in İzmir

In recent years, technological waves of advancements have greatly shaped social life in the urban landscape. İzmir has been known as one of the pioneering cities in the Republic of Turkey with its smart initiatives. The city has the intention to develop digital solutions by facilitating involvement, engagement, and equal access to all its municipal services. Here are some attempts serving as smart initiatives:

- ASC-Open and Agile Smart Cities Network: İzmir Metropolitan Municipality has joined ASC-Open and Agile Smart Cities Network by aiming to develop digital solutions in İzmir (İzmir Metropolitan Municipality, 2020). The municipality forming the OASC Turkey network and the Istanbul Metropolitan Municipality will contact smart cities worldwide to learn about smart and innovative solutions. In this regard, this initiation has the potential to upscale local efforts for a transparent, democratic, and accessible city on a global scale.

- İzmir Transportation Hackathon: İzmir Metropolitan Municipality organized İzmir Transportation Hackathon to provide innovative solutions that will highlight sustainability, social benefit, and accessibility for the local problems detected by Metro Inc. (İzmir Transportation Hackathon, n.d.). The focus of the event is rail transportation which plays a significant role in urban transportation systems due to its high carrying capacity, energy efficiency, environmentalism, and accessibility. Some proposed solutions are about informing passengers how many seats are empty in which wagon, evacuating people from metro stations in case of fire, and saving energy in brakes made by mechanic control. This Hackathon supported by the European Union, the Republic of Turkey Ministry of Industry and Technology is also supported within the scope of the Innovation Centres activities to be opened within the scope of the Employment Creation Component of the Resilience Project in Turkey in response to the Syria Crisis, carried out in cooperation with the United Nations Development Program (UNDP) and the İzmir Chamber of Commerce.

- İzmir Open Data Portal: İzmir Open Data Portal was established by the İzmir Metropolitan Municipality to manage the city with a transparent, accountable, and multi-stakeholder structure is a portal where data about İzmir are published (İzmir Metropolitan Municipality, n.d.). Researchers, entrepreneurs, or users do not need a formal process to access data in the portal. The data taken from the portal can be analyzed, used in different studies, and shared.

- Sustainable Urban Development Network: İzmir Metropolitan Municipality is one of the municipalities participating in the Sustainable Development Goals and Strategic Plan Training Program in which the issues of connecting locals to global-scale agendas, thus climate crisis, poverty, inequality, and strengthening institutional resources and structures are discussed and decided to work together to achieve sustainable development goals (Sustainable Urban Development Network, n.d.). The sustainable development goals are to end poverty, end hunger, healthy and quality life, quality education, gender equality, clean water and sanitation, accessible and clean energy, decent work and economic growth, industry, innovation, and infrastructure, reduce inequalities, sustainable cities, and partnerships, responsible production, and consumption. The recently developed Sustainable Urban Development Network whose first secretariat was decided as İzmir Metropolitan Municipality also invites for inclusiveness of the socially vulnerable groups in the city.

- FikrimİZ Ideathon: As an event of İzmir Gasworks Youth Campus (İzmir Tarihi Havagazı Fabrikası Gençlik Yerleşkesi) and FikrimİZ pre-incubation centre, FikrimİZ Ideathon was a competition for the young entrepreneurs who have innovative and creative solutions for İzmir (İzmir Metropolitan Municipality Career Factory, n.d.). The two main axes of this marathon, as İzmir Metropolitan Municipality explained were: [1] The First axis is, what kind of space and programs the participants envision which will promote entrepreneurship in İzmir and how these ideas will be useful in design, spatial use, content, workflow; [2] the second axis is, what could be done to prevent brain drain and help the bright minds settle in İzmir, and to make İzmir the Silicon Valley of Turkey. Also, it was discussed what should be done to commercialize technological and innovative products and services

that will jumpstart İzmir and Turkey internationally, and attract entrepreneurship and start-up ecosystems into İzmir (Stage-Co Innovate, 2020).

In the framework of this study, FikrimİZ FabrikaLab as the fab lab is a smart initiative that needed to be mentioned which was empowered by İzmir Metropolitan Municipality. In addition to the fab lab led by İzmir Metropolitan Municipality, universities and individuals play a significant role in providing opportunities for fab labs in İzmir.

İzmir Creative Industries Ecosystem is a survey conducted between the 1st of July and the 15th of August 2020 by the İzmir Development Agency to determine the actors at the micro, mezzo, and macro-level (İzmir Development Agency, 2020) (Figure 1). The core of İzmir's Creative Industries Ecosystem is constituted, at the micro-level, of creative enterprises, communities, networking activities, creative centres, and non-governmental organizations. At the mezzo level, universities and research centres function within the creative ecosystem; at the macro-level, the institutions that are responsible for developing the policies and instruments to support the development of the creative industries, in the form of central and regional public institutions, local administrations and public professional organizations. In İzmir, the mentorship and incubation services are supported by universities and research centres, non-governmental organizations, and occasionally by some creative hubs and events.

