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RIGA TECHNICAL UNIVERSITY
Architecture and Urban Planning
2022, Vol. 18, Issue 1, pp. 1–9
https://doi.org/10.2478/aup-2022-0001
https://content.sciendo.com
Online ISSN 2255-8764

Lithuanian Folk Architecture Research as a Repository for the Study of Urban Form

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Received 2021-10-08; accepted 2022-01-03

Keywords

Folk architecture, Lithuania, typology of settlements, urban form.

Abstract

Despite the increasingly global orientation of urban morphology, there still remain countries whose achievements in the field of urban form research are underrepresented. Although the attempts to study settlement form in Lithuania were rather early, the second half of the 20th century was the most productive period. The article presents context, process and findings of the folk architecture research, which became the nurturing environment for the establishment of contemporary urban form studies in Lithuania.

Introduction

In the recent decades, the global focus of urban morphology has become increasingly evident [1]. However, in this rapidly evolving field, there are fewer opportunities to present and discuss the urban form studies in smaller countries, especially, distinguished by relatively late urban development. These remaining 'blind spots' may become distinct cases of urban development trajectories, as well as reveal specific achievements within the broader landscape of urban morphological research. Therefore, there is a need to revisit the process of architectural and urban design knowledge formation in some European countries (e.g. Baltic States) in order to adequately present local processes and outcomes of urban form research to the international audience and, consequently, to stimulate broader comparative studies at regional and global scale.

The article presents the case of Lithuania. Despite the fact that urban development process in Lithuania has been somewhat erratic, it can be divided into five major stages [2]: early (until 15th century), feudal (15th – mid-19th century), capitalist (mid-19th – mid-20th century), socialist (1940–1990), and current (since 1990). All the stages have left traces on the network and inner structure of settlements. Although until the mid-20th century evolution of urban settlements was tolerably coherent, thereafter the situation has changed considerably. Nevertheless, the realities of the socialist period urged an interest towards national architecture and, subsequently, local urban forms [3].

During the interwar period, the morphology of historical settlements was already regarded as a repository for modern urban design [4], [5], but only in the post-war years the search for a further distinctive path of country's spatial development was inter-linked with the study of cultural heritage, including local architectural and urban traditions. In general, the investigations of urban form in Lithuania during the 1940s–1990s can be divided into two branches: rural and urban. The first one has been anchored in the study of folk architecture, while the second one diffused within a wide range of interrelated practices, such as protection of urban heritage, regeneration of old towns, modelling of urban spatial composition, etc. The aforementioned branches were closely intertwined, because different scientific and practical activities were carried out by the same researchers and organisations and coexisted together. Nevertheless, each of them represents specific topics and chronology of development of urban morphology in Lithuania.

This article presents evolution and findings of the folk architecture research during the second half of the 20th century. It became the nurturing environment for the establishment of modern urban form studies, at first providing first-hand research material and consequently

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laying down methodological foundations for the research of local rural and urban forms. Despite being nearly synonymous with the term 'vernacular architecture', the term 'folk architecture' is preferred in the article due to its broader meaning and direct connotations with population of a country or region, as well as references to their locally rooted culture and lifestyle.

I. Research Methodology

The article is a concise summary of the main achievements of folk architecture research, which could be related to the emergence of contemporary study of urban form in Lithuania. The research methodology is purposefully retrospective and based on the overview of literature resources. Further chapters describe general context, goals and process of the folk architecture research, as well as highlight major achievements regarding settlements' form and classification. The research concludes with a discussion, stating the need for further research in order to position the relatively small Lithuanian branch of urban form studies into increasingly global research landscape of urban morphology.

II. The Context, Objects and Goals of the Research

The interest in ethnic culture as a major pillar of national identity has sprung already in the interwar period [6]. However, the rise of coordinated research of folk architecture in Lithuania can be associated with the post-war situation in the architectural academia and practice [3]. At that time, execution of architectural research at Kaunas State University was entrusted to young lecturers. Due to the lack of personnel's professional and scientific experience as well as the university's limited technical resources, the humanities-based topic of non-professional architectural creativity and its achievements appeared to be a reasonable choice for developing architectural research agenda. In addition to academic, there were also professional motives to closely investigate Lithuanian folk architecture. After the imposition of the 'Iron Curtain', links with European architectural tradition were lost. Under the official doctrine of socialist realism, which stated that architecture and art should be socialist in content and national in its form, an initiative grew to interpret this instruction in the way that enabled search for the manifestations of national form in local architectural and urban traditions. Furthermore, issues concerning the protection of cultural heritage became also relevant. In the context of the country's rapid social and economic transformations in the post-war years, natural evolution of folk architecture ceased and the long-lasting harmonious coexistence of local population and environment was jeopardized. The latter could be sustained through recognition of folk art in general, purposive heritage preservation, as well as application of local architectural and urban knowledge for spatial development of rural settlements. These academic, professional and heritage-oriented motives laid foundations for the entire research methodology. Therefore, the comprehensive study aimed to reveal the country's ethnographic diversity, regional peculiarities and most typical and valuable objects of folk architecture. The outcomes of the research were envisioned to serve the protection of valued examples of folk architecture, educate society, and increase quality of architectural studies.

Although the selected research topic was not new [7], the previous inter-war attempts to analyse historical development and identify characteristic features of rural buildings and homesteads [8] lacked general methodology and common goals. Furthermore, the research material, mainly collected by local ethnographers, did not represent full geographic scope and diversity of folk architecture, therefore, it was inadequate for multi-purpose use and scientific generalization. Due to these shortcomings, the main goals of the study were formulated as follows: seek 1) to determine evolutionary trends and characteristic features of the Lithuanian folk architecture, and 2) to make use of the identified perspective features of folk architecture in the formation of national architecture [3]. The study was oriented to analyse the entire variety of folk architecture objects, including residential, public and other buildings, as well as various urban complexes, such as small towns, villages, and rural homesteads.

III. Process of the Research

Chronologically, the process of the Lithuanian folk architecture research in the second half of the 20th century can be divided into three stages (Table I). During the first stage (1947–1958), research material was collected and its initial analysis was performed. This was done mainly through field expeditions, organised despite the then critical post-war conditions, such as insufficient technical equipment, unstable political and economic situation, especially in rural areas (civil war, deportations, collectivisation, etc.). Scientific work was led by Kazys Šešelgis, while the expeditions were supervised by lecturers of the Faculty of Architecture. The goal of the expeditions was, with the help of architecture students, to register and inventory noteworthy objects of folk architecture. The registration was understood as a collection of information, which would allow to decide on the architectural and ethnographic value of the buildings and their groups, as well as to identify the dominant types

of separate objects and their prevalence in the area under consideration. Only the most representative objects of folk architecture were inventoried, which included photography and accurate measurement of current state of buildings and their complexes, subsequent preparation of detailed drawings and descriptions. While paying less attention to the historical-cultural nature of investigated objects, the applied measures were oriented towards collection of data directly serving architectural design knowledge, such as an explicit architectural form, rational functional, and constructive solutions [3].

During the second stage (1959–1970), research workflow diminished. Expeditions were not organized due to changes in the research agenda of the Faculty of Architecture, as issues of the country's industrialization and urbanization gained momentum and the Faculty's staff were instructed to reorient their activity towards formulation of theoretical foundations for coordination of these processes. Nevertheless, the analysis of previously collected data continued with preparation of reports, dissertations, and research articles. During this period, a two-volume monograph summarizing the findings of the first stage of the Lithuanian folk architecture research was published. Its first volume [9] presented peculiarities of rural settlements and residential buildings, including a typology and characteristics of villages and homesteads, while the second volume [10] discussed spatial structure of towns and architectural features of non-residential buildings and other complexes (e.g. manors).

There were several reasons which led to renewed interest in the folk architecture during the 1970s. First of all, in 1969 a list of protected architectural monuments was drawn up. Secondly, due to the rapid transformation of rural landscape (including historical settlements and their network), an approach towards preservation of heritage of folk architecture shifted. A perception was formed that detailed investigation of architectural objects, including field expeditions, was a significant measure for both protection and establishment of the general repository of the country's ethno-cultural legacy. Therefore, during the third stage (1971–1988), under an updated methodology [11] the focus was laid only on the declared monuments of folk architecture, including analysis of their evolution and inventory of their current state and discontinuing the search of new cases. Interestingly, the priority was given to the analysis of historical villages, arguing that they encompass the largest quantity and variety of types of traditional rural buildings and homesteads in a particular ethnographic area. In addition, it was considered that a comprehensive survey of villages would better illustrate former socioeconomic trends of Lithuania's development and their impact on folk architecture. Moreover, the degradation of spatial structure of historical rural settlements has been regarded as a more dangerous trend than the transformation of individual buildings or homesteads, leading to irreversible loss of valuable information about the Lithuanian folk architecture. In general, the village was considered as a territorial, social, economic, and architectural entity, while the settlement area – as an architectural complex – was its major component. Therefore, investigation included not only homesteads and their buildings, but also the development of the settlement, its demographic and economic characteristics, the plan and spatial structure, as well as the surrounding landscape, aiming to disclose possible contradictions and synthesis between original (traditional) and contemporary structures. This complex approach is reflected in the five-volume monograph presenting outcomes of the folk architecture research during the 1970s–1980s. The first volume is dedicated to *Zervynai* village [12]. The subsequent volumes present characteristics of small scattered villages [13], spontaneous villages [14], one-street villages in the south-eastern Lithuania [15], and one-street and standalone farm villages in *Aukštaitija* ethnographic region [16].

During the first decades of the post-war period, intensified research and collection of associated material revealed a growing interest in the heritage of the Lithuanian folk culture. These activities were carried out not only by expeditions organized by Kaunas State University and later Kaunas Polytechnic Institute (current Kaunas University of Technology), and Vilnius Civil Engineering Institute (current Vilnius Gediminas Technical University). Other organisations have contributed to this work as well, e.g. the Department of Archaeology and Ethnography of the Institute of History and Ethnography of the Academy of Sciences, Museum of History and Ethnography, Museum of Art and Regional

TABLE I

Evolution of Folk Architecture Research in Lithuania during the Second Half of the 20th Century [developed by authors]

Stage	Main activities	1940s	1950s	1960s	1970s	1980s	1990s
First	Registration and inventory of valuable objects of folk architecture (field expeditions), preliminary analysis and synthesis of collected material	1947 – 1958					
Second	Structuring and publishing of results of folk architecture research		1959 – 1970				
Third	Detailed investigation and inventory (including field expeditions) of folk architecture monuments				1971 – 1988		

Studies, the Department of Architecture of the Institute of Architecture and Construction of Kaunas branch of the Academy of Sciences, the Society for the Regional Studies and Protection of Monuments. However, due to the negative approach of political authorities towards manifestations of Lithuanian nationalism, these fruitful activities of ethnographers and other researchers later were restricted. Nevertheless, ethnographers still have managed to collect and publish a lot of material about the Lithuanian folk architecture. The topic attracted interest of foreign ethnographers as well.

Ethnographers' theoretical works and publications have undoubtedly expanded knowledge about folk architecture, especially the evolution of rural homesteads and their buildings. However, the research objects were frequently chosen based on their historical and material characteristics. With the intention of architects to use the research findings in architectural practice, the inventory cases were selected according to different criteria, such as the object's artistic expression and the level of folk artists' contribution. Furthermore, homesteads, villages, and other elements of rural and pre-urban settlements were investigated as integral spatial complexes [3].

IV. Major Findings of the Research

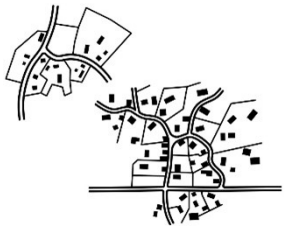
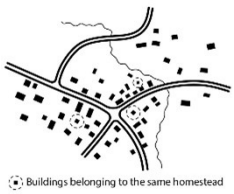
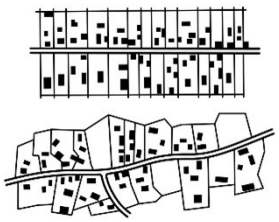
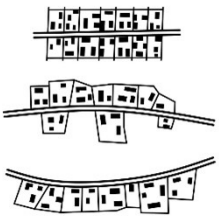
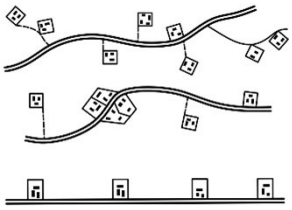
A. Peculiarities of Rural Settlements

One of the major achievements of the study of Lithuanian folk architecture during the second half of the 20th century is the retrospective classification of rural settlements. Although there were previous attempts to classify rural settlements in Lithuania [17]–[21], these proposals were inaccurate due to deficiencies in the analysed material and approaches to features of settlement form [9]. Therefore, in order to define the most common types of settlements' physical structure, researchers carried out detailed analysis of historical cartographic maps and organized field trips. Plan structure, grouping and form of homesteads were considered as key attributes for settlement classification. The following three most frequent forms of rural settlements in the Lithuanian territory were identified: scattered, one-street and standalone farm villages (Table II). Additional criteria (e.g. size of the settlement) were used to define subgroups and variations.

The scattered rural settlements are characterised by an irregular street network and compact homesteads of various forms. Depending on the amount of homesteads and the

TABLE II

Types of Rural Settlements (Villages) [*9*, *19*]

Groups	Sub-groups		Variations	
Scattered	Small		Group	
	Large			
One-street	Strip-like		Complete	
	Sparse		Incomplete	
			One-sided	
Standalone farm	Scattered		Unspecified	
	Nuclear			
	Linear			
Individual homesteads			Unspecified	

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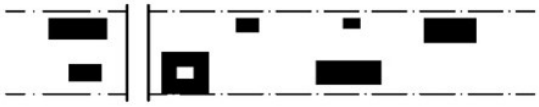
complexity of plan structure, this type of settlements was divided into two subgroups (small and large settlements) and an additional variation (group settlement). The one-street settlements have a simple plan structure, dominated by one straight or slightly curved street, lined up by homesteads or other buildings. The one-street settlements were classified into two subgroups (strip-like and sparse) and three variations, according to the built-up completeness of the street front (complete, incomplete and one-sided). The standalone farm villages are composed of separate distantly placed homesteads and, according to their placement, can be divided into three subgroups (scattered, nuclear and linear), representing distinctive forms of sporadically built-up rural landscapes. Other types proposed by the researchers concerned rare cases and were considered unusual (e.g. individual homesteads). Although variations of the one-street settlements were most numerous, the scattered form was considered as prior. The evolution and prevalence of different settlement forms greatly depended on various socio-economic factors, such as land-use and ownership reforms in rural areas [9]. This is illustrated by the fact that in the mid-19th century the proportion of one-street and standalone farm villages was similar, but during the first decades of the 20th century the majority of older villages were dissolved into steadings, therefore the latter form began to dominate. Nevertheless, in the mid-20th century there were still some rural areas with prevailing older settlement forms, such as a small part of the eastern and south-eastern Lithuania, where one-street and scattered rural settlements remain common.

