

KAROLINA KAPUSTKA

Uniwersytet Jagielloński, Kraków, Polska / Jagiellonian University, Kraków, Poland

Location patterns and factors influencing Polish makerspaces

Abstract: Makerspaces (MS) represent a type of new working space (NWS), a subject addressed by numerous researchers. Nevertheless, among the abundance of publications on NWS, only a limited number discuss the detailed distribution of MS and address the significant issue of their location factors. This article aims to supplement these research gaps based on the example of Polish makerspaces, through a comprehensive database of Polish NWS and spatial analysis conducted through GIS systems. According to the results, there is a predominance of MS in the main metropolitan centers, alongside a rising significance in peripheral areas while a co-occurrence of MS with other institutions focusing on innovation, creativity and education is recorded. It is also pointed out that location factors related to transportation are mainly found in large urban centers, but not noticeable elsewhere. Through the use of in-depth interviews, the author points to the significant relevance of social factors in the MS creation phase, together with accessibility and infrastructure-related factors. In addition, crucial components impacting on MS establishment include the engagement of MS members, municipal support, location and the characteristics of the MS environment. Lastly, the validity of the rules and regulations of organizations supporting the creation of MS are outlined.

Keywords: location factors; maker movement; makerspace; new working spaces; Poland; spatial distribution

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Introduction

Makerspaces (interchangeably referred to in the publication as MS) are acknowledged as a type of new working space (NWS) (Akhavan, 2021), which includes coworking spaces, living labs, fablabs and hackerspaces (Micek et al., 2024). NWSs are designated workspaces that provide opportunities for collaboration and knowledge sharing with users, as well as enabling social and spatial relationships in the work environment (Micek et al., 2020). Often, they are seen as potential anchors between “business, cultural and creative industries, civil society and education” (Cattabringa, 2019: 92).

MS emerged into widespread use at the beginning of the 21st century (Sharma, 2021) and gained immense importance on a global scale (Cattabriga, 2019). It should be emphasized that the MS phenomenon is best studied and visible in western parts of the world, especially in the USA and Western Europe. Nevertheless, there is a scarcity of publications showing a comprehensive overview of NWS locations, including the distribution of MS, especially in the Central and Eastern European context (Rafaj et al., 2024). The existence of these spaces has been reported previously in Poland (Sala, 2017), while the latest research indicates their growing relevance (Gądecki & Piziak, 2022). Thus, the main objective of this study is to identify the location patterns of MS in Poland. Furthermore, based on established literature (Mersand, 2021), the article distinguishes the types of enterprise in which MS are mostly found.

An additional objective of the article is to determine the location factors for MS due to the diversity of makerspaces (Mersand, 2021). Whilst the topic so far has been studied based on the example of coworking spaces (CS), it should be emphasized that there are important differences between CS and MS (Micek et al., 2020). Thus, the article discusses a topic that has not been addressed previously. In addition, the occurrence of MS relates to the culture of the maker movement where, as stated by Gądecki and Piziak (2022), it is largely driven by both place and the location of the space itself, so learning about the factors determining the emergence of MS is of significant value to the body of literature.

Referring to the goals indicated above, the author's research endeavors to answer the following research questions: (RQ1) what are the main patterns of MS location in Poland? (RQ2) what are the main factors influencing MS location in Poland? Moreover, this article examines previous research on MS which was primarily based on a case study format (Sharma, 2021) using surveys and interviews (Mersand, 2021). Instead, the research here is based on a mixed-method approach, which follows the analysis of Sharma (2021) who pointed to the increasing importance of using more diverse research methods and techniques to analyze MS. Additionally, the article seeks to advance the understanding of MS, in line with the need identified by Micek (et al., 2024) for a more in-depth categorization of makerspaces.

Literature review

Maker movement and makerspace

Recent years have shown a growing interest in the idea of the maker movement (van Holm, 2015; Akhavan, 2021), which refers to the concepts of do-it-yourself and do-it-together (Peppler, Bender, 2013). Initially, the movement was a grassroots initiative, however, due to its capacity to stimulate innovation it has gained global prominence (Dougherty, 2024). The principal characteristic of the maker movement is to define human beings as both creators and developers, rather than assigning them only the role of consumers (Otieno, 2017). Additionally, individuals engaged in maker movement activities, and using spaces related to it, are referred to as makers. An in-depth definition is provided by Mounde et al. (2020: 4) as "any individual who utilises a makerspace to build and create."