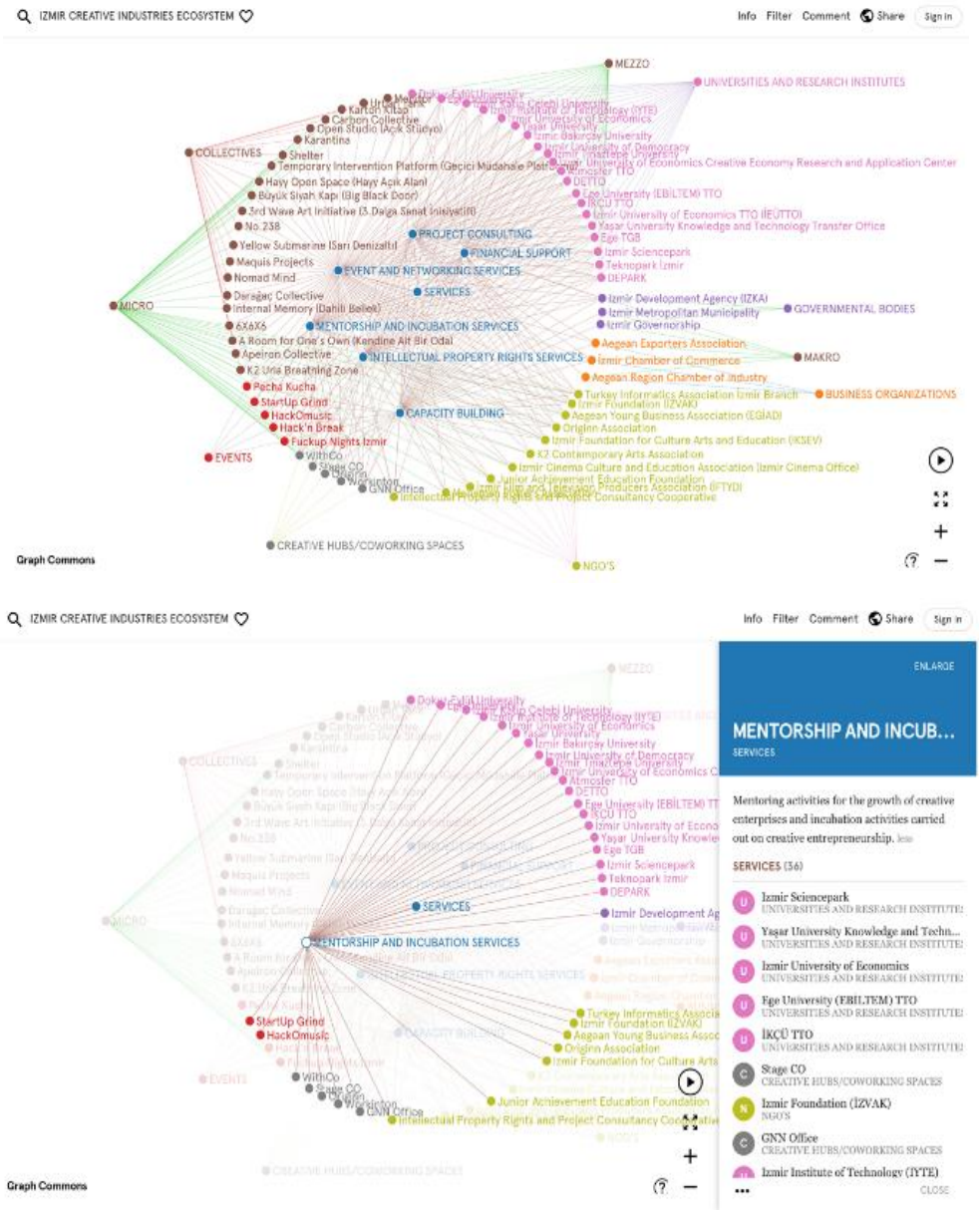

Figure 1. İzmir creative industries ecosystem by İzmir Development Agency (2020) by Bayrak & Akın, 2021

All in all, newly emerging projects of the İzmir Metropolitan Municipality aim to make İzmir a smarter, more sustainable (both naturally and financially), more technological, and more accessible city altogether. The near-term plans of İzmir Metropolitan Municipality including Information and Communications Technologies (ICTs) help to develop these innovations and make the cities' technologies more integrated into daily life.