The typology of homesteads also interested researchers because they were considered as the most stable elements of the settlement's plan structure and most typical complexes of folk architecture. The main features defining the type of a homestead were its connection with the street, shape, organisation and position of the inner-yard, as well as functional and compositional inter-relation of the buildings [9]. Three types of homesteads were distinguished:

TABLE III

Types of Homesteads in Lithuanian Villages [9, *30*]

Type			Plan	Characteristic to... villages
Street-type	One-sided strip-like			one-street strip-like one-street sparse
	Two-sided strip-like	Complete		one-street strip-like
		Incomplete		one-street strip-like one-street sparse one-street complete (variation)
	Rectangular			one-street sparse one-street complete (variation)
	Samogitian			one-street strip-like one-street sparse one-street complete (variation)
Regular				scattered standalone farm individual homesteads
Irregular				scattered scattered standalone farm

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street-type, regular and irregular (Table III). The direct connection with the adjoining street is most obvious in the spatial organisation of a street-type homestead because its buildings form the street front. In scattered and standalone farm villages and individual homesteads the relation between the homestead and the street or access road is less significant than the arrangement of the buildings, which determines geometric regularity of the yard. Even if the inner organisation of homestead was primarily based on practical considerations, it was also influenced by the natural condition of the site and aesthetic preferences of the owner. For example, in the narrow plots of street-type homesteads, buildings were often built near the site's borders with its narrow sides facing the street, leaving space for gardens and passages. Spatial configuration and composition of homesteads on wider and larger plots were, on the contrary, more diverse and distinctive.

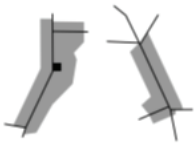
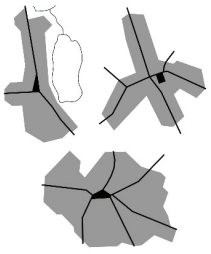
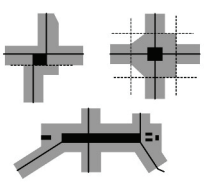
B. Peculiarities of Urban Settlements

Urban settlements have also fallen under the radar of the study of Lithuanian folk architecture because in these places local traditions and forms interacted with various historical-architectural styles. Towns evolved from the same early settlements as rural settlements, but the former eventually became more significant and acquired a more complex form. Nevertheless, town plans still resemble local architectural traditions. Since the formation of built-up structure and, subsequently, visual appearance of settlements is based on a plan, folk architecture has undoubtedly influenced urban forms. Therefore, the findings of the study of urban settlements were and continue to be useful for the planning of reconstruction and development of Lithuanian towns and cities.

The networks of arterial and subsidiary streets and the location of the settlement's centre were defined as the main distinctive features of the plan structure of Lithuanian towns. Based on the system of arterial streets, urban settlements in Lithuania were subdivided into three types: linear, radial and rectangular (Table IV). Taken separately, the network of subsidiary streets could be classified as undeveloped, multi-branch, rectangular, irregular or mixed. Depending on the location of the central square, two major variations of town plan were identified: (i) settlements with the central square positioned at the intersection of the main arterial streets and (ii) settlements with undeveloped centre

TABLE IV

Plan Types and Variations of Urban Settlements [10, *16*]

Plan types		Variations							
		Position of settlement's centre	Shape of central square	Characteristics of subsidiary street network					
				Buildings along roads	Multi-branch	Rectangular	Circular	Irregular	Mixed
Linear		Unspecified or undeveloped	Quadrangular	+	+	+		+	+
			Widened street	+	+	+			
			Undeveloped	+					
Radial		At the intersection of main arterial streets or roads	Triangular	+	+	+	+	+	
			Quadrangular	+	+	+		+	
			Widened street	+		+		+	
			Irregular or multiple squares	+	+	+	+	+	+
			Undeveloped	+		+		+	
Rectangular		At the intersection of main arterial streets or roads	Quadratic	+		+		+	+
			Quadrangular elongated	+		+		+	
			Undeveloped	+		+		+	+

because the central square was located separately from major streets, therefore, less significant.

Differences in the plan structure have led to the formation of individual character of urban settlements. The linear plan is typical for small towns which are dominated by one arterial street, lined up with buildings and homesteads, with a widened segment of the main street or a rectangular square functioning as the settlement's centre. The rectangular plan is also more frequent in small towns. In this case, main arterial roads intersect perpendicularly, forming a rectangular central square, while other parts of the settlement are subdivided by an orthogonal network of subsidiary streets. The radial plan is found in urban settlements of various sizes. It is characterized by a compositionally-strong centre, from which arterial roads radiate. Due to the irregular intersection of major streets, the settlement's central square can acquire various more or less irregular multi-angular shapes and in some cases even a system of several squares can evolve.

The classification of urban settlements according to their plan structure into types and their variations is another achievement of the study of the Lithuanian folk architecture. It was identified that general trends of the country's social and economic development had been more significant for the evolution and distribution of different plan types in the Lithuanian territory than various local factors, such as natural conditions of the sites [10]. However, due to the abundance of radial-type cases, these spontaneously developed urban settlements were considered as characteristic in Lithuania. Although the rectangular-type settlements were also numerous, they were more frequent in *Užnemunė* region (the area on the left bank of the Nemunas river), where due to the resettlement in the 15th–18th centuries new towns were built from scratch according to the then new urban design principles. Nevertheless, it was observed that in the mid-20th century almost half of the urban settlements in Lithuania were still at the initial stage of their development: without proper network of subsidiary (residential) streets, buildings concentrating just along major arterial streets.

Although the influence of folk architectural traditions is strong in smaller towns due to the weaker building regulation there, it is also visible in major cities, especially in their more or less spontaneously developed historical parts, where scenic street perspectives resemble inner urban spaces of small towns.

V. Discussion

As the article has shown, the development of both rural and urban settlements was largely influenced by external factors. Therefore, it can be assumed that the similarities and differences in these general development trends can provide a basis for comparing not only the settlement form characteristics itself, but the evolution of research field as well. The case of Lithuania revealed that during the second half of the 20th century the initiation of urban form studies in smaller European countries might be dominated by particular research field or agenda, which can differ from common understanding of evolution of urban morphology in Western Europe, where the three independent research traditions (British, Italian, and French) emerged and flourished [22].

Due to the centralized nature of the Soviet regime, various scientific activities were ideologically and politically motivated. Perhaps this is precisely why a significant portion of research dealing with the cultural legacy has naturally shifted towards less controlled disciplines in the humanities and arts, thus leaving the obligation to carry out most of the 'relevant science' to the fields of social, technological and other sciences. The study of urban form, including its roots in the architectural branch within the folk culture research, is not an exception.

Partly based on the research tradition from the interwar period and furthermore stimulated by rapidly changing historical rural and urban landscapes, as well as disappearing local cultures, fading under the influence of post-war socialist modernisation, folk architecture research during the second half of the 20th century presents a valuable repository for the study of urban form. Lithuanian researchers feverishly tried not only to document the most valuable cases of local architectural and urban forms but subsequently to condition reintegration of characteristic features into modern architecture and urbanism. The later attempt to practically use research findings might link the Lithuanian case to other urban morphology schools in Europe, for example, Italian typomorphological [23] or British historico-geographical [24] traditions. However, due to the partly independent development of urban form research in Lithuania, these possible ties need further investigation, but it is evident that interest in historical and architectural aspects of the development of rural and urban settlements in Lithuania has unfolded in parallel with the general European trends. Despite its local focus, the Lithuanian branch of urban form research could complement the regional and global landscape of urban morphology and contribute to the development of the field's scientific and practical methodology.

Conclusions

The evolution of urban form study in Lithuania is closely related to the country's urban development trends. Although interest in local rural and urban forms was not a new phenomenon, the research activities carried out during the second half of the 20th century were distinguished by their intensity and complexity. Within this context, the field of folk architecture research acted as nurturing grounds for initiation and further development of settlements' form studies.

The retrospective classification of rural settlements was one of the major achievements of the study of Lithuanian folk architecture. This complemented previous insular attempts to classify rural settlements by using rigorous attribute-based approach to defining most common types of pre-urban settlements (scattered, one-street and standalone farm villages) and their physical features (street network, homestead typology, etc.). Furthermore, further investigations revealed that prevalence of distinct settlement forms greatly depend on external socio-economic factors, especially, land-use and ownership reforms in rural areas. This resulted in regional disparities within relatively small area of the country and created characteristic rural landscapes (ethnographic localities) remaining to this day.

Historical towns were seldom built from scratch and evolve from pre-urban settlements, eventually acquiring a more complex form. They fascinated folk architecture researchers as locations where local traditions and forms interacted with diffusing architectural styles. Therefore, the classification of urban settlements in Lithuania according to their plan characteristics (network of arterial and subsidiary streets, location of settlement's centre) can be attributed to major achievements of the study of folk architecture as well. Differences in the plan structure have led to the formation of individual character (e.g. linear, radial and rectangular) of urban settlements. However, further research concluded that, similar to the case of rural settlements, distribution of plan types was heavily influenced by general social and economic development trends of the entire country. Furthermore, strict building and planning regulation eroded vast majority of pre-urban forms, except their spontaneously developed older parts, which still may resemble urban spaces of small towns and villages.

The material collected during the study of Lithuanian folk architecture is substantial not only for the knowledge and research of constantly disappearing cultural legacy of the nation, but also for its protection. Therefore, despite the unfulfilled hopes to use study findings in the formation of a specific local architectural language, the fundamental achievement of the study was organized efforts to establish protection of valuable objects of vernacular architecture [3]. The conducted research allowed to select and inventory the most valuable objects of rural architecture, preservation of which was extremely complicated due to the rapid social and spatial changes in rural areas. Therefore, outcomes of the study of Lithuanian folk architecture could be useful for the planning of reconstruction and development of rural and even urban settlements in Lithuania.

Characteristics and arguments behind the folk architecture research discussed in the article highlight a somewhat exceptional case of the emergence of settlement form studies. These initial investigations provided a sufficient material for the later development of urban form research in Lithuania. The research outcomes continue to possess an invaluable scientific, cultural, and practical significance. Furthermore, the rich archival material requires further analysis in order to integrate the methodology and results of these studies into the broader landscape of urban morphology.

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sciendo
RIGA TECHNICAL UNIVERSITY
Architecture and Urban Planning
2022, Vol. 18, Issue 1, pp. 10–16
https://doi.org/10.2478/aup-2022-0002
https://content.sciendo.com
Online ISSN 2255-8764

Prospects of Intuitive Interaction Modeling in Automated Shape Generation

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Received 2021-09-09; accepted 2022-02-02

Keywords

Art methods, embodied cognition, intuitive perception, parametric design, universal aesthetics.

Abstract

In this article, authors discuss new possibilities for the spatial design universal aesthetic development. Creative artistic means are conditioned by the human ability to comprehend and interpret objects in a particular context. Ideas of arts and science coexistence have been relevant since antiquity. The 20th century, especially the Bauhaus movement, gave a rational basis for conjoining artistic inspiration with the parametric constraints. Contemporary digital technologies provide new possibilities to enhance human creative potential by employing scientific methods. In search of material environment evaluation reference points, it is important to establish a robust connection of human mind and physical world. Subjectivity and intersubjectivity of experiences raise issues in human perception studies, involving both phenomenal and material processes. Embodied cognition reveals itself as an intuitive experience or discovery which provides a new perspective for the creative application. The authors aim to investigate the creative opportunities of automated shape generation systems. The main issue is to find a universal application of creative process analysis. Parametric constraints offer the opportunity to use statistical tools in art practice. These constraints are based on embodied cognition capabilities. Combined methods of qualitative and quantitative evaluation help to assess the contextual relevance of the object and to determine the cultural and pragmatic effectiveness of automated design solutions. The study offers theoretical and applied cross-disciplinary research direction to discover new creative means in material environment design, including architecture and urban planning.

Introduction

Intuitive design studies have shown the lack of the universal design methodologies that exploit the principles of intuitive cognition [1], [2]. This paper explores practical possibilities of integrating intuitive design principles into automated shape generation systems. The conceptualization of design as communication has proven to be a valuable approach for research and practice, since it provides designers with a perspective on product conceptual links and how they are experienced by the users [3]. Investigation in modern product design reveals the importance of implicit knowledge and everyday human experiences in creating a more intuitive design [4]. Subjective opinions are the key objects of good design discussion, hence automated shape modeling processes and design constraints provide opportunities to validate design solutions. The main issue is the formation of human connection with technology. Human ideas and creativity are not recognizable by machine or artificial intelligence, so the challenge is how to combine the best qualities of these agents without undermining the essential quality criteria. It is important to answer the question of how automated design is assessed in practice and conceptually, whether it is a tool or an assistant, or perhaps an independent actor.

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Since the 1970s, the new media, which do not require direct hand touch, have attracted much more attention from the public. Traditional artistic practices involve the union between consciousness and the bodily experience (in philosophy it is usually perceived as a 'qualia') in order to change the environment's conceptual and material properties. This attitude provides an opportunity for the further study of human and environment connections. The application of design thinking methods in automated design processes is a highly innovative field of research [5]. The studies performed on a parametric design application create preconditions for the integration of design constraints into parametric, generative or other shape modeling tasks [6], [7]. The integration of intuitively perceivable content to the automated design processes requires the introduction of new design stages to set the creative constraints. The object of this study is the process of design thinking. The aim of the paper is to reveal new interdisciplinary opportunities to model intuitive content and to integrate quantitative research methods into the art practice to assess and improve the quality of the material environment. The tasks of this paper are to evaluate the issues of automated design intuitive perception and to offer new scientific and artistic directions for the evaluation of its quality. Combining advanced spatial modeling techniques would underpin the applied methodical capabilities to model the shape's intuitive content. It is expected that the results of the research will provide data to support the development of a universal shape modeling tool to create new spatial expressions. The implementation of this approach does not deny the importance of the author but offers less constrained and specific (limited to professional knowledge) creative tools. The scientific application of this approach creates cross-disciplinary opportunities to study and adapt automated design processes for the universal integration of design constraints.

I. Research Context

Material environment quality depends on a successful reflection of contemporary cultural values in a particular society. In the multicultural world, it is becoming increasingly difficult to provide objects of cultural significance in the local communities, referring to the key role of contemporary social and cultural sustainability [8]. To ensure material environment sustainability and optimize communication means, the relationship between the new values within a particular space must be clarified at all levels of interaction. Urban planning, design, and art create dynamic systems that question and complement each other [9]. The harmony of the material environment is inseparable from the aesthetic feeling, which is directly influenced by the intuitiveness of the object [10], [11], [12]. Intuitive cognition is an essential participant in the creative process and evaluation, which involves all aspects of environmental manifestations [13]. The process of intuition occurs when the individuals encounter clues, which need to be quickly understood to obtain solutions to the complex problems in dynamic situations [14]. In terms of situation assessment, the limbic system has evolved from the need to avoid mistakes as a means to increase survival chances. Stimuli are judged from a position of potentially negative (primarily somatic markers act as 'alarm') and positive outcome. Somatic markers ensure 'early warning' and emphasize any potential adverse effects of a particular choice [15], [16]. In the case of intuitive theory in psychology, beliefs, desires and actions are linked by the rational action principle – the individual will try to fulfill his desires in the most efficient way possible, taking into account his beliefs about the world [17], [18]. Human intuitive interaction with the environment is profoundly influenced by the embodied cognition [19], which allows to explore, modify and simulate human choices/actions in the given environmental conditions. The agent is looking for the most efficient way to interact with the surroundings, and embodied cognition gives the notion of possible action affordance [20].