Physical space for makers is called makerspace (Micek et al., 2024), and the name itself was popularized in 2005 as part of MAKE magazine (Akhavan, 2021). MS refers

to business models of the sharing economy, whereby they represent an area of collaboration in terms of sharing manufacturing assets (Szymańska, 2021).

Within the literature, the term makerspace has a twofold meaning – in the narrower sense (*stricto sensu*) MS is understood as a workshop that enables the use of tools and the implementation of projects (Friessnig, 2021). They are collaborative workspaces, equipped with publicly accessible appliances (van Holm, 2015; Cattabriga, 2019), enabling learning through training and workshops (Micek et al., 2020). Gądecki and Piziak (2022) also introduce a *stricto sensu* MS definition, classifying them as creative-workshop spaces understood as “a place where people can meet freely to make, repair or invent new things, using traditional crafts or new technologies in individual or collaborative activities.”

On the other hand, in broader terms (*lato sensu*), MS is referred to as a subtype of space, including fablab and hackerspace (Gądecki, Piziak, 2022; Micek et al., 2024). Fablabs are publicly accessible workshops (Sala, 2017) operating at the interface of information and communication technologies, specializing in digital technologies for rapid prototyping (Micek et al., 2024). Hackerspace, by contrast, focuses on information technologies (and specifically software programming) (Micek et al., 2024). All the spaces identified are physical spaces where maker movement activities are implemented, having a similar structure and focus on community support (Rosa et al., 2017). However, they differ in terms of the use of the spaces (Capdevila, 2017), origin and form of the activity (Rosa et al., 2017) as well as in equipment and method of operation. Additionally, Capdevilla (2017) shows in his research that types of NWS should be understood as separate spaces.

Spatial distribution of MS

Among all NWS types, co-working spaces are the most commonly established (Rafaj et al., 2024), while MSs are reported significantly less frequently. Nevertheless, the MS phenomenon is recorded worldwide, where current estimates indicate that globally there are over 2000 (Dougherty, 2024). In addition, it is assessed that the number of active MS globally increased fourteenfold between 2006 and 2016 (Lou, Peek, 2016), so the trend of their expanding operations is clearly seen. Additionally, based on a map of their international distribution (Makerspace Map, 2024), the highest concentration is observed in the USA. Whereas, in terms of EU countries, the occurrence of a minimum of one (*lato sensu*) is indicated in each member country (Rosa et al., 2017), with a concentration in France, Germany and Italy. The number of MS is the highest in the Western European countries, with Poland ranking only 10th (Rosa et al., 2017). Meanwhile, the most up-to-date research on NWSs indicates that 15 MS were established in Poland between 2007 and 2021 (Rafaj et al. 2024).

Gądecki and Pizak (2022), studied the newest distribution of workshop-creative spaces in Poland, which included MS (*stricto sensu*) pointing out that the vast majority are located in the major metropolitan capitals, primarily in Warsaw, Kraków and Gdańsk. Therefore, they confirm previous analyses by Sala (2017) whose results showed an inequitable spatial distribution of makerspaces, fablabs and hackerspaces within Poland. According to the 2017 study, Mazowieckie Voivodeship dominated, while the fewest MS were located in the eastern part of Poland (Sala, 2017).

NWS have so far been recognized as an urban phenomenon, however, they have spread beyond designated areas (Mariotti et al., 2021). Location patterns indicate their

tendency to locate in major urban centers (Mariotti et al., 2021) with an enhanced distribution in metropolitan areas (Gato, Haubrich, 2024). In terms of suburban areas, NWS are located close to large metropolitan cities (see the example of Italian CS in Mariotti et al., 2021), particularly focusing on regions with high accessibility to skilled labour, knowledge and innovation (Mariotti et al., 2017). Also highlighted however is the increased diffusion of NWS to peripheral and rural areas (Vogl, Akhavan, 2022).

A study by Kim et al. (2022) analyzing the MS literature, provides insights into the dominance of MS location in urban and suburban areas. The results of this study are confirmed by Rafaj et al. (2024), where cities such as Warsaw, Kraków and Wrocław are identified as the primary distribution areas for Polish MS. At the same time, research by Nixon et al. (2021) has shown that the importance of MS located in rural regions is increasing.