3.2. Definition of FAB LABS

The rise in the participation and collaboration of individuals in the production of information, knowledge, or cultural goods (Benkler & Nissenbaum, 2006) refers to a digital revolution in the availability and openness of new information technologies. Following the first digital revolution in computation (personal computers) and the second digital revolution in communications (mobile phones), the next generation, according to Gershenfeld (2005), is the digital revolution in the manufacture of physical goods, in other words, personal fabrication. Furthermore, Kohtala (2017, 386) asserts that fab labs are part of a new industrial revolution that is "beyond the circumscriptions of the current industrial system: networked, distributed and enabling people's full potential".

Fab Labs are the abbreviation of fabrication laboratories are 'place[s] to make (almost) anything (Gershenfeld, 2005). Offering a commons-based peer production approach, they provide access to a range of low-cost fabricators. Fab labs originated from the course on digital design and fabrication given by Prof. Neil Gershenfeld at CBA (Center for Bits and Atoms) founded by MIT (Massachusetts Institute of Technology). In From bits-to Atoms: How to make almost anything, Gershenfeld (2012) constitutes his revolutionary manifestation with the collection of accumulated knowledge in this MIT course. The first fab lab was established in Boston in 2001 with the funding of the US National Science Foundation, and following the next three years, fab labs in Costa Rica, India, and Ghana were initiated (Bingöl, 2019). Following consecutive initiations, Fab Foundation was established as an organization for networking and collaboration in 2006. Fab labs can become network nodes to support other nodes by participating in this foundation. This provides the acknowledgment of every new fab lab by other existing ones. Besides, Fab Foundation launched the Fab Academy which is a formal training program given by different network nodes. This program links local labs together under a global network.

The official definition of fab labs according to fablabs.io (n.d., para. 1) web portal in which the list of fab labs across the world, their contact information, the set of devices, and the team of employees are found is that "a fab lab is a place to play, create, learn, mentor, to invent: a place for learning and innovation. Fab labs provide access to the environment, the skills, the materials, and the advanced technology to allow anyone anywhere to make (almost) anything."

The mission of the fab lab is "to provide access to the tools, the knowledge and the financial means to educate, innovate and invent using technology and digital fabrication to allow anyone to make (about) anything" (Fab Foundation, n.d., para. 1). This mission highlights the keywords of innovation, democratized accessibility, and openness. As Gaeiras (2017) asserted, fab labs provide democratized access to innovation and entrepreneurship with the availability of knowledge and technologies to any citizen. In this regard, fab labs have the potential to explore new models for open design, open innovation, open education, etc. (Kohtala, 2017). This makes fab labs the "centers of community-driven innovation, where problems can be solved using local materials, and those solutions can be shared with similar communities around the world-while" (Angrisani et al., 2018, p.2).

The planning of innovation through fab labs may be top-down or bottom-up. For example, in 2005, a network of fab labs was launched by South Africa to encourage innovation in a national context through its National Advanced Manufacturing Technology Strategy (Gershenfeld, 2012). On the other hand, a fab lab in Detroit initiated by the entrepreneur Blair Evans acts as a social service by creating an environment for at-risk youth to design and build things (Gershenfeld, 2012). Regardless of their type as top-down or bottom-up, fab labs have the intention to build better communities by building up things through digital fabrication.

Considering the initiation figure of fab labs, Coşkun (2021) categorizes fab labs into three groups: institutional-public, institutional-private, and grassroots-community. The physical space is universities, schools, and public spaces for institutional-public ones, and is co-working spaces, business offices,

design offices, and foundations for institutional-private ones, and associations, foundations, and third places for grassroots-community ones. The institutional-public fab labs and grassroots community are supported by public funding, also including volunteer work for grassroots-community. On the other hand, the business model of institutional-private fab labs is crowdfunding or private funding. The institutional-public and grassroots-community types of the fab lab are non-profit whereas institutional-private has a hybrid character in terms of profit.

The several studies that have been examined have different definitions of fab labs. It is divided by their definitive sentences via keywords, to explain it thoroughly (Table 1). The keywords that are predominantly extracted from the literature are innovation, openness, networking, collaboration, co-creation, participatory, democratized accessibility, sustainability, and entrepreneurship.