Problems of 'embodiment' and 'embodied experience' are closely related with the so-called 'hard problem of consciousness' or relation between physical processes in the human nervous system and phenomenal experiences [21]. While the 'explanatory gap' of experiences still exists [22], with no final consensus among philosophers and neuroscientists, Metzinger's model of consciousness as 'phenomenal self' proposes the most relevant solutions to this moment [23]. Metzinger describes consciousness as a 'transparent avatar', a byproduct of cognitive brain activity. 'Transparency' means that 'self-model' cannot perceive itself as a 'model' and is illusively convinced of his 'authenticity'. For this reason, consciousness cannot be investigated as a natural phenomenon. Cases of people creating in an unconscious mental state have been described, but these reports have not been scientifically validated [24]. Despite the fact that the question of whether unconscious visual creation is possible remains open. Artistic creation is rightly associated with a first-person perspective, speaking from a subjective point of individual consciousness placed in the world of phenomenon. On the other hand, the aesthetic values are something that exists in the intersubjective field, and therefore in itself demand third-party assessment. An artist cannot detach himself from subjectivity, as a scientist aspires, but he can combine the perspectives of the first and third person. Recent work on the development of artificial intelligence systems, based on artificial neural networks, provides strong evidence in favour of a 'mysterianist' approach to the embodiment process [25] that denies the possibility to resolve the nature of the body-consciousness relationship. It also follows that without clear criteria to

define the boundaries of an object's interactivity, we fall into a situation of contradiction because it is difficult not to construct a demarcation between the subject's abilities and the object's content. Examining the problem of 'embodiment', Metzinger introduces the concept of minimal phenomenal self (MPS) – a 'self-model' detached from any bodily experience [26]. Usually, the functioning of self includes various bodily experiences, becoming a base for any kind of conceptual metaphors [27], essential for any verbal or visual language. At the same time, self can expand to the objects out of the individual physical body, for example, in the notorious 'rubber hand' experiment [28]. In a very similar way, consciousness can expand into certain external objects – tools, artifacts, vehicles, treating them as part of the 'body'. Such expansion is a kinesthetic sense, which is often necessary for the successful interaction with the environment. For instance, an experienced driver unconsciously perceives a car as part of his body. It is important to note that such self-expansion usually occurs on an intuitive level, independently of conscious processes. In such a case, the good example of material environment design allows this process to take place easily and smoothly, which undoubtedly affects the level of user's satisfaction with an object/environment.

In this article, the intuitive interaction is considered as a human ability to comprehend physical causality [29], [30]. Efficiency in communication can be optimized by using behavioural patterns, suggestive interaction or using mechanical dissemination principles. The analysis of scientific sources reveals that the cross-disciplinary research provides the basis to discover methods for aesthetic shape analysis, modeling and evaluation. By combining art with science, a method of aesthetic shape modeling exploits cognitive abilities and the causality of the environment. The author's previous research has confirmed that the human ability to comprehend Newtonian physics is embodied into cognition and allows us to intuitively perceive and anticipate the interaction with the environment [31]. It can be concluded that the principles of intuitive cognition can be directly applied in creative processes.

Not all material environment objects are easily expressed via visual language due to the structure of the human cognitive mechanism. The conceptual human imagination can operate on non-visualized objects [32]. Various methods of visual decomposition can be used as a means of conveying such narratives by artistic language, expanding the user's cognitive abilities. Also, a promising path is the use of technologies 'beyond cognition' in combination with traditional artistic practices. Interaction with the material environment is conditioned by the constitution of intuition and embodiment. The effective design of the material environment should take into account the specifics and limitations of human perception. Over the last ten years, the progress in artificial neural networks research has opened up completely new opportunities [33]. The process of image recognition, generation and transformation is stochastic in nature, hence the final result can only be predicted. Another important aspect of this system is the use of evolutionary machine learning algorithms. The paradox is that these systems are created by a man, but a man is no longer able to comprehend how exactly they work [34]. The crucial moment is the use of digital graphics technology aimed at controlling markers of personal psychophysiological limitations (hand shake, sensitivity, pressure, etc.). Combining embodied cognition limitations with an automated shape generative system offers new methodological insights in design thinking processes. This approach has a universal application in intuitive design methodology. Modeling constraints can be used to optimize the aesthetic and functional quality of an object.

II. Methodology

In line with the existing consensus that humans are conscious beings, it must be acknowledged that the depiction of one or another object is a conscious activity [35]. The process of artistic creativity is influenced by the embodiment of conscious self. An image taken by a self-operating camera can be processed by a relatively simple algorithm and transferred to a device that will create a depiction of the object. All this process requires neither the buds of consciousness nor the beginnings of intellect. Still, it is a direct capture of an existing image, which is fundamentally different from drawing from memory or imagination. The word 'memory' is used here to express human memory, unlike the 'memory' of a computer. Human memory is directly related to the ability to create counterfactual situations and objects never existed before (i.e., imagination) [29].

In this study, it is important that inherent human abilities such as imagination can be successfully conjoined with the machine learning process. Parametric design allows the exploitation of human creativity to define the initial design constraints [7]. The process in itself is autonomous, and the outcome is unknown. As a case study, an important contribution to the research field is the development of methodology for grammatical evolution and the definition of representation for the certain architectural spaces coding [5]. This work examines the potential of automated processes to generate simple boxes – the external building envelope and combine architectural box shapes with the complex shapes of the facade elements. This study presents a method of grammatical evolution based on genetic programming for the automated shape modeling. Three experiments of two types of shape generation are presented: architectural box design and facade design, respectively. This study demonstrated the applicability

of the evolutionary approach to facilitate the early stage of architectural design. It is concluded that automatic shape generation in the evolution of grammar offers tremendous opportunities to create performance-based creative systems. In the presented experimental phase, the representation of architectural shapes is independent of context and environment, which would normally influence architectural design solutions. It may also lead to the formation of functional constraints based on cost, area, volume, or other geometric and functional properties. Application of parametric design principles in architecture allows to define and apply data in a fractal manner (Fig. 1). Embodied design can be used in a material environment formation from the smallest scale (hand) to the largest (human group) in urbanism.

A relevant aspect in the search for more effective design methods is to reduce the amount of the design stages and to objectify design processes. It has been found that it is possible to develop new intuitive design methods that can be used universally in the material environment development [36]. Evaluation of aesthetic shape is inseparable from its function, which determines the shape input arguments (control shape) and limitations of experimental modeling. Authors propose such shape conceptualization steps [31]:

1. Set limits for correct interaction with the element.
2. Determine the location and direction of the interaction.
3. Explain the peculiarities of the correct interaction and collect data (anthropometric or other).
4. Describe and explain human mechanical interaction with the element by visual schemes.
5. Interpret data conceptually and visually.

Application of visual shape decomposition methods to the aesthetic shape monitoring, modeling and evaluation, reduces the number of elements, as a result visual complexity. Shape decomposition techniques and

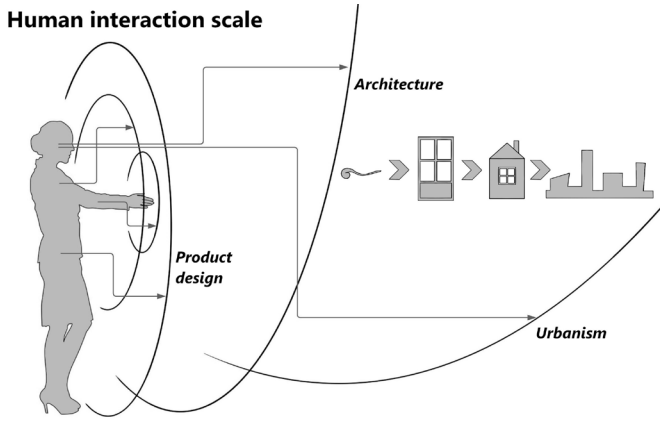

Figure 1. Human embodied cognition and material environment scale relation [authors].

evaluation conditions are important initial constraints that determine perception quality and amount of information needed to reflect the modification. Many studies have been done to formalize the object's shape decomposition and evaluation process [37], [38], [39], [40], [41]. Decomposition of the 3D shape to represent it in a 2D media is relevant because of the issues arising due to the complexity of 3D shape position and view angles and, as a result, allows to reduce the information noise. The established methods of shape conditioning, modeling and experimental techniques enable the creation of conceptual models and monitoring of intuitive interaction effectiveness.

Evaluation of the object must include its context and function. Applied functional and interaction analysis allows defining pragmatic value criteria. By combining investigation methods, it is possible to examine the object in terms of utilitarian and cultural indicators. In his dissertation, Žukas proposed stages for the experimental shape monitoring [31]:

- Establish experimental observation conditions (context) for the particular object.
- Perform monitoring of the object's shape value and determine points of functional significance.
- Determine interaction mechanical causality and integrate embodied impressions into the object's design frame.
- Evaluate conceptual shape models in terms of intuitive interaction effectiveness using qualitative and quantitative methods.

The author determined that the shape which reveals the method of use and universally harmonizes the intuitive interaction. The criteria for the shape evaluation were also established as the ability to reveal the method of use and the acceptability of the shape's aesthetic quality. Based on these two criteria, it is possible to investigate the pragmatic and cultural value. An intuitive shape harmonization variable was implemented into the box design to reveal the method of use. This impression can be attributed to the object's function – to open the lid of the box and human interaction peculiarities. The aim of the experiment is to test the possibility to model and evaluate intuitive interaction effectiveness using observation methods to obtain quantitative data. In this case, the intuitive interaction effectiveness criteria are the number of attempts to open the box. The fewer attempts – the better the shape effectiveness. The results strongly support intuitive harmonization methodology to complement the object function and to teach interaction. To test the variable's ability to improve the aesthetics of an object, experiment participants were asked to rank the same shapes' appeal using the MaxDiff qualitative evaluation method. It has been found that this method is suitable for investigating intuitive reactions to aesthetics as information is evaluated while avoiding deliberate consideration [42]. This experiment opened an opportunity

to correlate utilitarian qualities with the aesthetic ones. The results confirmed that shape, which complements function, improves aesthetics as well.

The quantitative investigation requires clear criteria according to which the design object effectiveness is tested. The criteria can be defined according to the function of the object/space, which can be enhanced at the same time improving aesthetic value. By combining qualitative and quantitative research methods, it is possible to assess aesthetic and pragmatic values and monitor their interrelation.

III. Findings

Interdisciplinary approach to research reveals the opportunities for the quantitative evaluation of the design result effectiveness. In connection with the object design, the value of parameters facilitating the embodiment process is important. Given that the process of embodiment can be reflected (in everyday practice it usually takes place intuitively), it can be quantified through intuitive design research. The questionnaire, which allows the evaluation of the product's intuitive user-friendliness, also reveals the smoothness of the embodiment process and provides valuable information about the correlation between physical reality and mental experience. In quantitative investigation, the analysis of the object's function provides criteria that allows to assess the objective and pragmatic effects of shape harmonization. To examine intuitive effectiveness, various criteria or sets of the criteria, such as time, distance, amount of force, number of attempts, etc., can be employed.

It can be concluded that this methodological approach allows to effectively introduce the embodied design capabilities to reflect human values in an automated parametric design process. This method creates an independent design tool and can be introduced as a part of the conceptual content.

Conclusions

Given that art and visual design perform primarily a communicative function, the creator must pay attention to how the addressee can read the message. It can be concluded that the author should create a certain mental model for the user. This model must also include the totality of the user's unconscious mental processes. In this context, anticipating the intuitive reactions to the material environment object becomes crucial. The artistic application of the proposed intuitive interaction investigation will allow a more efficient and dynamic isolation of shape variables, providing quantitative data within the framework of artistic concept. It will allow improving communication means and measuring their effects on a conceptual basis. The creator defines the content aims; hence this tool allows to not only measure the impact of the artwork but gives an inherent content element.

In today's context, cultural acceptability problems have become particularly acute, since many opinions must coexist in a public space. The proposed artistic means provide an opportunity to create aesthetic content without the use of symbolic language, which depends on particular knowledge, thus responding to the needs of modern society. The development of new shape modeling methods and their application, invoking interdisciplinary knowledge, will provide advanced opportunities for the spatial design research. Further studies should experimentally explore the applied methods for integrating intuitive design principles into automated shape generation systems.

Authors' remark: Some parts of this article are published in the PhD Thesis "Harmonisation of an aesthetic shape from the perspective of intuitive cognition" by J. Žukas.

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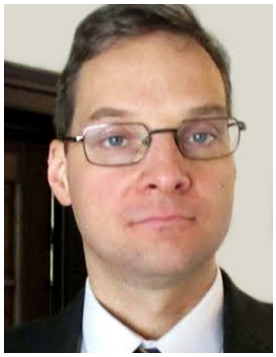

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sciendo
RIGA TECHNICAL UNIVERSITY
Architecture and Urban Planning
2022, Vol. 18, Issue 1, pp. 17–29
https://doi.org/10.2478/aup-2022-0003
https://content.sciendo.com
Online ISSN 2255-8764

Digital Interpretation as a Bridge to Support the Sense of Place: "Lord Guan Online!" DaxiDaxi Website

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Received 2021-10-15; accepted 2022-04-22

Keywords

COVID19, Daxi Wood Art Ecomuseum, digital interpretation, folk belief, sense of place.

Abstract

In the context of coronavirus (COVID-19) pandemic, large-scale events have been forced to stop as well as movement of people between cities. At Daxi in Taoyuan, Taiwan, there is an event that lasts for over a century, *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday*, held every summer on June 24 of the lunar calendar. It is not only registered as Taoyuan City's intangible cultural heritage but also considered as the second Chinese New Year for local people. In order to express gratitude to Saintly Emperor Guan for his blessing, the local groups 'She-Tou', residents, shopkeepers and volunteers make a great effort on the preparations before the celebration. Local people who at the time do not live in Daxi because they are studying, working or after marriage are living in other cities would also come back to the town on this day. This traditional and cultural event bred from belief has become a mechanism of community cohesion and has shaped Daxi's unique sense of place. Unfortunately, the traditional pilgrimage of the celebration in 2021 has been paused due to the pandemic situation. However, thanks to the long-term collaboration and participation of the local museum, the ritual of faith can continue in a new way. This article takes the DaxiDaxi "Lord Guan Online" website and its Facebook page as an example. By analysing how the Daxi Wood Art Ecomuseum interprets the traditional celebration and its culture in a digital way, we try to explore the possibility of digital tools as a powerful medium for connecting people and people and place during the pandemic period.

Introduction

Over the past year, the novel coronavirus (COVID-19) raided the world and has changed our lives. In order to maintain social distancing and reduce the spread of the epidemic, large-scale events, such as celebrations and festivals have been forced to stop, as well as movement of people between countries and cities. The online virtual world has gradually become the main place for people to live and connect with others.

Some travel agencies, museums, institutions and government agencies try to reinterpret travel experiences, exhibitions, cultural content, and events in a digital way online and transform the original veins and connotations into a new model that fits the digital experience. For instance, by grafting offline activities into online from 2020, e.g., Airbnb launched the *Online Experience*, which invites local hosts to share their cultural itinerary, the production of food, or the beauty of landscape through online live streaming with guests from all over the world [1]. Another Amsterdam-based case, the Rijksmuseum digitalized Rembrandt van Rijn's *The Night Watch*, and has released a giant, hyper-resolution image of it. Now it is possible to view this masterpiece online, with interactive version that enables researchers and art lovers alike to pore over the details from its brushstrokes, cracks and stray paint splatters on the drawing [2]. In the online guided tour, visitors can also discover the soundscape of different aspects of the painting – such as the swish of a cloak, a horse's hooves, an eerie melody, etc.