MS types in relation to their location

Mersand (2021) points to MS differentiation in terms of physical location by identifying three main types. The first is a temporary center where tools and materials can change on a rotating basis, and can take the form of an equipment cart or portable modules (Moorefield-Lang, 2015; Gierdowski, Reis, 2015). Another type is the so-called 'mobile makerspace' (Mersand, 2021) which, following Moorefield-Lang's (2015) definition, is a location that can move, noticeable in the creation of buses, which move within cities and therefore are independent of geographical places. Lastly, the most widely discussed type of MS is the stationary type, which is based on the presence of tools and materials which "are always available to participants in the same space" Mersand (2021: 175).

Initially MS were associated with universities (Mounde et al., 2020), therefore their location often refers to higher education institutions. Current MSs are developing outside of universities or wider inventive activity areas (Gądecki, Pizak, 2022) and are associated with social and educational institutions (Halverson, Sheridan, 2014) which include public and school libraries as well as academic ones (Gierdowski, Reis, 2015). This connection stems from the library's role of providing resources and learning opportunities to the community, and thus linked to the core values of the maker movement (Kim et al., 2022); one of the largest groups of institutions at which makerspaces are located is in fact schools (Høibo1 et al., 2024). Thus, the literature highlights the co-occurrence of MS with other developmental, educational or innovative facilities. Furthermore, co-occurrence with innovation units is also noticeable, examples of which are high-tech clusters (Giusti et al., 2020). Makers draw on their ability to absorb knowledge from cluster ecosystems in areas such as ICT, telecommunications and software (see the Italian cluster example in Giusti et al., 2020). Hollands (2015) analyzed MS at BMW, through which the high importance of MS in generating creative solutions and prototyping was noted. There are also MSs in hospitals, reported by Svensson and Hartmann (2018), which have contributed to increased innovation there.

Location factors of NWS

Previous studies of NWS location determinants have pointed to traditional factors as explaining the phenomenon (Mariotti et al., 2021), a discussion undertaken by Szymańska and Płaziak (2014). Budner (2007) also emphasizes the considerable diversity of general

location factors focused among three generalized groups: spatial-environmental, techno-economic and socio-political.

Regarding NWS location factors, Małochleb and Wojnar (2022), identified them using agglomeration economies theory with an emphasis on the strong co-location of NWS with other companies, especially 'hot spots' of advanced producer services (Coll-Martínez, Méndez-Ortega, 2023). Research by Mariotti et al. (2021) outlined that the location patterns of NWS relate to service industry patterns in urban and creative cluster areas. In addition, a high density of economic activity, proximity to dense services and business activities or proximity to a center (Coll-Martínez, Méndez-Ortega, 2023) were also underlined. Concerning NWS location factors, attention is drawn to the demand for NWS by local residents (Orel, Kubátová, 2019), where the needs of a community to have places that allow collaboration and interaction with colleagues are analyzed (Advikos, Merkel, 2020). However, recent results for NWS location factors show that their relationship with location theories cannot be established (Mariotti, Micek, 2024).

Wang et al. (2022) categorizes the types of activity relevant to the location of a NWS as catering, recreational and medical facilities. In terms of food service infrastructure, cafes, restaurants, bars and pubs in close proximity to the space is important (Sutriadi & Fachryza, 2021). Further considering recreational services, fitness centers and sports facilities are indicated (Tiwari, 2022). Wang and Loo (2017) further emphasize accessibility to banks, municipal offices and institutions, which can be particularly useful in terms of administrative procedures. Moreover, accessibility to transport and the presence of local public transportation is discussed as a key factor, while Coll-Martínez and Méndez-Ortega (2023) outline the correlation of NWS with transportation amenities. In this regard, Di Marino and Lapintie (2017) point to the high importance of tram, metro, train or bus stations.

Considering locational factors, MS show that the most relevant typology is in terms of socio-material relations (Debowski et al., 2024), as they fit into a community and are modeled to ensure that their objectives correspond.