Table 1. The keywords extracted from the literature are shown

Keywords	Definition
Innovation	Facilitating innovative manufacturing techniques (Ropin, et al., 2020) Being localized spaces in which innovation, making, and creativity occur (see, e.g., Capdevila, 2017; Schmidt, 2019; Schmidt & Brinks, 2017; as cited in Johns & Hall, 2020) Being centers of community-driven innovation (Angrisani et al., 2018) Empowering citizens and fostering innovation (Gaeiras, 2017)
Openness (Open Innovation, Open Design, Open Source)	The proliferation of sites of open innovation, including open workshops, hackerspaces, maker spaces, FabLabs, living labs, and urban laboratories (Johns & Hall, 2020) Creating new possibilities in STEM (science, technology, engineering, and math) education in diverse contexts (Angrisani et al., 2018) Exploring new models for open design, open innovation, open education, etc. (Kohtala, 2017)
Networking	Being embedded in local economies and wider maker networks (Johns & Hall, 2020) Being part of a global community and collaborating with other fab labs (Gaeiras, 2017) Being different from the current industrial system: networked, distributed, and enabling people's full potential (Kohtala, 2017) Having their distinct network and identity (Kohtala & Bosqué, 2014)
Collaboration	Being innovative, collaborative economic spaces (Gershenfeld, 2005, 2012; as cited in Johns & Hall, 2020). Providing openness and collaboration in STEM education (Angrisani et al., 2018).
Co-creation	Suggesting the importance of team creation and how learners collaborate inside them (Milara et al., 2017) Implicating co-creating visions of a better world (Kohtala, 2017)
Participatory	Providing the participation of industrial companies capable of proposing activities with a high level of innovation (Angrisani et al., 2018) Having a mode of participation of members of the open community (Morel & Le Roux, 2016)
Democratized Accessibility	Democratizing access to the modern means to make things (Gershenfeld, 2012, p. 48 as cited in Johns & Hall, 2020) Making knowledge and technologies available to any citizen (Gaeiras, 2017) Promoting democratized access to innovation and entrepreneurship (Gaeiras, 2017) Offering "democratic", "widespread access to the means for invention" (Gershenfeld 2005, p. 42)
Sustainability (Social, Environmental, Financial)	Having a sustainable business model to maintain their activity to get funds (Gaeiras, 2017) Creating sustainability by participating in creating their technological tools for finding solutions to problems (Mikhak et al., 2002, as cited in Milara et al., 2017) Making economic sustainability their priority (Kohtala & Bosqué, 2014)

Entrepreneurship	Creating entrepreneurial opportunities and advancing society in general (Gershenfeld, 2005, 2012; as cited in Johns & Hall, 2020) Giving a boost to local entrepreneurship and job (Angrisani et al., 2018) Implementing its broader strategy in favor of innovation and entrepreneurship (Gaeiras, 2017)

3.3. Examples of FAB LABs in İzmir

In this study, five fab labs in the city of İzmir have been examined: FabrikaLab İzmir in Konak, Yasar University Design and Application Centre (YÜTAM) in Bornova, Fab Lab IZTECH in Gülbahce, Fab Lab İzmir Tınaztepe in Tınaztepe, and Ödemiş Fab Lab in Ödemis (Figure 2). Two of the fab labs are initiated by the municipality, three of them are university founded and actively used, and the last one was a joint project of two private institutions which is no longer in use. In addition to these fab labs, a virtual lab initiated by Goethe Institut & Institut Français was a temporary fab lab workshop that took place in Göztepe, İzmir in 2018 (Kültür İçin Alan, 2018).