In the long run, the development of digital content is not only a response to the post-pandemic era, but

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also a major element that is gradually changing the contemporary lifestyle of people [3], [4]. Different from the way of viewing and experiencing in physical space, the application of digital tools provides a new contact point for understanding culture and knowledge of place [5], [6], [7]. However, how to interpret content under its original veins and inner meaning, or even interact with audience in a breakthrough way without being submerged, is a major challenge of digital interpretation. Especially, comparing the exhibition of dynamic content to static, the two-way interaction between people is the more difficult part to emphasize after digital interpretation. Using the lens of digital interpretation and drawing upon Taiwan case, this article aims to develop an understanding of how the involvement of a museum can assist the preservation and sustainable development of local intangible cultural heritage and transform the dynamic traditional festival in a digital way. By considering the case of the DaxiDaxi "Lord Guan Online" website and its Facebook page (which has been created for an event that lasts for over a century, *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday*) through the Daxi people experiences, emotions and perceptions, the article examines the possibility of digital tools as a powerful medium for connecting people and between people and place during the pandemic period.

I. Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday and the Sense of Place

Daxi is a historical town in Taoyuan, Taiwan. Since ancient times, Daxi has been the first choice for custom-made furniture in northern Taiwan [8]. In this place, there is a celebration called *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday*, which started in 1917 and has been held every summer on June 24th of the lunar calendar [9]. It is not only a registered intangible cultural heritage of Taoyuan City, but has also become the second Chinese New Year for Daxi people that fully shows the local culture. The most valuable characteristic of this festival is the procession of She-Tou groups, a tradition of over a hundred years [10]. Since 2015, the local museum, *Daxi Wood Art Ecomuseum,* has been established, which is dedicated to the preservation of cultural heritage in collaboration with the local community. Besides Museum fairs, *Daxi Wood Art Ecomuseum* also takes the responsibility of holding *Daxi Art Festival*, an event originally sponsored by the Daxi District Office since 2007. The museum took *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday* and the She-Tou culture as the core of the festival and created an art festival naming it DaxiDaxi, "*a city festival that spans contemporary design and folk belief*" [11].

A. The Faith of Guansheng Dijun and She-Tou

The *Guansheng Dijun* (Lord Guan) temple, Puji Tang (普濟堂), was originally a private phoenix hall. Since 1903, it started to offer several spiritual healing services and spiritual consultation [12], [13]. The services were widely popular. As the faithful and honest character of Lord Guan matched the spirit of the commercially vibrant Daxi town at the time, Lord Guan became the common spiritual guide for the locals in Daxi [9]. Later, supported by local intellectuals and merchants, the private phoenix hall was rebuilt into a public temple, the Puji Temple [13]. Starting from 1917, in appreciation of Lord Guan's guidance in securing the miners, the shareholder of the mining company founded Tong-Ren-She (同人社), the first 'She-Tou' (社頭, a guild-based religious performing group) in Daxi, and collected funds to build one sacred palanquin for Lord Guan [9]. In general, religious performance groups developed in Taiwan are called 'Din-Tou' (陣頭; formation). Since these groups in Daxi are mostly composed of different industrial guilds, they were given a special name – 'She-Tou' (社頭). The first word 'She'(社) is the abbreviation of '株式會社' in Japanese, which means a company. The honor of the sacred palanquin, as donated by the mine guild, to greet the deity's holy procession stimulated a trend among other guilds, which one by one formed their own 'She-Tou' to participate in the pilgrimage procession. Nowadays, the century-old *She-Tou* culture has consolidated the community and also embodied the communal life itself.

Members of the groups who are usually busy at work would get together to prepare at least one month before the festival. They practice their skills of pilgrimage parade formation, like Dragon-Loin Dance, Beiguan orchestras, giant puppets Tong Zai (deity figures), and Da Xian Wang Zi (holy generals). The giant puppets, usually stored away, are assembled (Fig. 1). During the preparations, the elderly members teach the younger male members the instruments they play as well as the generals they have assembled, while the female members provide snacks and support the needs of male members [14]. Wen considered that the *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday* is the core of the sense of place in Daxi [14]. She took She-Tou groups as an example, "*many people learned how to maneuver a giant puppet on their shoulders, or helped She-Tou groups during their childhood. When they were older, they continued to serve as coaches or consultants of She-Tou, sometimes they also offered financial aid*" [10, *49*]. For people in Daxi, it is not only a folk-custom group established for the pilgrimage event, but also the cohesion of the community, and the essence of their lives. The skills taught by the elder members to the juniors become the mechanism of intangible cultural heritage inheritance and preservation (Figs. 2 and 3).

Fig. 1. Assembling of a general. Source: photo by authors.

Fig. 2. Giant puppets Tong Zai (deity figures). Source: DaxiDaxi.

Fig. 3. The Lion team dance of children. Source: DaxiDaxi.

B. Ritual of the Pilgrimage on June 24

Annually, on June 24, Lord Guan's Birthday, of the lunar calendar, more than 30 local She-Tou groups celebrate the pilgrimage parade (Fig. 5). In recent years, as the number of local Se-tou groups continues to increase, the pilgrimage's starting time has been brought forward and starts on June 23 and 24 [11]. The whole-day-long pilgrimage procession is divided into two phases: 'tshut-ke' (出街, get out of the street) in the morning and 'jip-ke' (入街, enter the street) in the afternoon. Before the start of the pilgrimage on June 23, the Puji Temple holds a ceremony following the ancient ritual, the sounding of cannons, bells, and drums symbolize the beginning of the festival [15]. The procession departs from the Puji Temple through the surrounding suburban settlements at around 7 o'clock in the morning, returns to the meeting place in town at noon and enters the street at 1 o'clock in the afternoon. In the evening, lively performances by She-Tou groups are leading all the way through the township to the Puji Temple (Figs. 7–9) [13], [16].

The formation of the Daxi pilgrimage parade can be divided into three parts of a whole: (1) *Khui-loo Din (*開路陣*; vanguard team),* which is formed by the flag of Puji Temple, the giant puppet of Earth God and the music teams from She-Tou groups for opening the parade. The God of Earth opens and leads the way of the gods and reduces accidents; (2) Local She-Tou performance in which 30 more local She-Tou groups participate. The art performance teams of each She-Tou group, including Beiguan music, giant puppets, and dragon-lion dances are deployed. Some She-Tou groups have tried to bring innovative ideals into the parade, such as young-ladies' pop music dances, riding a unicycle or flying trapeze (Figs. 3 and 4) *Ah-bue Din (*押尾陣*; rearguard team),* which is composed of *Tong-Ren-She* responsible for Lord Guan's sacred palanquin. The owner of the temple-incense-burner and the deputy owner in tenure carry the official seal and imperial decree of Lord Guan, which represents the Lord Guan's decree. Lord Guan accompanies the pilgrimage parade walking through the Daxi area and blesses the people of the town to keep their families safe and in peace [14].

In addition to Se-Tou, everybody in Daxi gets involved in preparations unprompted, buying sacrificial items and providing tea and snacks on the route (Fig. 6). Moreover, locals, who have moved to other towns come to Daxi for the parade to take part and are welcomed by relatives. More than one hundred thousand people from all over Taiwan always accompany the entire pilgrimage parade each year. The whole old town area is as bustling as on the Chinese New Year.

Fig. 4. Giant puppet riding a unicycle. Source: DaxiDaxi.

Fig. 5. The pilgrimage parade. Source: DaxiDaxi.

Fig. 6. Residents prepare the incense table to welcome the God. Source: DaxiDaxi.

Fig. 7. Giant puppet – a general. Source: DaxiDaxi.

Fig. 8. Dragon dance at night. Source: DaxiDaxi.

Fig. 9. Lord Guan's sacred palanquin. Source: DaxiDaxi.

C. Festival DAXIDAXI – Refocus and Repositioning of the *Celebration of Saintly Emperor Guan's Birthday*

The Daxi Wood Art Ecomuseum, established in 2015, has dedicated its mission to continuing preserving, recording, and promoting the culture of Daxi wood industry and of people living with the locals [17]. Besides Museum fairs, Daxi Wood Art Ecomuseum also takes the responsibility of holding the Daxi Art Festival. While reviewing the resources and developing the Daxi Art Festival, in 2015, the museum took the *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday* as a core idea and enriched it with *Celebrating one-hundred-years-parade with arts* through revitalizing She-Tou's history, cultural relics exhibition, and dynamic exhibitions to let the public re-experience the celebration and the She-Tou culture.

After a three-year experience of *Daxi Art Festival*, the museum pondered the significance of folk belief in contemporary life, and decided to move the festival three weeks before Lord Guan's birthday with the name, the "advance festival" for the celebration [18]. The Daxi Art Festival was renamed the 'DaxiDaxi Festival", the first 'Daxi'(大溪) represents the town as the main subject, while the second 'Daxi'(大禧) means the Great Celebration of Lord Guan's Birthday and blessing with good luck [11]. DaxiDaxi purports to highlight the vibrant celebrative spirit of the entire town through a series of events. Participation of the community was much encouraged in every stage, including the event design, exhibitions, preparation of performances and installations. Designers and residents of different background were invited to participate in a cultural celebration that embraced both tradition and innovation (Figs. 10–12) [18]. Following the traditional etiquette, with contemporary design thinking, interpretation and linkage, DaxiDaxi became one of Taiwan's most important town festivals [19]. By repositioning the festival, the museum clearly stated that the purpose of art and contemporary design is to let these creators take responsibility of helping the Daxi and She-Tou culture tell stories in order to arouse the interest of the community and encourage the residents to participate. Moreover, by means of new media and marketing, the goal of sustainable promotion and preservation of intangible cultural assets has been achieved. The town's arts festival in which a new-type of regional festival interprets traditional culture has been created [18].

However, both the Daxi Art Festival and the DaxiDaxi the festival is only a section, medium or a platform of demonstration. In response to the preservation of She-Tou culture and the process of interpretation of folk belief, the museum has facilitated the She-Tou groups to revisit their own history and cultural relics and even to start improving the environment, repairing and recording the preservation of cultural relics. These changes aroused the attention of

Fig. 10. Dance with God, 2019. Source: DaxiDaxi.

Fig. 11. The Generals and Exhibition, 2019. Source: photo by authors.

Fig. 12.Daxidaxi key vision on Facebook. Source: DaxiDaxi Facebook page. Designer: Liao Chun-yu (廖小子).

She-Tou groups, as a result, they have gradually changed from passive interviewees into active interviewers, and are willing to share information with the museum, to co-preserve and inherit culture and relics. The movement of change can better represent the accumulation of local memory and cultural heritage.

II. "Lord Guan Online!" and "DaxiDaxi" Facebook Page

Starting from 2020, the time when the public needed to be mentally comforted, DaxiDaxi launched a new digital project – "Lord Guan Online!" website, to function in conjunction with the live events [20]. This website provides insight into the culture, stories, and content knowledge of the *Lord Guan's birthday celebration* and the pilgrimage event, which are reinterpreted digitally to create an online and offline integration. People who cannot come to the site can also use this online platform with interactive games and live broadcasting to feel the blessing and share the faith of peace and happiness. However, in the early summer of 2021, Taiwan has been in the greatest danger since the outbreak of Coronavirus. All physical activities in DaxiDaxi, including the century-lasting celebration, *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday*, were forced to suspend. Nevertheless, the belief of Daxi people and the gratitude to Saintly Emperor Guan that has been concentrated in Daxi year after year have not dissipated because of the pandemic. This kind of unchanging mind has made the "Lord Guan Online" website and DaxiDaxi Facebook page continuously operate and publish new Daxi-based online projects. The museum has become a virtual land where everyone gets together to count down the celebration day, share the emotions and feel the sense of place without boundaries.

D. DaxiDaxi – "Lord Guan Online!"

"Lord Guan Online" uses the experience of a first-person role-playing-game (RPG) to lead the visitors into the online pilgrimage event. The plot of the website starts with waking Lord Guan up and helping him get ready for work, from which the visitors can learn about Lord Guan's distinguishing features. Following Lord Guan to his online temple, the visitors can make a wish or draw lots anytime and anywhere. After that, the game guides the visitors to join and explore the pilgrimage parade online during the June 24 event. Besides, on June 24, the visitors can use this website to watch the live broadcast of the traditional pilgrimage event onsite from a bird's-eye view as well (Fig. 13).

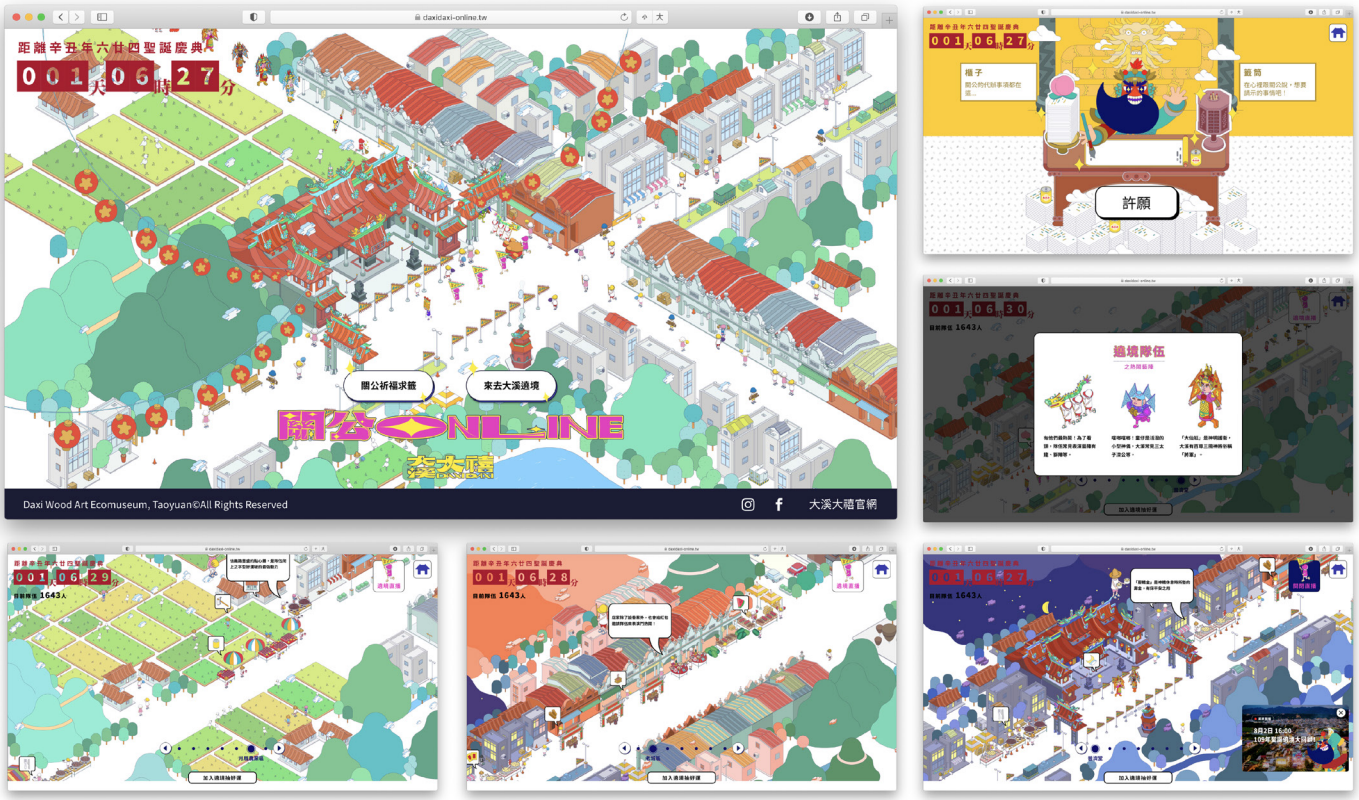


Fig. 13. DaxiDaxi "Lord Guan Online!" website. Source: screenshot by authors. Illustrator: Kuo-Cheng Liao.