Methodology and data

Given the widespread use of the term MS in the literature, this analysis only considered spaces whose nature of operation fitted Gądecki and Piziak's (2022) definition and the author's stated criteria. Thus MS had to be a public physical space (widely open to any user, usually free of charge) and providing access to innovative tools (e.g. laser plotter, 3D printer). In addition, the activities carried out in the MS had to relate to the DIY style and the ideas of the maker movement, along with educational activities in a broad sense. Accordingly, NWSs that do not meet these characteristics were excluded from the analysis. The study was based on mixed-method approach.

For the analysis, a database containing aggregated data on functioning Polish MS, current as of June 2023, was used. The database was constructed using desk research and a web investigation of websites designed for maker movement members. Information about the type of MS was recorded for each space based on Mersand's (2021) breakdown and expanded by those described in the literature review on where MS occurs (using Google Street View).

Additionally, in-depth interviews were conducted with 16 representatives, managers and owners of MS, and one interview with an expert, throughout 2022 and early 2023.

The selection of interviewees was driven by the need for an insightful understanding of the underlying intentions that prompted them to open a MS. For the in-depth interviews, a questionnaire was used consisting of questions about the collaboration of MS with partners, the rationale for setting up the space, including the choice of a particular location for the MS headquarters, and the motives for choosing the premises for the MS office. Analysis of the interviews was carried out using MaxQDA software, on the basis of which the factors of MS location were determined, and divided into three groups, i.e. social, economic, and accessibility and infrastructure-related. A division was applied based on previous analyses undertaken by the author in the publication of Małochleb (2022) and the breakdown of general location factors detailed by Budner (2007). Subsequently, the relevance of each of these factors was analyzed and its validity was classified based on a 5-point scale. For very strong importance, a value of 5 was assigned, while irrelevance was attributed a value of 1. Similarly, values were allocated for strong, moderate and low levels. The assessment was carried out by analyzing the respondent's naming of the factor, or in some related language. Overall relevance was then aggregated and assessed by deriving an average.

The main location patterns of MS were explored through mapping and descriptive statistics. In terms of visualizing the distribution, geographical coordinates assigned to individual MS positions from the database were used utilizing QGIS software. For the spatial analysis, distance buffers were determined from each of the MS based on the coordinates contained in the database within a five-minute walking distance. The buffers were generated using QGIS and geoprocessing tools. Subsequently an extensive list of NWS location factors adopted in the study by Małochleb and Wojnar (2022) was used. For the acquisition of data for the location factor categories, the QGIS program and the QuickOSM plug-in were used, permitting the collection of data directly from OpenStreetMap resources. Then, with the assistance of vector analysis, the results for individual factors were determined within a buffer of five minutes. Factors in the form of polygons were converted via geometry tools to centroids. The records were then assigned separately for each MS, which made it possible to determine the number in each spatial unit according to the chosen categories of location factors indicated in Table 1. The division into categories was implemented from the section used in the study of Małochleb and Wojnar (2022) and includes categories such as transportation and food services.