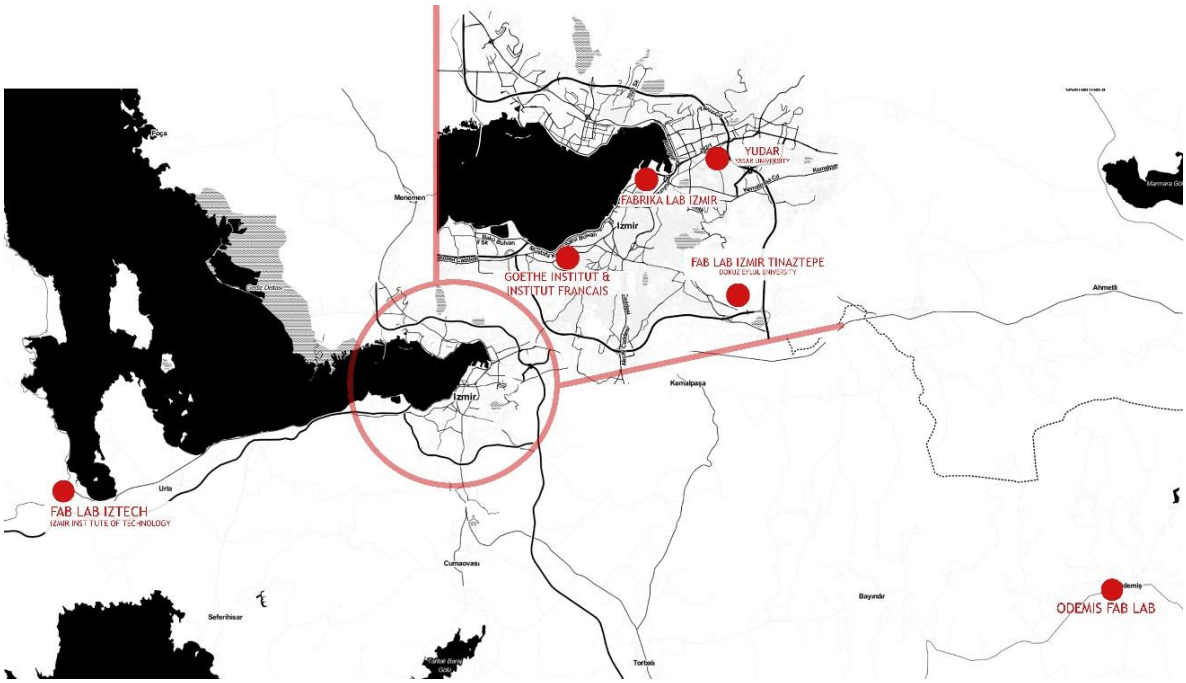

Figure 2. The Fab Labs in the City of İzmir are Shown on the City Map. The Base Map is retrieved from http://maps.stamen.com/toner/#11/38.4493/26.9378

3.3.1. Yaşar University Design Application and Research Center (YÜTAM)

YÜTAM is Turkey's first international design centre founded in 2012, on the premises of the Yasar University campus in Bornova, İzmir (Figure 3, 4, 5). Financed solely by Yasar University funds, YÜTAM serves mainly İzmir province, but its geographical impact range prediction could also reach to Aegean Region. For instance, YÜTAM helped health workers during the production shortage of quarantine and produced visors for them during the 2020 Covid-19 pandemic.

YÜTAM provides a different range of equipment: conventional machines, electric and manual hand tools, different types of CNC machines, robotic arms, numerous 3D printer machines, and high-precision laser cutters. This design centre also helps users reverse-engineering the designs with 3D scanners and could manipulate them with virtual tools to archive optimal products. The production capacity of the fab lab can vary according to the project type. Approximately 15 people can work simultaneously on their projects depending on the equipment capacity. However, working unattended with some of the equipment requires a mandatory 16-hours training provided by YÜTAM, and some other equipment (i.e., a robotic arm) cannot be accessed without supervision.

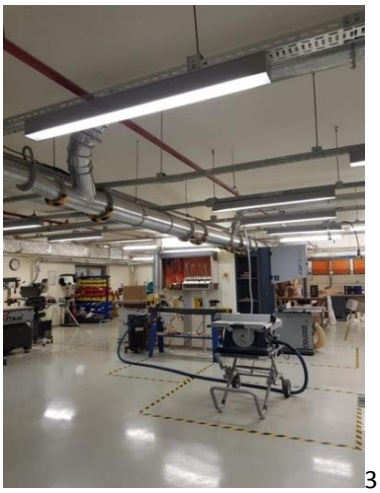
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Figure 3, 4, and 5. YÜTAM Design Application and Research Center, Bornova, Yaşar University (YÜTAM, 2021)

Designers can implement their projects with the help of several machines for the most realistic production. YÜTAM does not involve the design process, but simply generates users' designs. They aim to serve designers, predominantly their own institution's students, alumni, associates, and professors; with their studio projects, graduation projects, BAP (scientific research project), TÜBİTAK, and EU projects for whom do not have access to this kind of laboratory and equipment, or could afford to implement their project elsewhere. They do not charge their users for the processes, but most of their users bring their materials nonetheless. Even though fab labs can make a profit from the work they've done, YÜTAM explained they have no desire to make a profit but to remain a sustainable business model with minimum costs. At the time being, they have only 2 full-time employees; the Director of YÜTAM and the Head of the Industrial Design Department at Yasar University Tolga Benli, Ph.D., and one technician. They also have two university students as part-time workers. Currently, they have several ongoing projects at YÜTAM (2021): 3 BAP projects, 7 student projects, and 1 TÜBİTAK project. Although it is not accredited in the official FabLab network, it has the same characteristics and aims to serve as a fab lab.

3.3.2. Dokuz Eylül University - DESUM / FAB LAB İzmir Tınaztepe

Fab Lab İzmir Tınaztepe (Figure 6 and 7) was established in 2015 by DESUM (Dokuz Eylül University-Industry Application and Research Centre) in alliance with the university's other initiatives; DEPARK (DEU Technopark) and DETTO (DEU Technology Transfer Office) funded by Dokuz Eylül University via BAP grant. Their vision is to create synergy with the private sector and public institutions in the fields of research, education, and social service within the framework of university-industry cooperation and to establish, operate and maintain functioning mechanisms that will contribute to economic and social development at national and regional dimensions. Fab Lab İzmir Tınaztepe asserts it was established to produce structural or functional prototypes of digital designs at various scales, using various materials. They mainly aim to serve their institution members who live in the city of İzmir. In Fab Lab İzmir Tınaztepe, projects are carried out in line with the demands of DEU's faculty members, and Ph.D. or Master's level students. This fab lab provides its users with CNC Router, 3D Printer, Laser Cutter and Engraver, and 3D Scanner.