E. Digital Interpretation of the Traditional Pilgrimage Event.

Through the following aspects, "Lord Guan Online" website leads the visitors to understand and experience the folk beliefs of Daxi and the traditional pilgrimage parade.

1. Choose a Role and Join the Parade

Before joining the parade, visitors can choose a role of different occupations, which reflects the local Se-tou culture. During the choosing process, visitors could learn the special characteristic of Se-tou in Daxi. While joining the parade, people can also enter a text message to share and interact with others.

2. Guided Tour for the Formation of Pilgrimage Parade Procession

Through interacting with the comic-style objects in virtual parade by clicking out, visitors can learn about the connotation of the "Kui-loo Din" (開路陣; vanguard team) formed by the flag, the giant puppet of Earth God, and the music teams in the front of the parade, the "art performance teams" formed by local She-Tou groups in the middle, and the "Ah-bue Din" (押尾陣; rearguard team) formed by Ton-Ren-She and Lord Guan's sacred palanquin in the back section of the pilgrimage parade.

3. The Parade Route with the Humanistic and Natural Landscape in Daxi

The museum invited a professional illustrator to interpret the real parade route into a digital interactive version with the form of 2.5 D scroll map. On the map, the route is strung through five locations that have important implications in the traditional pilgrimage. Visitors depart from the *Puji Temple*, pass by the *Yamay Leisure Agriculture Area*, *Sanceng Mountain Trail*, *Daxi Wood Art Ecomuseum buildings,* and the *Old Downtown Area* along the way and finally return to the departure point – the front entrance of the *Puji Temple*. While digital parading, comic-style dialog boxes and button hints pop up to introduce visitors to the regional characteristics of each location, including municipal historical sites, local industries, museums, natural environment, and cultural knowledge related to the pilgrimage event. The illustrator also presents the time sequence of the pilgrimage parade and environmental atmosphere of the surroundings from day to night through drawing performance.

F. Posting Plan and Feedback on Audience Interaction on the DaxiDaxi Facebook Page

Post Planning Corresponding to the Traditional Pre-Celebration Schedule

Throughout June of the lunar calendar, everybody in Daxi town is busy preparing for the Celebration of Saintly Emperor Guan's Birthday. Through the posts on the Facebook page, the Daxi Wood Art Ecomuseum introduces to the audience the preparations for the Celebration of Saintly Emperor Guan's Birthday taking place in Daxi during this month. According to the time schedule, the museum uses "# Stories of Shen-zhi-xiang" (神之鄉; *the Holy Town*, which is a TV series with the *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday* as the background, adapted from the comics of the same title by Zuo Xuan) and "# Lord Guan's Birthday Schedule" as themed tags, and conveys the knowledge and the content of intangible cultural heritage to the audience through real recorded images and texts. It is the embodiment of the museum as an educational institution. Table I summarizes the posts on DaxiDaxi Facebook page 2021 from June 1 of the lunar calendar (which was July 10 in solar calendar) to June 29 (August 7 in solar calendar), and the data of feedback (including like, love, ha-ha, wow, sad, and angry), comments, and shares obtained by each post.

TABLE I

Abstract of the Posts and the Statistical Data on DaxiDaxi Facebook Page (www.facebook.com/DaxiCulFes/) from June 1 to June 29, 2021 of the Lunar Calendar [developed by authors]. Statistics as of September 10, 2021

No.	Date	Abstract of the post	Figure in post	Reactions		Comments		Shares	
				figure	post	figure	post	figure	post
1	1/6	Call on the first day of June and promoting the new TV series "神之鄉" (The Summer Temple Fair).	f-1.1	41	**1.3K**	0	34	0	**104**
			f-1.2	31		0		1	
			f-1.3	21		0		0	
			f-1.4	**128***		**9***		0	

No.	Date	Abstract of the post	Figure in post	Reactions		Comments		Shares	
				figure	post	figure	post	figure	post
2	4/6	Introducing background information on Daxi – its legends, humanities, environments, and lifestyle.	f-2.1	4	**1.3K**	0	45	0	**68**
			f-2.2	**50***		2		0	
			f-2.3	30		0		0	
			f-2.4	**80***		2		0	
3	6/6	June 6 is the date of Lord Guan's godsons' reunion at the Temple. Introducing the godson and grandson culture of Lord Guan.	f-3.1	20	711	1	4	0	20
			f-3.2	24		0		0	
			f-3.3	**93***		**11***		1	
			f-3.4	13		0		0	
4	8/6	Introducing the key figures of local Se-tou groups.	f-4.1	21	799	0	10	0	25
			f-4.2	18		0		0	
			f-4.3	**61***		**3***		1	
			f-4.4	27		0		1	
5	12/6	Reviewing of the selected activities of DaxiDaxi from 2018 to 2020, and inviting audience to comment and share their favorite activities that they have participated in.	f-5.1	15	870	0	**126**	0	27
			f-5.2	21		2		0	
			f-5.3	**37***		**23***		0	
			f-5.4	21		3		0	
			f-5.5	34		3		0	
			f-5.6	19		2		0	
			f-5.7	26		0		0	
			f-5.8	23		0		1	
			f-5.9	38		2		0	
			f-5.10	20		0		0	
			f-5.11	20		0		0	
			f-5.12	**145***		**27***		1	
			f-5.13	19		0		0	
6	15/6	Se-tou special feature: Introducing the art performance teams of Se-tou groups	f-6.1	34	647	0	17	0	38
			f-6.2	34		0		0	
			f-6.3	56		0		1	
			f-6.4	34		0		0	
			f-6.5	39		0		0	
			f-6.6	37		0		0	
			f-6.7	48		0		0	
7	17/6	Se-tou Special Feature: Introducing the Dragon dance teams of Se-tou groups	f-7.1	25	633	**9^**	18	1	25
			f-7.2	21		**3^**		2	
			f-7.3	39		0		0	
			f-7.4	27		**6^**		2	
			f-7.5	19		0		0	
			f-7.6	23		0		0	
			f-7.7	22		0		0	
			f-7.8	43		**7^**		1	
			f-7.9	38		0		0	
8	18/6	Introducing the Temple Washing Day on June 18 – the residents of Daxi gather at the Puji Temple to clean up and prepare for the celebration.	f-8.1	14	527	0	6	0	5
			f-8.2	8		0		0	
			f-8.3	10		0		0	
			f-8.4	4		0		0	

No.	Date	Abstract of the post	Figure in post	Reactions		Comments		Shares	
				figure	post	figure	post	figure	post
9	19/6	Introducing the "Lord Guan Online!" website and inviting the audience all over the world to join online and make a wish.	f-9	-	494	-	**88**	-	**72**
10	20/6	Introducing the "Lord Guan Online!" website and inviting everyone to join the online pilgrimage parade this year.	f-10.1	8	294	0	8	0	6
			f-10.2	7		0		0	
			f-10.3	8		0		0	
			f-10.4	6		0		0	
			f-10.5	28		1		0	
			f-10.6	22		0		0	
11	21/6	Introducing the incense table culture – before 21 June in the lunar calendar, every household was ready to set up the incense table to welcome the gods on the day of the pilgrimage event. The prepared objects include incense candles, incense burners, fish, meat, fruit, drinks and other food.	f-11.1	13	560	0	7	0	7
			f-11.2	3		0		0	
			f-11.3	3		0		0	
			f-11.4	3		0		0	
			f-11.5	28		0		0	
			f-11.6	33		0		0	
			f-11.7	14		0		0	
			f-11.8	18		3		0	
			f-11.9	5		0		0	
12	22/6	Introducing the anti-epidemic version of the Puji Temple worship guide for this year.	f-12.1	9	516	0	2	0	17
			f-12.2	9		0		0	
			f-12.3	12		0		0	
			f-12.4	9		0		0	
13	24/6	On the day of June 24. Introducing the ceremony of welcoming Lord Guan, the pilgrimage, and the parade route.	f-13.1	39	**1.2K**	0	**84**	0	**62**
			f-13.2	33		2		0	
			f-13.3	**63^**		**5^**		0	
			f-13.4	**108^**		**21^**		1	
14	24/6	On the day of June 24. Introducing the Snack and drinks stands – local shopkeepers, residents along the route will prepare free snacks and drinks for people who join the pilgrimage.	f-14.1	8	518	0	4	0	4
			f-14.2	6		0		0	
			f-14.3	8		0		0	
			f-14.4	11		0		0	
			f-14.5	8		0		0	
			f-14.6	7		0		0	
			f-14.7	8		0		0	
			f-14.8	8		0		0	
			f-14.9	18		0		0	
			f-14.10	19		0		0	
			f-14.11	11		0		0	
15	25/6	Introducing the day of June 25 before dawn, the pilgrimage parade back to the temple and the grand closing of celebration.	f-15	-	665	-	9	-	1
16	25/6	Introducing the owner of the temple incense burner culture. All Se-tou groups in Daxi gather at the Puji Temple on June 25 to choose the next owner of the temple's incense burner by casting moon blocks. It symbolizes the beginning of a new year.	f-16.1	14	299	2	4	0	3
			f-16.2	2		0		0	
			f-16.3	1		0		0	
			f-16.4	9		0		0	
			f-16.5	49		0		0	
			f-16.6	6		0		0	
17	29/6	On the last day of June. To exhibit that faith is like a big magnet and to share the last episode of the TV series "The Summer Temple Fair".	f-17	-	208	-	4	-	3

G. Exploring the Sense of Place from the Interactive Feedback of the Audience; Trends in the Number of Reactions, Comments, and Shares in the Posts

According to the statistical data in Table I, some pictures that cooperate with the post, cause more reactions and comments. The content of these pictures is mostly related to people familiar to the audience. People who aroused heated discussion included the local Chief of Village with a member role of the *Fu'an* Se-Tou group (f-1.4), 100-years-old local senior (f-2.2), members of different Se-tou groups (f-3.3, f-4.3, f-5.12), and other local residents participating in the activities. There are also some resonant pictures related to performance teams of Se-tou groups, such as the Dragon and Lion Dance teams at f-7.1, f-7.2, f-7.4, f-7.5, and the pilgrimage records of Se-tou groups at f-13.3, f-13.4.

In terms of posts, the top 5 in Reactions are Post No. 1 (1.3K reactions), Post No. 2 (1.3K reactions), Post No. 13 (1.2K reactions), Post No. 5 (870 reactions), Post No. 4 (799 reactions); the top 5 in Comments are Post No. 5 (126 comments), Post No. 9 (88 comments), Post No. 13 (84 comments), Post No. 2 (45 comments), Post No. 1(34 comments); and the top 5 in Shares are Post No. 1 (104 times) , Post No. 9 (72 times), Post No. 2 (68 times), Post No. 13 (62 times), Post No. 6 (38 times). Among them, Post No. 1, Post No. 2, and Post No. 13 have repeatedly appeared on the list 3 times. Posts No. 5 and No. 9 are repeated twice on the list.

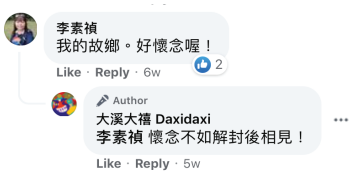
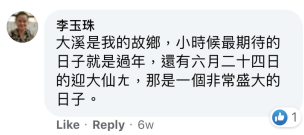
H. The Composition of the Audience and their Responses to the Posts

Under the guidance of the posts, some of the content aroused the common feeling of the audience, which made them leave messages and share their emotions under the posts. Other audience members and the editor who run this Facebook page also interact with the audience, who leave the comments (Table II). While maintaining the relationship, it also stimulates more possibilities for discussion about Daxi. Most of the comments can be divided into three main categories: (1) memories of the audience of Daxi; (2) sharing of cultural and historical knowledge about Daxi; and (3) emotional expression of audience on Daxi. The following table extracts some comments of the audience.

It can be observed from most of the shared comments that the audience participating in the interaction is local residents of Daxi, and they are of a wide range of ages. Corresponding to the data on its Facebook page backend (Table III), it also confirmed that 42.6 % of the main audiences of the DaxiDaxi Facebook page are Taoyuan local users, with most users falling between the ages of 25–34, followed by 35–44. Users between the ages of 45–54 and 18–24 also account for a certain percentage. Overall, the proportion of female users is slightly higher than male users.

TABLE II

Comments of Audience on DaxiDaxi Facebook Page [developed by authors]. Recorded Date: September 10, 2021

Audience's local memories	Cultural and historical knowledge	Audience's emotional expression
		
Li Kuan-ting (李冠霆): The pilgrimage walking by the intersection of Zhongyang Rd. and Zhongshan Rd. at June 24, 1976. There were "Daguangming" photo gallery and "Yingying" beauty salon. I participated in Setou Dayou to raise the flag.	Tom Yo: June 24, 1988. Tseng Chen-yen (曾晨雁): Tom Yo, Is Xieyi the Setou in this photo?	Li Su-jen (李素禎): My hometown. I miss it so much. DaxiDaxi: It's better to meet after unblocking than to miss!
		
Li Yu-chu (李玉珠): Daxi is my hometown. When I was young, what I looked forward to most was the Chinese New Year and the big deity dolls on June 24. It was a very grand day.	Tsai Chia-cheng (蔡嘉正): Yes, it was Setou Xieyi, and the colour of pants was light blue. Tzutzu Chen: Tom Yo, Thank you. The black big deity doll in photo was made by my grandfather.	Hsiao Hui-chun (蕭慧君): The summer without pilgrimage. (ㄒ_ㄒ) DaxiDaxi: Summer is not summer anymore. Chien Hui-chi (簡慧琪): What a pity.

Audience's local memories	Cultural and historical knowledge	Audience's emotional expression
		
Lo Ke-Chiao (羅可喬): I love Daxi. I still remember the year when there was a firework show of National Day at Kanjin Bridge, and we all went to Dahan River to watch it.	Chang Hua(張華): The old place name of Daxi is Daguxian. Chou Hsiu(周脩): There is another old name called Dakekan.	Lin Tzu-yun (林孜芸): Miss Daxi already.
		
Lu Ya-ling (呂雅玲): I am a child of Daxi who after marriage moved to Kaohsiung. Every year on June 24, I take my children to Daxi. This is a common celebration event for every Daxi person inheriting its culture and memories.	Yu Hun Hsieh: I saw the last stop of the pilgrimage in 1916. The old house of my family is still there with the old house number hanging on it.	Huang Chen-lung(黃俊龍): Thanks for the blessing from Lord Guan. My mind remains the same. Wishing Lord Guan a happy birthday.