Results

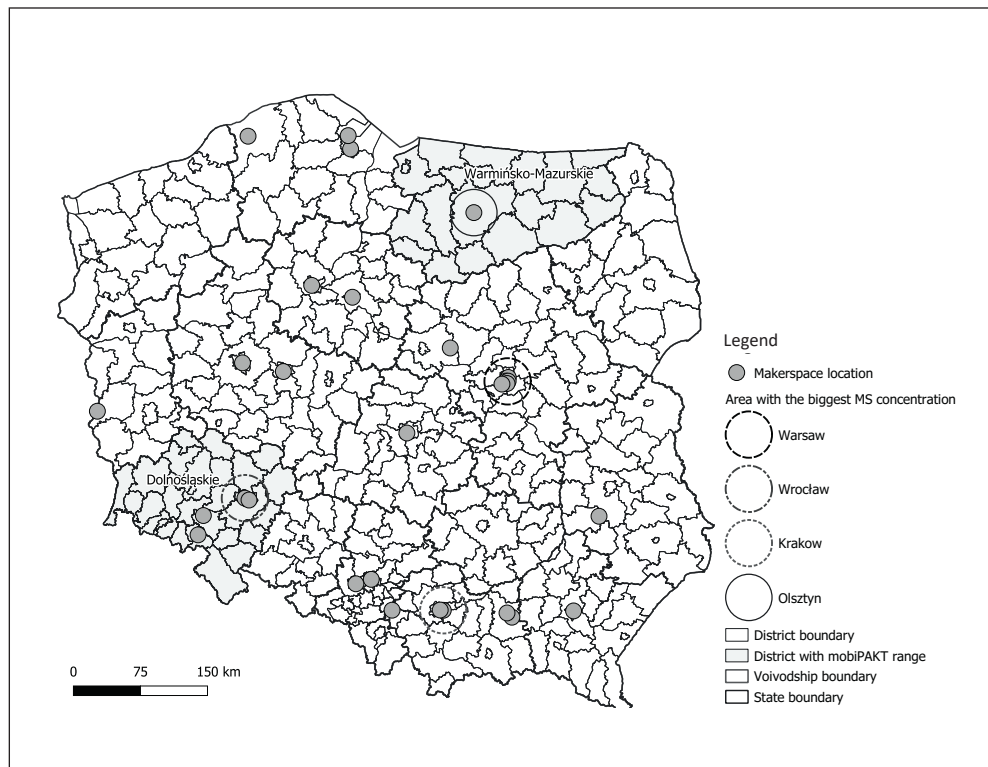
Characteristics and spatial distribution of Polish MS. Analysis of Polish MS indicated the occurrence of three MS networks, the most numerous of which are the makerspaces of Pracownia PAKT (*Pracownia Aktywnego Korzystania z Technologii* – Eng: Workshop for Active Use of Technology) (6 MS), followed by the Orange Foundation (5 MS) and Men's Sheds (4 MS). The first MS were created on the basis of financial support from the European Union and provide modern spaces for educational activities for students, teachers and adults. The Orange Foundation makerspaces are established with its support creating MS in areas with a population of less than 40 000 residents, based on grants to equip already functioning Orange Workshops. At this point, it is important to highlight the considerable development of the Orange Foundation's activities for the creation of MS in peripheral areas, which is linked to further grants for the equipping of new spaces. Men's Sheds are MS that are supported by the company Julia, which provides

makerspaces with tools and materials. The name MS is not registered and can be used by everyone, without restrictions.

As of 2023, 31 MS fitting the definition applied in the article are functioning in Poland. The vast majority representing public institutions (18 MS), defined as spaces developed by the government (including Pracownia PAKT) and operating in public establishments, along with Men's Sheds and makerspaces created by the Orange Foundation. Nine MS constituted private units whose activities were run by profit-oriented individuals. The least numerous type is the so-called private-public MS operating on the basis of cooperation with a state entity (e.g. an innovation center or a science and technology park) but managed by individuals.

In Poland, the idea of mobile MS is developing, provided through the PAKT foundation. Such spaces are called mobiPAKT and are established in the form of buses equipped with modern do-it-yourself equipment, enabling knowledge and activities to reach peripheral areas. Until now, there have been two mobile MS operating in the Warmińsko-Mazurskie Voivodship (with headquarters in Olsztyn) and Dolnośląskie Voivodship (with headquarters in Wrocław) (see Figure 1). It should be noted that these also have stationary offices in addition to mobiPAKT. The remaining 29 MS are stationary spaces, the vast majority of which operate in rented or private premises (19 MS), followed by a library or cultural center (7 MS) and a scientific, research and development, or innovation unit (3 MS).