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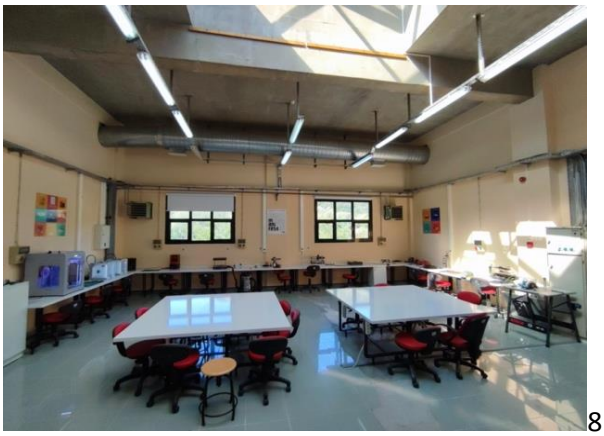
Figure 6 and 7. Fab Lab İzmir Tınaztepe Workspace, DESUM, Dokuz Eylül University (Fablab İzmir Tınaztepe, 2021)

Currently, there is only 1 full-time employee at the fab lab, who is a computer engineer. For users who have the proper competence to work with the equipment, Fab Lab İzmir Tınaztepe allows them to have access to the machines on their own. Even though there are no active projects at the time being, the fab lab had several projects; creating templates with laser cutting for Environmental Engineering Ph.D. program students, model printing with a 3D printer within the scope of Electrical and Electronics Engineering Undergraduate Graduation Project, for Biomedical Engineering PhD. program student and undergraduate students of the Architecture Department (Fablab İzmir Tınaztepe, 2021).

3.3.3. FabLab IZTECH

Established in March 2021 within the IZTECH Department of Industrial Design, FabLab IZTECH (Figures 8, 9) has been funded within the scope of the IZTECH BAP Research Infrastructure Strengthening Project. The fab lab aims to create a maker space for a diverse range of students, faculty members, and all inventors that wish to experiment in openness, and create and share innovations by collaborating, co-creation and co-design.

FabLab IZTECH provides its users with digital manufacturing tools like FDM and SLA type 3D printers, laser cutting machines, vacuum forming machines, and CNC; also, as manual modeling tools like a handsaw, sanding paper, hand motor, thermoform machine, and circle sander. In terms of equipment, FabLab IZTECH can respond to the needs within the İzmir Institute of Technology campus and has a geographical impact area that can serve the extent of İzmir province in the information ecosystem, cooperation, project, and consultancy processes.


8

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Figures 8, 9. FabLab IZTECH Workspace, Gülbahçe, İzmir Institute of Technology (FabLab IZTECH, 2022)

Compared to many fab labs where digital production tools are prioritized, FabLab IZTECH aims to prioritize the concepts of co-creation, local production, and learning together, and to encourage new craft and post-industrial production mentality with an open-source workshop structure. They encourage its users to become a part of the platform of knowledge production and share their know-how. 2-3 project teams a day can use digital tools at the same time. In addition, 2 more teams can benefit from the workshop space. Two project teams use fab labs a month, but it is aimed to increase this number 4-5 times in 2-3 months with various projects and promotions. One industrial design

student and a workshop technician are currently working at the fab lab. Currently, there are seven ongoing projects in the fab lab (FabLab IZTECH, 2022).

3.3.4. FikrimIZ - İzmir Metropolitan Municipality Career Factory / FabrikaLAB İzmir

The first fab lab established by a municipality in Turkey, FabrikaLAB (Figure 10, 11) is an innovative initiative of İzmir Metropolitan Municipality that started as a part of the İzmir Development Agency (IZKA) İzmir City College Guided Project in 2014. FabrikaLAB İzmir was founded in 2018 with the help of Yasar University Research, Development, and Application Center (serves under a new name, YÜTAM now) on the precedents of fab labs in Turkey and around the world. There are one Laser Cutter, Vinyl Cutter, Computer-Aided Sewing Machine, Robotic Arm, Band, Circular Saw, Lathe, CNC Router, four FDM technology 3D Printers, one SLA technology 3D Printer, and one 3D Scanner in the fab lab workshop area of 300 m^2. In addition, hand tools that can be used in the prototype production phase are also available in the fab lab.