TABLE III

The Composition of the Audience on DaxiDaxi Facebook Page [source: Daxi Wood Art Ecomuseum, Taoyuan]. Statistics as of September 8, 2021

大溪大禧DaxiDaxi Facebook page Likes						
23,317						
Facebook Page Likes by Gender and Age			Facebook Page Likes by Top Cities		Facebook Page Likes by Top Countries	
Age	Female	Male	City	Value	Country	Value
18–24	**7 %**	**6.5 %**	Taoyuan City	**42.6 %**	Taiwan	**97.8 %**
25–34	**23 %**	**16.6 %**	Taipei City	**17.4 %**	Malaysia	0.3 %
35–44	**17.1 %**	**13.7 %**	New Taipei City	**16.1 %**	China	0.2 %
45–54	**6 %**	**4.6 %**	Taichung City	5.1 %	Japan	0.2 %
55–64	2 %	1.8 %	Kaohsiung City	3.3 %	US	0.2 %
Over 65	0.9 %	0.8 %	Tainan City	2.9 %	Hong Kong	0.2 %

III. Comparing Realistic Pilgrimage and Virtual Pilgrimage

The interview records of local residents in the official publication, *Feeling Life in Daxi* [21], and the comments of Facebook audiences provide us with the data for analysis of the experience of on-site pilgrimage and enable to compare it with the experience of virtual pilgrimage in "Lord Guan Online!" website.

In the script setting of the virtual pilgrimage on "Lord Guan Online!" website, the visitors are first guided to join the parade line. However, people who participate in the realistic pilgrimage parade on-site are not necessarily to follow the parade line. To choose a good location, to enjoy the art performance by She-Tou groups or to wait for the parade passing by your home is also one of the ways to participate in the pilgrimage event. Yao recalled her own childhood memories and said: *"My home is considered a GA floor section for watching She-Tou performances. When I was young, while She-Tou passing through, my siblings and I would rush to the corridor with benches in order to have the best perspective. We don't have to come to the street in the early morning like other people to grab a good seat"* [21, *17*].

In addition, there are other things that cannot be experienced through virtual pilgrimage but will happen in the process of the on-site pilgrimage. As Jian said: *"We place incense table at our front door and exchange incense with Lord Guan in sacred palanquin, which means bring blessing into the house to keep it safe and in peace"* [21, *23*]. When they are on-site, what the participants see, feel, or

TABLE IV
Differences between the Realistic Virtual Pilgrimage [developed by authors]

	Process	Seeing	Hearing	Smelling	Physical feeling	Psychological feeling
Realistic pilgrimage	Instantaneous, present, dynamic	Near, shocked, hallucinating	Environmental, overlapping	Sweat stinks, firecrackers, incense	Moving, exhausting, hot, mysterious energy	Impressive, wsatisfied, familiar
Virtual pilgrimage	Recorded, able to replay	Far, panoramic	Digital audio	-	-	Knowledgeable, easily accessible

impress is not just the She-Tou groups' performance or the scenery along the pilgrimage route, but the dynamics of other people around them. As Lin observed: *"You will see a lot of grandpas and grandmas being methodically busy in and out, skillfully preparing and cooking from day to night"* [21, *21*]. Or like Jian said: *"Although the pilgrimage starts at 7 o'clock in the morning and ends the next day at 4 o'clock before dawn, the neighbors would still automatically clean the streets after the celebration. Through the pilgrimage ritual, the neighbors also show a sense of unity"* [21, *23*].

However, comparing to the short-lived instantaneous experience of pilgrimage on-site, the digital pilgrimage provides the conditions for repeated reading and slow exploration. With a lot of organized knowledge, which is provided in an easy-to-learn way, digital visitors can have more time and opportunity to understand the values and meanings behind the whole lively pilgrimage on "Lord Guan Online". If the realistic pilgrimage is to provide an impressive experience, the visual pilgrimage is to give visitors a possibility to bring the knowledge behind intangible cultural heritage back. Table IV tries to trace the differences between the realistic and virtual pilgrimage in the experience of seeing, hearing, smelling, physical and psychological feelings with adjectives.

IV. Discussion and Conclusions

First of all, the study shows that the local residents and groups play the most important role in urban regeneration, interpretation of a place and culture heritage. What can we do, whether as a museum, an artist, or a designer getting involved by using different methods or tools, we can only be supporters to the locals to make the place better. Before discussing how to use digital tools, we must be clear that the content itself is always the core issue as well. It is necessary to fully understand and be careful so as not to lose focus in the process of digital interpretation.

1. Strong Relationship between the Locals and Place Leads to Success in Digital Interpretation

When local residents talk about June 24, the first thing coming to their mind is that it is a day to return to Daxi. For Daxi people, this day even surpasses the importance of the Chinese New Year. It symbolizes not only the reunion of family members, but also the celebration of the whole town. It is not just a day to express sincerest thanks to Lord Guan's blessing, for many people it has much more expectation and meaning. It might be a date that an appointment is made with a playmate, or might be a date with allusions of memory. On the other hand, during the process of participating in the *Puji Temple Annual Celebration of Saintly Emperor Guan's Birthday*, they are able to realize the existence of a unique sense of place belonging to Daxi. These feelings born from within can only be possessed through long-term participation and accumulation. The literature on sense of place emphasizes the importance of closeness, physical as well as social and emotional. At the core of this literature lies the focus on personal experiences and involvement related to places as being keys to creating the foundation for a sense of place, which includes a sense of deep care, concern, and responsibility for the place [22], [23]. In the case of Daxi, *She-Tou* is an important mechanism for maintaining a sense of place. Also, they are charged with the task of preserving intangible cultural heritage.

The core power of all these is actually derived from the belief of Lord Guan. Due to the faith, thanks to Lord Guan for his blessing, *She-Tou* groups chose to express their gratitude on Lord Guan's birthday, June 24. This faith has been passed on to people of Daxi from generation to generation, and it also formed the emotional connection and belonging of people, to be reflected on the day, June 24. Even if the pilgrimage is suspended due to the impact of coronavirus (COVID-19) pandemic, the faith, the affection toward Daxi will not be diminished. Their sense of place is the reason why "Lord Guan Online!" website and its Facebook page interpreted digitally can successfully act as one of the ways people linked up with each other and the contemporary place. Moreover, the infinite nature of internet and specialty of content interpretation of museum makes "Lord Guan Online" not only to be used as a media to connect with affection in the era of pandemic, but also provide more intellectual content about intangible cultural heritage of Daxi. At the same time, the trajectory of the Daxi people's activities to maintain their sense of place on digital media has also been recorded automatically.

Even though there are great differences of experience between on-site parade and online parade, there may be complementary characteristics between the two. If the realistic and virtual activities can be combined, people shifting between physical and virtual spaces, events, or dialogues will stimulate more possibilities and experience. It is clear that digitalized content activity cannot replace the entity or on-site activity, but the sense of place is the reason that makes digital tools work. Based on the sense of belonging, deep concern, and profound content, digital tools can be used as a medium to connect the relationship between people and a place.

J. An In-depth and Participatory Imagination of Digital Interpretation

For "Lord Guan Online!" website, it is currently dominated by the official event, showing the composition of the parade procession, a simplified version of the route, brief She-Tou group features, and the humanistic and natural landscape. These only cover general knowledge about Daxi Pilgrimage. Using digital platforms as a medium, there are more possibilities to be discussed and implemented. For instance, there are more than 30 She-Tou groups in Daxi with a rich knowledge and connotations of intangible cultural assets. If the government (the museum) can take the lead, cooperate with the locals by studying and displaying the stories behind the She-Tou groups, the common good life mechanism, and unique cultural relics digitally on the website it can not only strengthen its contents, but also give the locals the ability to organize and digitally interpret their own culture. When the mechanism of co-creation and co-learning can operate on it, the culture could be better preserved and promoted in perpetuity. In addition, instant interactivity is another aspect that can be explored in digital interpretation. At the moment when the physical pilgrimage is held, beside watching the live broadcast, as an online platform, "Lord Guan Online!" website could also provide a possibility of a real-time interaction. For example, real-time number display of online participants, providing online participants to walk into the live broadcast with virtual characters, or through the assistance of other digital tools, the participants who are on-site can interact with the one online in real time. These are ways to make online visitors have a more in-depth sense of presence and participation.

K. The Influence of Digital Interpretation and Digital Placemaking

Traditional festivals and pilgrimages, when the inner allusions and meanings are not known, for foreign visitors, it might be just a lively event, meaning non-existence of difference. However, through the reinterpretation of the content, it is transformed into a medium that can communicate with the contemporary era. By presenting in interesting ways such as digitalization, visualization, or gamification, the inner content can be more easily understood by people from different backgrounds and generations. In this case, for those who did not know about the Daxi Pilgrimage, the "Lord Guan Online!" website provides a new perspective and contact point for understanding the culture. Through the arrangement of the online pilgrimage tour guide, visitors can understand the cultural landscape of Daxi, Lord Guan beliefs and the knowledge of the pilgrimage culture beforehand. In the process of browsing, it is an experience of pre-travel or online tourism. When the visitor has the opportunity to visit the scene later, he can feel that this traditional celebration is not just an event. As he walks down the block and, in the parade, he might take a step closer to thinking about what the celebration means to the place. Different from the former, this outsider will have different memories of this urban environment. Therefore, for the visitor who has visited the website, there is a greater possibility of being able to connect with this place. Besides, for people who have already known about the Daxi Pilgrimage, they can once again re-understand the pilgrimage on the website from a different point of view.

The value of Daxi Pilgrimage culture lies not only in its long history and deep beliefs, but perhaps more importantly, they dare to innovate while the traditional culture that keeps pace with the times. From the unique composition of She-Tou groups, which are different from other religious performance groups in Taiwan, the introduction of pop culture into parade performances, and even the experiential website of virtual pilgrimage, etc., it can be seen that in each era, they are willing to interpret and express their beliefs using the means of that time. Digitization is only a tool of our time, if we want to make culture sustainable, a more important factor is to remain open and flexible.

Acknowledgements

This research is supported in part by The Ministry of Science and Technology, Taiwan (MOST 109-2923-E-011-002-MY3). Thanks to Daxi Wood Art Eco Museum for providing us the data.

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sciendo
RIGA TECHNICAL UNIVERSITY
Architecture and Urban Planning
2022, Vol. 18, Issue 1, pp. 30–42
https://doi.org/10.2478/aup-2022-0004
https://content.sciendo.com
Online ISSN 2255-8764

Broadening Public Engagement in Spatial Planning through Digital Participatory Mapping: Experiences from Latvia

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Received 2022-02-24; accepted 2022-05-23

Keywords

GIS, participatory mapping, public engagement, spatial planning.

Abstract

Digital participatory mapping is an emerging and largely unexplored practice in Latvia despite its potential to broaden and diversify public engagement processes. This study explores the spectrum of currently used digital participatory mapping tools through select examples from Latvian municipalities. Furthermore, the study examines the citizens' participatory habits and preferences using a small-scale citizen survey and co-design activity. The obtained results allow reflection on the design, functionality, and engagement formats of the existing participatory mapping tools compared to the citizens' expectations.

Introduction

Geographic information systems (GIS) emerged in the 1960s in response to challenges in land use planning [1]. However, significant expansion of GIS use in local governments started in the 1990s, focusing primarily on intraorganizational analytic and decision-making processes [2]. Further advances in GIS and information and communication technologies (ICT) have facilitated the expansion and diversification of GIS applications, including a growing interest in developing participatory mapping methods and tools for generating place-specific knowledge to support plan-making and decision-making [3].

Broadly speaking, participatory mapping refers to using maps as the primary medium to engage people in a dialogue about the world [4], [5]. Participatory mapping is also called geo-participation, meaning the use of spatial tools to involve citizens [6] or a collection of geographical practices with participatory potential [7]. The participatory mapping methods include a spectrum of approaches, from primitive sketch mapping and hardcopy maps with markers or stickers to sophisticated three-dimensional models [5], [8]. GIS enables the capture, storage, analysis, and management of digital spatial or geographic data [5] that has resulted in a range of GIS-based solutions, including public participation GIS (PPGIS), participatory GIS (PGIS), volunteered geographic information systems (VGI), and participatory three-dimensional modeling (P3DM). These solutions are used in urban planning [9], [10], natural resource planning [11], [12], landscape planning [13], crisis management [14], and other fields around the world.

There is no clear distinction between participatory mapping concepts (e.g., PPGIS, PGIS, VGI, crowdsourcing, and others), generating confusion for academics and practitioners alike [7], [15]. Brown & Kyttä [15] have attempted to propose distinguishable characteristics for PPGIS, PGIS, and VGI. However, the practice shows that the distinctions do not always stand up in real-life applications [7], especially since GIS technologies have become accessible not only to expert users but also to citizens, community organizations, and other non-expert actors [2]. Therefore, this study will use Tulloch's definition of PPGIS to define digital participatory mapping as a "field within geographic information science that focuses on ways the public uses various forms of geospatial technologies to participate in public processes,

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such as mapping and decision making" [16]. It will allow encompassing all practices of extraorganizational digital participatory mapping, involving collaborative mapping activities [2].

Overall, participatory mapping or geo-participation promises to enhance public participation in spatial planning [7] by supporting map-based dialogue and data collection [17]. The studies show that PPGIS tools can ensure a relatively large number of voluntary participants at various phases of the planning process and in different planning situations. These tools typically provide functionality for collecting diverse place-based knowledge and supporting interactions among stakeholders [7], [17]. The obtained data can help identify conflicting issues or views early in the planning process to be addressed in follow-up deliberative processes [3], [17], potentially resulting in greater public support of the planning solutions. However, not all PPGIS tools deliver on these promises. There are still many challenges in PPGIS use associated with participatory strategies, representativeness, digital divide, and data collection strategies, to name a few [17], [18]. From a technological and methodological standpoint, the key issues or knowledge gaps are linked with the selection of appropriate participatory mapping methods, adaptation or customization of digital tools for different contexts or user groups, and facilitation of continuous public engagement and interaction throughout the process [5].

These and other issues are especially relevant for post-socialist countries that do not share the same history of public participation in spatial planning and decision-making with Western democracies. The post-socialist societies have started to adopt democratic innovations comparatively recently, and they are still under-researched [19]. There are studies on participatory planning in Poland [20]–[22], the Czech Republic [23], [24], Slovenia, Hungary, Bulgaria, Romania [23], and other contexts, but with limited insights into how these new practices incorporate digital participatory mapping [18], [19], [25]. Moreover, in some post-socialist countries, e.g., Latvia, participatory mapping for spatial planning is mainly unexplored, providing potentially new insights.

Latvian municipalities and planning consultancy companies are working with different GIS solutions, but the incorporation of participatory components in public GIS-based platforms is only beginning to emerge [26]. Some planning agencies or municipalities have succeeded in attracting EU funding that has allowed them to develop or experiment with digital mapping tools in different contexts. However, there are limited insights into how these early experiences have helped to facilitate public engagement or improve spatial planning processes. Therefore, we aim to explore what digital participatory mapping methods and tools are used for spatial planning in Latvian municipalities and how they contribute to public engagement. Moreover, we examine the participatory habits and preferences of citizens to understand how the design and functionality of the existing tools align with their expectations and wishes.