Figure 1. Distribution of Makerspaces in Poland



Source: author

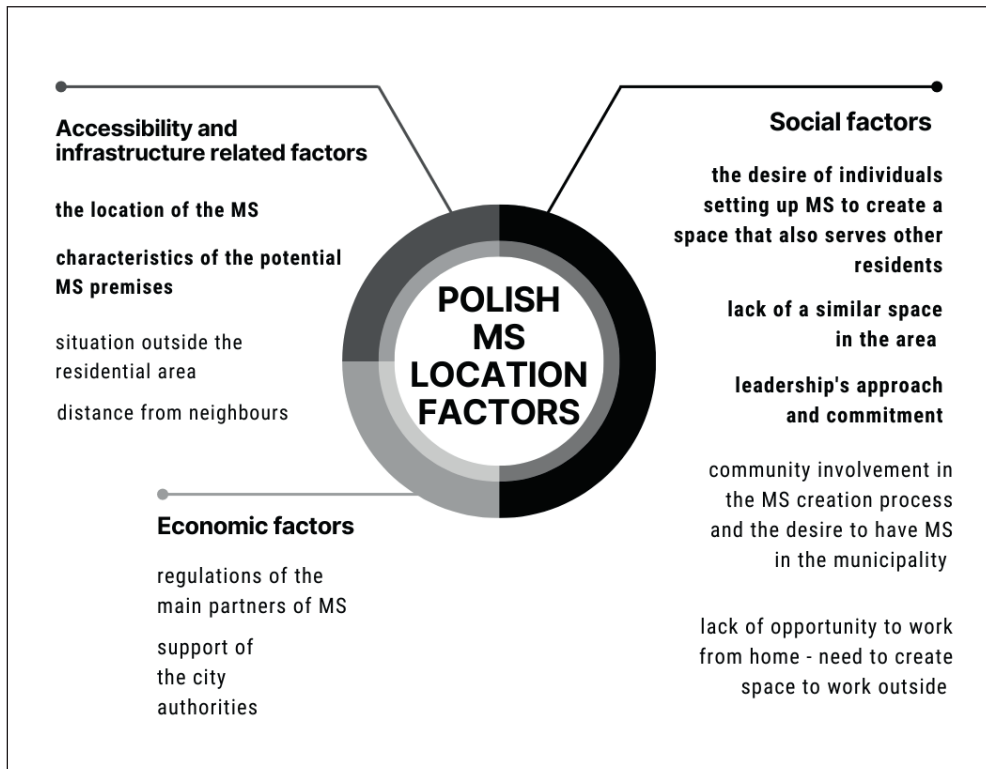
Spatial distribution analysis of Polish MS shows major diversification in concentration on a national scale as they are mainly located in southern Poland in Małopolskie, Śląskie and Dolnośląskie Voivodeships. A substantial absence in western and eastern areas of the country is noted. The number of MS is most highly represented by Warsaw (5 MS), which is the capital city and the main metropolitan region of Poland, followed by Wrocław (3 MS), Kraków (2 MS) and Olsztyn (2 MS) (see Figure 1). Only individual spaces are located in all other centers where MS have been reported and it should also be emphasized that the vast majority of centers are cities with more than 100 000 inhabitants. Disproportion is visible in relation to peripheral areas (understood as rural areas, small towns of less than 20 000 inhabitants and medium-sized towns with a population of up to 40 000) where about 23% of MS are recorded, with only three in rural areas. It should be stressed that the vast majority are located near to the central areas of settlements, however the survey shows that some occur in areas away from the centers.

Location factors for Polish MS. From in-depth interviews, conducted on the basis of a detailed questionnaire with makerspace representatives in Poland, location factors identified by the interviewees were distinguished. Among the specified location factors, i.e. social, economic, and accessibility and infrastructure related, the dominance of social factors is evident. Its significance value was 4.4 points, while the accessibility and infrastructure related factor was 4.2; the lowest relevance is attributed to the economic factor with a value of 3.5 points. Nevertheless, it should be emphasized that the high ranking of the accessibility and infrastructure related factor is due to the detailed requirements for Orange Foundation makerspace premises contained in its regulations.¹ The conditions determine for example the availability of utilities, and the size or adaptation of a room to the users' needs. In addition, the value for economic factors is generated by the requirements of the makerspace Orange Foundation together with the conditions of the Jula company, which is the main partner of Men's Sheds in Poland (e.g. the distance of the facility from the shop division – *"they also have such a policy that they support those setting up Men's Sheds, but in some area from their shop"* (R20)). Therefore, it should be acknowledged that, effectively, the greatest influence on the location of MS in Poland comes from social factors that are not linked to regulations or other policies of external stakeholders.

Major social factors involve the need to create MS for the benefit of other people, *"I thought to myself, since we already have this place for ourselves, maybe we will also do it in such a formula, so that other people can also use it, because we knew ourselves how it is, when there is no place, there is nothing to use, but the willingness is present [...]"* (R2). Furthermore, *"[...] it turned out that we are not the only ones with such needs, there are more people with similar demands, so I decided that we will make an open workshop like this"* (R4). Additionally, the lack of a similar space in the area *"there is not so much competition [...]"* was also important (R33). The leadership's approach and commitment become valid too *"[...] I try to help, both paid and unpaid, any organization or individuals who would like to set up this type of place"* (R32). Among other social factors listed, interviewees also pointed to the possibility of working outside of their place of residence. In this regard, it should be mentioned that social factors are highly relevant to the possibility of creating dense social networks, especially in terms of developing cooperation between MS.