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11

Figure 10 and 11. FabrikaLAB İzmir in Career Factory, Alsancak (FikrimIZ FabrikaLAB İzmir, 2021)

FabrikaLAB also provides materials, use of equipment, and mentorship by their expertise or selected individuals from the FikrimIZ mentoring pool. Since the year 2018, FabrikaLAB has interacted with 6414 users through their visits, workshops, fairs, and project applications. Though, 233 people have actively participated in innovative projects, training programs, and competitions in FabrikaLAB İzmir by fabricating prototypes of their designs. FabrikaLAB İzmir asserts:

FabrikaLAB İzmir creates opportunities and provides equipment, machinery, and space for those who have ideas and wants to procreate their designs and who want to be a part of collective and scientifically driven social transformation in addition to technological innovation and progress. The aim is to make advanced technology, enabling digital and conventional production tools for everyone in today's world; where the quality of education declining, education is being commercialized and the digital culture entails individualization. FabrikaLAB İzmir renders an experience of space, where science, innovative design, and technology are welcomed by everyone creating, developing, and achieving (FikrimİZ FabrikaLAB İzmir, 2021).

3.3.5. FikrimIZ - İzmir Metropolitan Municipality / FABLAB Ödemiş

FabLab Ödemiş has been established in 2015 in Ödemiş, İzmir. This fab lab project was funded by the İzmir Development Agency (İZKA) and continued to operate under Ödemiş Municipality until the year 2020 and later became inactive.

The fab lab is located at the industrial site. They provide 3d printing, laser cutting, CNC routing/milling, extensive sewing/embroidery, and small-scale electronics production services to inventors from all demographics. In addition to the design and production in a wide variety of fields such as home-office-outdoor furniture, kitchen utensils, decorative objects, household goods, electronic goods, robots, medical equipment, and textile products, with existing machines, depending on the supply of necessary external components. Since many different functions can be performed up to machine production, a net production capacity cannot be said.

FabLab Ödemiş is open to everyone and although there are opportunities for everyone, including individual entrepreneurs, high school and university students, those working in production areas, product designers, SMEs, and corporate companies, the level of participation has remained very low since its establishment in 2015.

FabLab Ödemiş aims to combine the classical production methods with new technologies, help inexperienced designers get integrated into the knowledge network, and support incubation processes to be prototyped and produced. Anyone interested in any level of production can improve themselves by participating in training in the fab lab and increasing their potential by sharing what they have learned with new people they meet.

Although the fab lab is dormant at the time being, Ödemiş Municipality's spokesperson for the fab lab has announced that the municipality has plans to revive FabLab Ödemiş by restructuring the labor regulations and paving the way for new recruitments (FabLab Ödemiş, 2021).

3.4. Discussion: FAB LABS to FAB CITIES

The Fab Labs, located in the city of İzmir, have different characteristics and aspects to cover (Table 2). A simple inquiry was conducted with each Fab Lab directory to examine them more systematically. The sample questionnaire has been sent to each of them and each has reciprocated. All the data of these Fab Labs in this study has been cross-checked in light of this information.

Table 2. Characteristics of Fab Labs in the City of İzmir are shown

Name of Fab Labs	Found. Year and Location	Funds	Type	Legal Partnership	Geographical Impact	Accessibility Characteristics
FabrikaLAB	2018 İzmir	Local government	Institutional public	FikrimİZ, İzmir Metropolitan Municipality	City / Region	Invite only
FABLAB Ödemiş (inactive)	2015 İzmir	Local government	Institutional public	FikrimİZ, İzmir Metropolitan Municipality & Odemis Municipality	Town	Invite only
YÜTAM	2012 İzmir	University	institutional public	-	City / Region	Invite only
FAB LAB İzmir Tınaztepe	2015 İzmir	BAP aided University	institutional private	DESUM, DEPARK & DETTO	City	Invite only
FabLab IZTECH	2021 İzmir	BAP aided University	institutional public	-	City	Invite only

These five fab labs, one of which is already inactive and waiting to be revived, have no interrelations with each other. Even though in the inquiry process, the YÜTAM director revealed they aided in setting up the equipment of FabrikaLAB, this remained as a singular exchange and the two fab labs have not been in contact ever since as the other ones aforementioned in this study. However, fab labs have the potential to expand beyond their physical and social boundaries and start a conversation with other fab labs. This enables them to expand their sphere of influence and begin to reach a larger scale. They can play a significant role in Fab City Program whose aim is to enhance the collaboration between fab labs and actors (universities, research centres, public administrations) to create a solution for the urban environment (Fab City, n.d.). However, upscaling fab labs mean neither providing accessibility and technological availability to everyone nor turning the whole city into a laboratory. It is about creating a community having a culture of knowledge production and sharing. At that point, it becomes valuable to question the strategy of fab city to develop this understanding.