I. Research Design & Methods

The predominantly explorative nature of the study led to choosing a primarily qualitative research design that allowed applying a multi-method approach for data collection and analysis. The research was conducted in three subsequent phases: (1) analysis of the use of digital participatory mapping tools in Latvian municipalities, (2) exploration of participatory habits and preferences of citizens, and (3) co-designing participatory mapping user experience for spatial planning (Fig. 1). The obtained results are first presented separately to illustrate the outcomes of each research phase. We then reflect on the main outcomes to gain additional insights into how the design and functionality of the existing tools align with the expectation of potential users.

In *Phase 1*, we explored the current status quo of participatory mapping in Latvian municipalities. We used convenience sampling to identify potentially interesting case studies among Latvian municipalities that would allow exploring the spectrum of currently used digital participatory mapping tools. In each case, we analyzed existing digital participatory mapping tools focusing on their functionality, application for spatial planning or urban management, and engagement format or level (e.g., inform, consult, involve, collaborate, and empower [27]). Additionally, we conducted semi-structured interviews with local planning and GIS experts (Table I) to get further insights into the challenges associated with tool development and implementation. The interview topics covered the development process of locally-used digital participatory mapping tools (from idea to implementation), their usage, maintenance, deficiencies, the potential for broader use in public engagement processes, and others. The questions were adjusted to the expertise of each interviewee before the interview. The obtained data were aggregated and analyzed qualitatively.

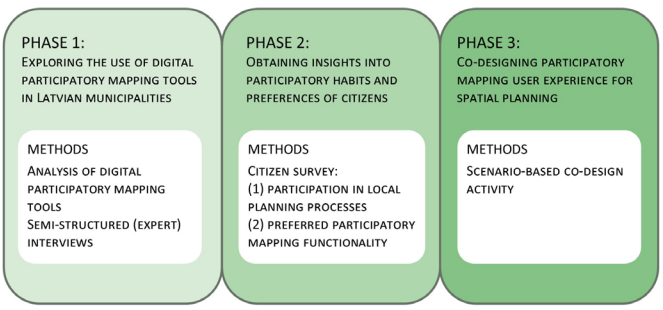


Fig. 1. Research phases and methods [Authors' illustration].

TABLE I

List of Conducted Interviews [Authors' compilation]

Ref. code	Format	Municipality	Expertise
INT_01	In-person meeting	Jūrmala city	Strategic planning, GIS implementation
INT_02	Virtual meeting	Rīga city	Geospatial information
INT_03	Virtual meeting	Mārupe county	Geospatial information
INT_04	Virtual meeting	Kuldīga county	Spatial planning
INT_05	Virtual meeting	Jelgava city	Urban management and GIS
INT_06	E-mail	Jelgava city	GIS
INT_07	Virtual meeting	Daugavpils county	Geospatial information

Phase 2 aimed at obtaining insights into the participatory habits and preferences of citizens. The data was collected using an online citizen survey disseminated via social media (Facebook newsfeed and community groups). The questionnaire was structured in three thematic blocks: (1) demographic data, (2) participation in municipal planning processes, and (3) functionality of participatory mapping tools. It included 22 questions comprised of nine single-choice questions, ten multiple-choice questions, and three open-ended questions. At the end of the questionnaire, the respondents were asked to provide their e-mail addresses to participate in the next research phase – the co-design activity.

170 respondents (112 female and 58 male) filled out the questionnaire. The majority of the respondents (132) were from the Rīga planning region (including 96 from Rīga city). The respondents made up a comparatively small and non-representative sample (Table II). The average respondent was a female aged 25–34 with higher education and living in Rīga. The survey results are presented as indicative trends among the dominant respondent groups, which at least partially describe the habits and preferences of typical participants in the public engagement activities. The acquired data on the preferred participatory mapping functionality was also used to prepare the co-design activity for Phase 3.

Phase 3 was dedicated to co-designing the user interface of a participatory mapping tool. Initially, it was planned as a participatory design workshop with several target groups, but the approach had to be transformed into remote participatory design activity due to the epidemiological restrictions in Spring 2021. It was chosen to develop a scenario-based online worksheet (using the visual collaboration platform Mural) where each participant could develop the preferred user interface of a generic participatory mapping tool.

The chosen scenario was based on a typical spatial planning situation – a public discussion of a detailed plan (a detailed plan is developed in order to implement a particular development proposal, specifying the requirements stated by the spatial plan or the local plan in more detail [28]). It consisted of six steps: (1) user authentication, (2) start page/view, (3) selection of the relevant spatial area, (4) retrieval of information about the detailed plan, (5) adding a suggestion, and (6) getting feedback. At each step, the participants were provided with a brief description, a customizable interface of a mobile application, and a set of user interface elements that could be "dragged and dropped" to create a preferred design solution. The participants were also encouraged to leave comments or suggestions describing their proposed design or adding other important information (e.g., additional features or functions).

Individual access to the online worksheet with task description and video instructions was disseminated among those survey participants who had indicated a wish to participate in the co-design activity. A total of 10 participants (5 male and 5 female, representing two dominant age groups among the survey respondents) filled out the worksheet. The resulting design concept

TABLE II

Overview of Survey Respondents' Age, Education Level, and Occupation [Authors' compilation]

Age		Education		Occupation (multiple-choice)	
<18 yrs.	2	Lower secondary	0	**Employed: government/public sector**	**71**
18–24 yrs.	8	Upper secondary	4	**Employed: private sector**	**74**
25–34 yrs.	**96**	Vocational	6	Self-employed	13
35–44 yrs.	**40**	Unfinished higher	11	Entrepreneur	15
45–54 yrs.	16	**Higher**	**149**	Student	17
55–64 yrs.	8			Unemployed	5
>65 yrs.	0			Other	8

contains aggregated elements and functions selected by most participants (more than a half). Special attention has been paid to the positioning of the elements on the interface and participants' comments that provided more detailed insights into their thought processes.

The obtained generic design concept allowed us to draw tentative conclusions about the expectations and wishes of the potential user group. These were then analyzed comparatively to the existing solutions to obtain insights into similarities and differences that illustrate the need for adaptation or customization of the existing tools.

II. Digital Participatory Mapping Tools: Examples from Latvian Municipalities

A. National Spatial Development Planning Information System

On the national level, the Ministry of Environmental Protection and Regional Development has developed the Spatial development planning information system (SDPIS) – *a structured set of information technologies and databases which ensures the creation, compilation, accumulation, processing, use, and destruction of information required for the development and implementation of spatial development planning documents* [29]. It consists of four components: (1) a central module (tapis.gov.lv) for planning experts supporting the preparation, publication, and upkeep of the planning documents; (2) a regional development indicators module (RDIM) allowing public access to different municipal data sets; (3) publicly available national geospatial information portal (ĢeoLatvija.lv); and (4) e-services on state service portal (Latvija.lv) [30].

Public engagement is ensured through the national geospatial information portal (section "Spatial development planning"). The authenticated users can sign up for spatial planning news for a selected territory. These include notifications about decisions related to different planning documents, public discussion processes, and public hearings or meetings. The portal also provides access to all official documentation and allows viewing land-use zoning in the integrated map browser. When there is an ongoing public discussion process, the authenticated users can submit proposals or suggestions through the portal. The users can submit a written statement with or without selecting a specific location related to the suggestion. Planning experts, in their turn, can view and respond to these suggestions. The research shows that only about 800 citizens have signed up for the news, indicating that people who are not interested in or work with planning issues are unaware of this tool [26].

The SDPIS is essentially a one-stop platform providing access to all available planning documents in Latvia and ensuring uniformity in specifications and visualizations. It allows for easier search and usage of the relevant information. However, the system has limitations regarding public engagement. The proposals and suggestions can be submitted only during the public discussion process. Moreover, there are no options for engagement in

TABLE III
FUNCTIONALITY OF COMMONLY-USED DIGITAL PARTICIPATORY MAPPING TOOLS [AUTHORS' COMPILATION]

Engagement level	Tool	Functionality
Informing	Map browsers	• Viewing different data layers • Viewing different map types
	Geoportals	• Viewing and searching geospatial data sets • Viewing attribute information about objects • Adding data layers from external sources • Data selection and filtering • Layering different data sets and maps • Printing, drawing, or marking points on the map • Viewing metadata (information about data sets)
	3D models	• Viewing three-dimensional spatial visualizations • Simulation and visualization of new plans or projects
Consulting	Crowdsourcing solutions	• Viewing information about a project or plan • Submission of geo-referenced suggestions • Viewing suggestions of other contributors
	Geo-questionnaires	• Creating questionnaires with geospatial components • Linking questionnaire answers to locations on a map by marking points or sketching polygon features
Involving	Interactive mobile & web applications	• Viewing information about a project or plan • Submission of geo-referenced suggestions • Viewing status updates for suggestions • Viewing suggestions of other contributors • Getting feedback from the municipality • Reacting (like/dislike) or commenting on suggestions of other contributors

everyday decision-making and planning processes. The communication is formal, often resulting in a long wait for a response that can be avoided by contacting the municipality directly. Direct communication also provides more options for dialogue and collaboration. Overall, the interviews reaffirmed the primarily formal use of the SDPIS as required by law and its limited role in ensuring public engagement.

B. Local Digital Participatory Mapping Solutions

Latvian municipalities demonstrate a comparatively limited use of participatory mapping solutions for public engagement in spatial planning. The obtained results show that participatory mapping is not an everyday practice among planners due to an implementation gap in adopting existing GIS solutions for participatory planning. Overall, it is possible to distinguish four commonly-used participatory mapping approaches: (1) map browsers and geoportals, (2) 3D models, (3) crowdsourcing solutions and geo-questionnaires, and (4) mobile applications for interactive communication. The identified tools and approaches primarily ensure informing and consulting levels of engagement for spatial planning and urban management (Table III).

The most commonly-used digital mapping solutions in Latvian municipalities are **map browsers and geoportals**. Both solutions are developed to aggregate different data on the municipality and its territory in one system. The objective is to improve the work efficiency of municipal services, ensure data circulation among different departments, and build a basis for the preparation of different cartographic materials, e.g., for spatial planning or data visualization. The difference between a map browser and geoportal lies in its interactivity. Map browsers only allow viewing different data layers and maps, whereas geoportals provide options for dynamic interactions, e.g., data selection and analysis, data upload, and download. The analyzed case studies show that these solutions were initially developed for internal use among municipal experts and departments. However, some municipalities have publicized separate data layers, e.g., the Daugavpils county GIS browser allows viewing different planning documents and thematic maps, municipal statistical data, and information on business activity [31]. In their turn, Kuldīga Development Agency provides an interactive map for viewing municipal spatial plan and adding extra layers like village borders and different base maps with specific information, e.g., areas where it is not allowed to build wind turbines [32]. The available data layers also allow viewing attribute information for individual objects, e.g., area size or zoning code. Rīga, Jūrmala, and Mārupe municipalities have also developed their geoportals based on a similar concept, but they are currently available only for intraorganizational (municipal) use. The main differences among the analyzed examples relate to the complexity and volume of the available data and functionality.

Another informing tool is **3D urban models** that provide three-dimensional spatial visualization of the natural and built environment. These models are gaining popularity in spatial planning, as they allow visual simulation of different development scenarios. 3D urban models help assess how the proposed buildings fit into the existing urban environment and communicate the expected changes in a more comprehensible way for non-expert audiences. These models can be an integral component of a geoportal, but they are typically developed as separate tools due to large data volume that can slow down other services.

Among the analyzed case studies, only Daugavpils county has developed a 3D model [33] under the umbrella of the Interreg project "Trans-form", aimed at revitalizing degraded territories. The model allows viewing a three-dimensional model of four industrial areas, measuring distances, comparing changes, and preparing visual materials. In this case, the model is aimed at a specific target group – entrepreneurs and potential investors interested in the sustainable development of these areas [34].

Overall, tools like map browsers, geoportals, and 3D urban models do not facilitate active participation but ensure the most basic engagement level – informing. It allows citizens to view or obtain information about their local environment and helps to stay up to date with different planning and development processes. Moreover, access to visualized information often facilitates a better understanding of the local context or proposed planning solutions leading to informed participation.

When going beyond the informing level, some municipalities have used GIS-based **crowdsourcing solutions** to collect suggestions or ideas from citizens. One such solution – terGIS – has been developed by a planning consultancy company Metrum Ltd. and used in three different municipalities (Jūrmala, Kuldīga, and Rīga). It was first used to display citizen suggestions and their status during the spatial plan amendment process in Jūrmala [35]. Later, the terGIS was developed to allow submitting new suggestions or ideas directly through the web platform using a simple form. This version was used in Kuldīga during the preparation of the local plan for the old town area [36]. The latest terGIS version, used for crowdsourcing ideas for a local plan in Rīga (Riga Technical University campus area in Ķīpsala [37]), incorporates more data layers, categorization of suggestions, and new functionality allowing to vote and comment on collected ideas that are already characteristics of interactive web applications. Although the terGIS tool has evolved and improved over time, it has limited functionality primarily aimed at consulting – collecting suggestions and obtaining feedback for a specific planning project. Moreover, the

suggestions are submitted as free-form written messages that complicate the data processing and analysis.

For consulting purposes, some municipalities have also tried using **geo-questionnaires** that allow integrating geospatial components with a typical question-answer process. The case studies revealed two instances where the Esri ArcGIS Survey123 tool was used for citizen engagement. One was in Kuldīga county, where citizens were invited to submit suggestions for the new strategic planning documents using the ArcGIS Survey123 questionnaire [38]. In this case, the questionnaire mimicked a simplified suggestion submission form without taking advantage of the geospatial component or more structured geospatial data collection options. Therefore, its application resembles crowdsourcing solutions for idea collection.

A different approach was used in the Interreg project "Land-Sea-Act", which aimed to find ways to balance national interest for wind energy production at sea with coastal community interests and tourism development. In this case, Baltic Environmental Forum (*Baltijas Vides Forums*) employed geo-questionnaires (1) to collect data on locations in the Southwestern Kurzeme coastal area that are considered important for tourism and recreation and (2) to assess identified landscape units in the same area based on four different landscape qualities [39]. Both geo-questionnaires used a fully or partially structured data collection approach to obtain information that is comparatively easy to analyze. Moreover, the results of these questionnaires and other studies were fed into a geoportal (map explorer) that displayed project outcomes using textual descriptions, interactive maps, and dashboards that are updated in real-time [40]. Such an approach ensures greater transparency of the project outputs and provides access to easy-to-understand information that can be used by different stakeholders.

Finally, several municipalities use **interactive mobile and/or web participatory mapping applications** for two-way communication with citizens. These solutions typically allow to submit real-time reports on problems in the urban environment, view submissions of other users, and follow the report's status. For example, Jelgava municipality has developed a geoportal integrating an interactive problem-reporting map linked with the municipal operative information center [41]. This way, the municipal services can respond quickly, ensuring feedback and facilitating good communications practice. The application is primarily used for urban management, but it can also be adapted for citizen engagement in spatial planning. Similar solutions are also used in Daugavpils and Valmiera municipalities that have developed mobile applications with integrated problem-reporting maps. Mobile applications typically have a broader spectrum of functionalities (e.g., newsfeed, event calendar, and offers), and they can become a one-stop information and communication solution with the municipality for smartphone users. It supports different engagement levels (informing, consulting, and involving) and can be adapted for various uses.