¹ A detailed record of the Regulations is available in Polish at: <https://pracownieorange.pl/app/uploads/2023/07/Regulamin.pdf> (Last accessed: 4 July 2024).

Figure 2. Polish makerspace's location factors divided into three categories (bold content is the most significant)



Source: author

Predominant among the accessibility and infrastructure related factors was the location of the MS, “we wanted it not to be the outskirts of the city, instead we are actually in the center, close to the old town, so it is easy to get to us from different parts of the city” (R2). The characteristics of the premises themselves play a huge role, which is particularly relevant for MS where “we have to have a big hall to have a big capacity” (R18). One interviewee details the conditions that the premises had to meet in terms of requirements for MS activities “[...] because this space just lends itself to that. We have industrial ventilation, we have an industrial extractor [...]. Very large machines were stationed here originally, so that we also have electricity, an electrical network that can handle large loads comfortably, because normally it's hard to have a space like this” (R18). Furthermore, the distance from neighbors and the location outside the residential area are significant “we don't have neighbors close by, in the sense that people are living behind the wall, so we can make noise freely” (R2) and “people can't wander from nearby houses because there are no houses” (R17).

As mentioned earlier, the value for economic factors derives from the internal regulations of the main partners of MS “[...] without Julia's support, we would not have the resources to set up this place” (R20) or “we got this money from the Orange Foundation for the maker-space” (R5). Furthermore, the support of the city authorities in the creation of MS was highlighted, mainly in terms of providing premises for the activities of the workshops “the city lent us a premises that was to be renovated, we renovated it” (R4). Another type of support

from the municipal authorities is direct assistance in finding the right type of premises *"because we wanted to stay in the city, we looked for a new location, we applied to the city, the city and they found premises for us to renovate"* (R1).

Table 1. Occurrence for each location factor by unit size and category type

Location factor category	Location factor	Occurrence for each location factor divided by settlement type				Total
		Large	Medium	Small	Rural area	
Infrastructure	Bicycle stands (bicycle parking lots)	256	1	1	0	258
	Stations of bicycles for rent	21	3	0	0	24
	Parking stands	481	28	25	30	564
Art and Culture	Cultural centers	2	1	1	0	4
	Cinema	3	0	0	0	3
	Museum	18	1	1	0	20
	Theater	6	1	0	0	7
Beauty and Wellness	Sports center	12	0	2	0	14
	Fitness center	10	1	1	0	12
	Beauty center (spa, beauty salon, beauty facilities excluding hair salons)	27	4	5	0	36
	Hairdressing salon	30	9	12	0	51
	Massage salon	3	0	0	0	3
Education and Research	University	49	0	0	0	49
	Office of an educational unit	2	1	0	0	3
	IT office	10	0	0	0	10
	NGO office	4	5	0	0	9
	Office of a research and development unit	9	0	0	0	9
Food Services	Bar	14	0	2	0	16
	Café	58	9	0	1	68
	Fast food restaurant	70	9	8	0	87
	Pub	30	7	0	0	37
	Restaurant	139	18	7	0	164
	Local grocery store	71	14	8	6	99
	Kiosk (convenience store premises)	18	3	0	1	22
	Supermarket	20	5	3	4	32
Public Services	Bank	55	20	1	2	78
	City office/administrative building	6	4	1	1	12
	Child care	3	0	0	0	3
	Kindergarten	28	1	0	1	30
	Post office building	10	2	0	2	14
	School	51	9	0	2	62
	An office of government agency or department	22	7	3	1	33

Transportation	Access to a tram stop	28	0	0	0	28
	Access to a bus stop	28	3	0	0	31
	Metro entrance	32	0	0	0	32
	Access to an airport within 10 km	12	0	0	0	12
	Number of metro and railway stations	5	0	0	0	5

Source: author

Taking into account the classes of location factors listed in Table 1, the most relevant are those related to infrastructure, especially parking spaces in the vicinity of MS, which are of high importance in all settlement types. In addition, the number of bicycle places in the vicinity are distinguished, followed by food services, mainly the presence of restaurants and a local grocery store. However, the last mentioned is the most significant in rural areas, which may be related to the lack of other types of establishment described as local. In terms of public services, access to banks dominates, especially in large cities. Moreover, a high difference is also noted for small and medium-sized settlements, with more banks within the five-minute MS buffers located in medium-sized. Noticeable also is the number of schools in buffers, particularly high in large cities.