IAAC, MIT's CBA, the Barcelona City Council, and the Fab Foundation initiated the concept of Fab City connecting to the global Fab Lab Network. The Fab City (n.d., p. 10) whitepaper prepared by Fablabs.io, which is in a collection of online resources for the international Fab Lab community, claims that they are "*proposing a model for cities to be resilient, productive and self-sufficient in order to respond to the challenges of our times and to recover the knowledge and the capacity to make things, to produce energy, to harvest food, to understand the flow of matter, to empower its citizens for them to be the leading agents of their destiny.*" The current literature on the fab city is guided by this definition of a still-developing timeframe following its initiation in 2016 (Diez, 2017; Hildebrant et al., 2022; Rigobello & Gaudillière, 2019). The Fab City whitepaper draws attention to the possibility of becoming a global network. By valuing humans and nature, it comprises ten values: ecological, inclusive, globalism, participatory, economic growth and employment, locally productive, people-centered, holistic, open-source philosophy, and experimental. The manifesto clarifies the focus of fab city as community-centered by highlighting the technological inclination of the locally productive community, governance with participatory, open-source, ecological, globalism, and economic growth (Rigobello & Gaudillière, 2019). The keywords in this manifesto evoke an understanding of how to respond to the whole ecological and social challenges the world is facing.

The Fab City Prototype has the potential to provide a paradigm shift from the current linear economy to a circular economy by making consumers design actors, enhancing the production process at a local scale, and sharing knowledge globally (Diez, 2017). The prototyping project strongly emphasizes business model innovation for circular economies, commons-based production, and open source. This prototype contrives the collective transformation for more resilient city life with the start of an individual change. In other words, the local and global transformation starts with the self-transformation of the citizen. Citizens passing from passive engagement to active engagement learn to design, produce and share knowledge locally and globally. They will find local solutions with digital technologies and share their approach with others through the global network. Thus, they become a participant in the production process and get involved in a network. In this regard, the Fab City Prototype does not provide only environmental and cultural but also economic and social benefits by creating new jobs and professions in the knowledge economy and technological solutions. Besides, it needs to be highlighted that this initiation creates an opportunity for the development of collaborations between different private and public actors such as universities, municipalities, private cooperation, etc.

İzmir Metropolitan Municipality with its fab lab initiatives has the infrastructure and resources to become a generator for collaboration between different scales. According to the directive on working procedures and principles by the Department of Social Projects Career Factory Branch Directorate, collaborating with universities, professional chambers, non-governmental organizations, and public institutions/organizations is expressed among its powers and responsibilities (İzmir Metropolitan Municipality, 2021).

4. Conclusion

In this study, considering the intention of the city of İzmir for initiating smart solutions for local needs, it is asserted that fab labs in İzmir may have the potential to develop a locally productive and globally connected city. The number of fab labs may be increased, and they may become neighborhood community production spaces. In that sense, each neighborhood may develop technological solutions for local needs and share its knowledge with other neighborhoods. The networking between neighborhoods may enable them to reach broader contexts by establishing local communication networks on a city-by-city basis and establishing a network with the membership of the fab lab foundation on a global scale. As a result, anyone can create anything anywhere. Gershenfeld (2012, p. 57), in “How to Make Almost Anything: The Digital Fabrication Revolution”, asserts:

> *Digital fabrication is an evolving suite of capabilities to turn data into things and things into data. Many years of research remain to complete this vision, but the revolution is already well*

underway. The collective challenge is to answer the central question it poses: How will we live, learn, work, and play when anyone can make anything, anywhere?

The probe of the understanding of anything anywhere and anytime introduces the U-city referring to "a built environment where any citizen can get any services anywhere and anytime through any ICT devices" (Lee et al., 2008).

The shift to individual production processes has strongly influenced the DIY movement as well as the rise of prosumers whilst they started to invest in production machines which are becoming more affordable and accessible each year (Toffler, 1980). The know-how and the intellectual heritage created by the exchange between designers/manufacturers remains the most important aspect of collective, collaborative, participatory, and inclusive production spaces. Knowledge production and sharing help circular production and economy which helps cities to be a part of a healthier financial ecosystem. As Stacey (2014, p. 221) asserts, fab labs "can be centres of community-driven innovation, where problems that governments and corporations have not addressed can be solved using local materials—and those solutions can later be shared with similar communities around the world."

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This study has collected data from each case study of fab labs in İzmir. The authors have contacted these fab labs and sent them a sample questionnaire to obtain the necessary information. Due to the limitations of this publication, these inquiries are excluded from the paper. However, these inquiries can be shared on demand.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. We hereby declare that there is no conflict of interest.

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