The analysis shows the low importance of factors in the beauty and wellness, and art and culture categories, as the figures there are decidedly lower compared to the others. In addition, the analysis indicates a low number in the education and research category, with only universities standing out. It is pointed out that location factors related to transportation are mainly found in large urban centers, and are not noticeable in medium-sized settlements. Elsewhere, the analysis showed a lack of transportation stops in the five-minute buffers, except in the case of bus access in medium-sized.

Thus, it should be concluded that MS only partially relates to NWS location factors and their occurrence does not have as strong an association with transportation accessibility issues as in other NWS types. Access to parking and bicycle spaces play a much greater role. Such an issue may be due to the location of MS within municipalities where it is located away from centers.

Summary and further research

Polish MS are distributed unevenly across the country. Accordingly, their highest concentration is in southern areas, while the least are located in the eastern and western areas of Poland. The concentration of MS is in large urban centers, as only 23% are located in peripheral regions (RQ1). As mentioned earlier, the Orange Foundation is strongly committed to the creation of MS in peripheral areas, so it is possible that new MS will emerge there through the foundation's activities, thus, the potential for development in Poland's peripheral areas is noted. In addition, it is possible to identify the main MS hub in Warsaw, the capital of Poland. MS are often established at public institutions, particularly libraries and cultural centers, however, private MS also exist. It is also important to emphasize the relevance of MS networks in Poland, which include those created by the Orange Foundation, Men's Shed and the 'Workshop for Active Use of Technology' (Pracownia PAKT). This last network is developing mobile MS in Poland, which allows for the technological activation of groups living in peripheral areas (RQ1).

The analysis using a mixed-method approach has outlined the high relevance of social factors in the matter of MS location (RQ2). In particular, they are created by maker movement enthusiasts who set up spaces to collaborate with others interested in working in the DIY spirit. The issues regulating their establishment, affected by the high value of accessibility and infrastructure related factors, are important to emphasize. Necessary conditions related, for example, to the size of the rooms or access to electricity and ventilation that the spaces must meet, are also presented. Economic factors have the lowest relevance, however they show that there is a high level of support from local governments in pursuing the space needed for MS operations. The quantitative analysis using GIS, outlines the importance of location factors from the infrastructure category, especially in terms of parking and bicycle spaces. However, the analysis shows that MS does not strictly follow the NWS factors indicated in other researchers' studies (Mariotti et al., 2021).

Due to the research carried out, it is possible to delineate a number of important topics for elaboration and continuation in the context of MS. First and foremost, there is a lack of comprehensive research discussing their occurrence at various spatial scales. As Dougherty (2024) discusses, current statistics for the numbers and distribution of MS on a global scale are estimates, hence actual figures may differ from those reported. In addition, the factors of MS location, which the author attempts to determine, require further research for differences between the location factors in each type of unit, given the small number of Polish MS located in rural areas. It is also possible to learn more about the types of building in which MS are located.

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Karolina Kapustka, MSc, Faculty of Geography and Geology, Institute of Geography and Spatial Management, Department of Regional Development, Jagiellonian University in Kraków. Ph.D. student in Socio-Economic Geography and Spatial Planning, Doctoral School in Social Sciences (DSSS). The author's interests focus on issues related to collaborative spaces, in particular co-working spaces and creative-workshop spaces like makerspaces.

ORCID: <https://orcid.org/0000-0002-9088-7279>

Address:

Jagiellonian University
Faculty of Geography and Geology
Institute of Geography and Spatial Management
Department of Regional Development
ul. Gronostajowa 7, 30-387 Kraków, Poland
e-mail: karolina.kapustka@doctoral.uj.edu.pl