III. Development and Implementation Challenges of Participatory Mapping Solutions

The interviews with municipal experts revealed several challenges they faced when developing and implementing digital participatory mapping solutions. First of all, there are technological or practical challenges like data availability, data quality, data protection, systems' complexity, and design. Second, there are also user-related challenges, e.g., competencies and digital skills of user groups. Finally, there is an overarching challenge of facilitating changes in thinking and dominant practices among citizens, municipal experts, and decision-makers.

No mapping solution can function without an adequate database or content. Therefore, data availability and quality are crucial challenges when developing a new solution. Initially, it is important to identify, prioritize, and categorize the available data sets based on planned usage (internal or public). If developing a public platform, another issue is data protection following the existing legal requirements. No less importance should be given to regular data updating to ensure the long-term usability of the developed tool. Essentially, any successful solution is continuously maintained, updated, and improved to ensure up-to-date information and expansion of its usability.

The complexity and design of the developed solutions are linked to two main user-related challenges: (1) the competencies and skills of municipal experts and (2) the existing digital divide in society. When developing and implementing participatory mapping solutions, the municipality has to engage experts with relevant knowledge and competencies and ensure the training of internal system users. The continuous maintenance and update of such solutions require skilled human resources that not every municipality in Latvia has or can afford. Furthermore, there is still a digital divide among different social groups. Specifically, not all citizens have adequate digital skills or access to technologies. It results in a spectrum of potential users from a complete beginner to advanced or expert level. Therefore, the mapping tool requires a simple, user-friendly, and intuitive design that is easy to perceive and understand by all user groups while maintaining the options for more complex functionality. This aspect is crucial for public engagement tools to avoid the exclusion of potential users due to poor design or lack of skills.

Finally, the interviewed municipal experts repeatedly pointed out that a lot of time and work is invested in explaining and educating their colleagues on the

advantages and benefits GIS-based solutions can bring to everyday work, like data processing, data visualization, and citizen engagement. It requires a shift in thinking and planning practice on the municipal level and subsequent work with society to make these tools integral to everyday practice.

The interviewees also proceeded to provide some suggestions for tackling the abovementioned challenges. For example, they suggested an intervention on the national level to provide unified guidelines and regulations on implementing digital mapping solutions and data usability. Moreover, there is a lack of unified data templates or sets that municipalities could integrate into their systems. Instead, the data comes in different formats or with diverse database structures requiring preliminary data conversion or processing, often using additional software.

For those municipalities that have not implemented participatory mapping solutions, it would be helpful to provide a handbook with basic technical or practical guidelines. According to the interviewees, it should include potential data sources, define primary data layers or sets, and describe guidelines for setting up a database. Furthermore, it is necessary to provide a minimum licensing package and paid training for municipal experts to ensure the availability of skilled personnel. The interviewees also thought there was a need for national support in setting up a joint geoportal. The existing national geospatial information system currently does not include the same functionality as municipal geoportals. Moreover, it is primarily used due to mandatory legal requirements regardless of the usability issues.

IV. Participatory Habits and Preferences of Citizens

The limited use of participatory mapping solutions for public engagement has to be viewed in the context of the participatory habits and preferences of citizens. The survey results of 170 respondents primarily reveal opinions of socially and economically active citizens that are easily engaged digitally (in this case, via social media) and at least partially represent typical participants in the public engagement activities.

The survey results show that respondents obtain information about the activities and current events in their municipality, primarily from municipal social networking sites (Fig. 2). Approximately half of the respondents also use municipal websites or get information from their friends, relatives, or colleagues. A surprisingly small number of respondents obtain information about planning processes from the national geospatial portal (Geolatvija.lv) despite the possibility of signing up for direct notifications. Admittedly, the respondent recruitment method can explain the preference for social media. In comparison, a study from 2017 shows that citizens usually obtain information about events and services provided by Rīga municipality from relatives, friends, or acquaintances (53 %), online news portals (52 %), social networking sites (42 %), TV (39 %), radio (32 %), and municipal (specialized) websites (29 %) [42]. It suggests a comparatively lower use of social media as an information source despite the increasing usage of social networking sites by community organizations and municipalities.

The respondents were also asked whether they knew how to get involved in spatial planning. A comparatively small portion of the respondents indicated that they know and use the existing participatory opportunities (Fig. 3). More than a third of respondents said that they know about the participatory opportunities but choose not to participate, while another third of the respondents do not know how to get involved but wishes to do so. These results indicate that there is a societal group that could potentially get involved but lacks information. It suggests that municipalities have not provided sufficient information about participatory opportunities or used communication channels that are not reaching the specific audience.

When asked about the participation formats, approximately half of the respondents indicated that they have never gotten involved in any participatory activities (Fig. 4). Among the other half of the respondents, the most popular formats were citizen surveys and public

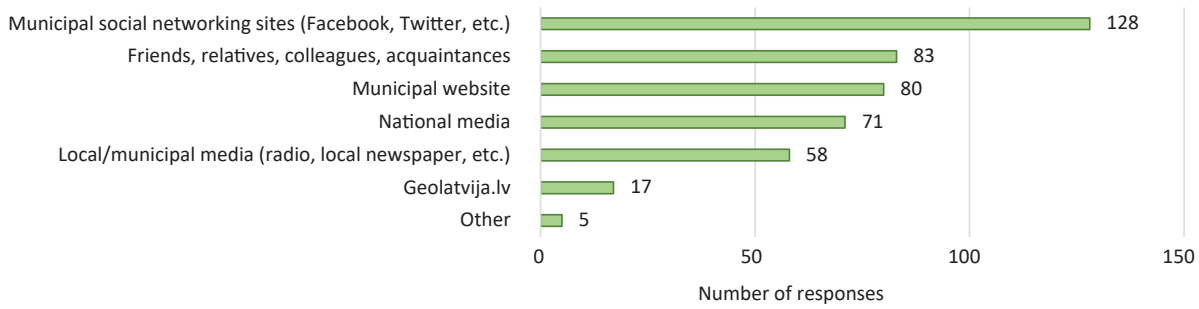


Fig. 2. Overview of the answers to the question "Where do you get information about municipal activities and current issues?" [Authors' illustration].

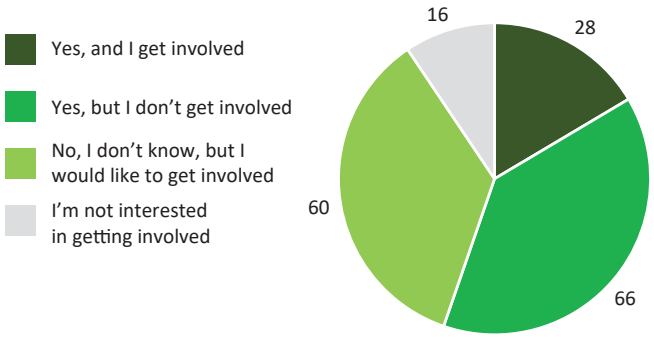


Fig. 3. Overview of the answers to question "Do you know how to get involved in municipal planning processes?" [Authors' illustration].

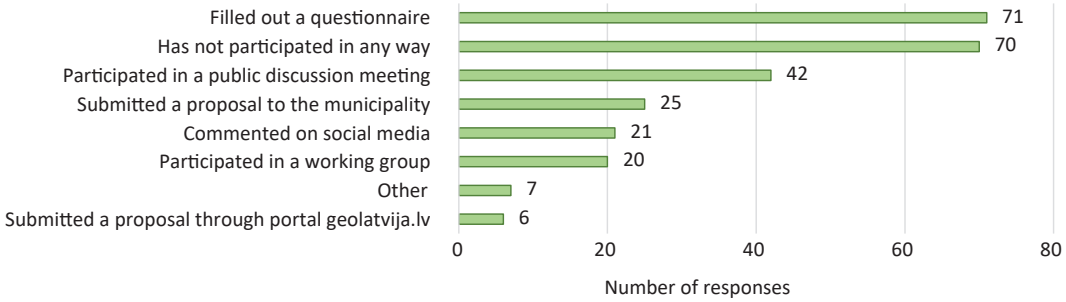


Fig. 4. Overview of the answers to the question "In what way have you participated in planning your city or neighborhood?" [Authors' illustration].

discussion meetings. These are two very different approaches – an easy question-answer process that ensures anonymity and does not take up much time or resources versus an in-person event that typically requires travel and considerable time investment (In pre-pandemic situation). However, the data shows that these are two of the most popular participatory methods used by Latvian municipalities [26], which explains their prevalence among the responses. The comparatively higher preference for citizen surveys could suggest a greater interest in simple and convenient participation formats. Moreover, most of the respondents said that they would be interested in online or online and in-person participation formats indicating an unexplored potential of digital engagement methods.

The next step was to explore respondents' familiarity with map-based digital tools. The results show that most respondents use map-based applications regularly, with a general preference for Google Maps. Admittedly, the Google Maps application is an integral component of Android-based smart devices; therefore, citizens have developed a habit of using it. Also, the application is visually and functionally very simple. The standard base map is not satiated with different elements. It is easy to read and incorporates different points of attraction or landmarks. Additionally, Google Maps provides a good search engine, street view options, several base map types, and more advanced options for experienced users. Finally, the application ensures global coverage in different languages facilitating wide usage.

Respondents were further asked questions about the preferred functionality of a generic participatory mapping tool. The results reveal demand for functionality enabling four primary user operations: (1) getting information, (2) expressing an opinion, (3) communicating, and (4) collaborating (Fig. 5).

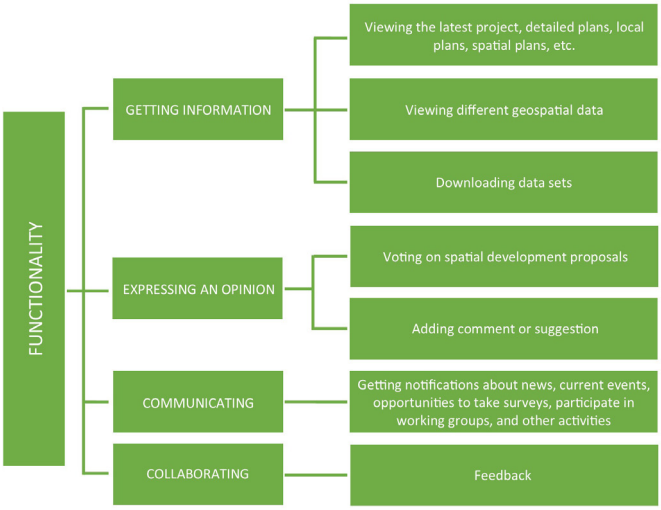


Fig. 5. Overview of the preferred digital participatory mapping tool functionality [Authors' illustration].

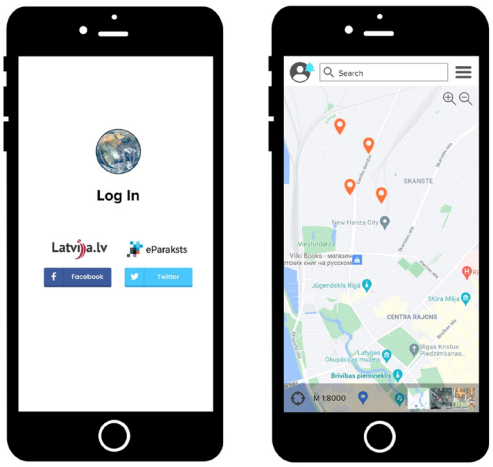
The respondents indicated a wish to view available geospatial data sets and planning-related data in one place. Moreover, they expect to be able to download the data for other uses. Another important aspect is the option to express an opinion on current issues by voting on specific proposals or submitting their comments or suggestions. Additionally, the respondents see a need for direct communication with the municipality. They would prefer to receive notifications about news and current issues and have an option to send messages to the municipality. Finally, the respondents wish to receive feedback, which is an important step in ensuring continuous participation, as it provides acknowledgment of the importance and value of the contribution in addressing local issues.

V. User-Friendly Participatory Mapping Tool: A Design Concept

The citizen survey suggested the preferred functionality, but it did not explain how it would translate into a participatory mapping tool or engagement in a real-life planning situation. Therefore, a scenario-based co-design activity was carried out with a small group of participants to develop a design concept for a generic participatory mapping tool. Based on similar approaches used in developing other ICT solutions, it allows exploring the user experience of a target audience. The results demonstrate a simple and convenient design concept aimed at a positive user experience.

User authentication. Most information and functionality should be accessible to any user without authentication. However, the users must create an account or log in using an existing account in another platform to express an opinion – add a comment or suggestion about a spatial development project. The results show a preference for official authentication options, e.g., using state service portal Latvija.lv, electronic signature eParaksts, or social media profiles (Fig. 6 (a)).

Start page/view. The start page or home page of the participatory mapping tool uses a base map that is simple and easy to read without specific symbols that are found, e.g., in topographic maps. The example in Fig. 6 (b) uses Google Maps as a base map, but it can be any other similar product. There is a user profile icon in the left upper corner that displays a notifications symbol if there are new announcements pertaining to the user. The tool also incorporates search and zoom functionalities displayed in the upper part of the screen together with the menu. By clicking on the menu, it is possible to access available data layers, e.g., educational institutions or playgrounds. The menu also allows launching other options, e.g., an area selection tool. Finally, the menu can contain other information or functions that the developer wishes to integrate into the tool.



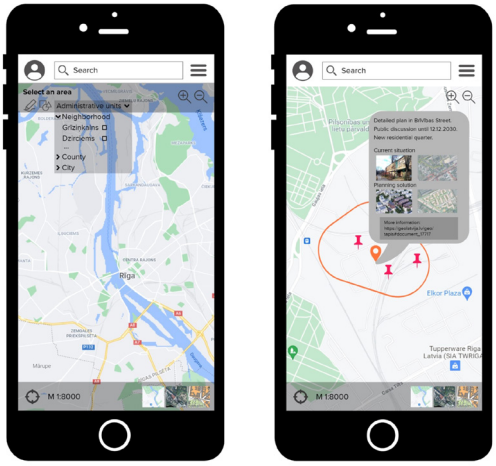
(a) User authentication (b) Start page

Fig. 6. Design concept of a participatory mapping tool: (a) user authentication page and (b) start page/view [Authors' illustration].

A semi-transparent bar is displayed at the bottom of the screen. It shows the map's scale, the 'find your current location on the map' tool, and other available base map types. On the map, the orange markers display places with ongoing planning projects. The user can access more information by clicking on the marker. The chosen icons or markers are shaped similarly to those used in the map browsers indicated by the respondents. It ensures that the design will seem familiar, and the users will be able to navigate it intuitively.

Selection of the relevant spatial area. The survey respondents wished to receive notifications about planning projects or engagement activities in the specific (selected) spatial area(s) – those relevant or interesting to them. Therefore, the participatory mapping tool provides authenticated users with an option to select such areas. The functionality is launched from the main menu that activates a pop-up menu bar with selection tools. The user can choose from the existing administrative units or demarcate a specific area with a drawing tool or polygon. It ensures that the user can select either a municipality or a specific part of the municipality that is smaller than any administrative unit. Additionally, it is important to display a search function that allows users to find a specific address, object, or their location on the map. The design concept example (Fig. 7 (a)) uses Rīga as a demonstrative case with integrated neighborhood units. In other municipalities, the selection field of administrative units would display locally-adapted areas.

Retrieval of information about a detailed plan. When a user receives a notification about a new development project or public discussion process, the tool allows clicking on the notification to find the specific location on the map. The user should also be able to access the exact location from the start page. It displays a borderline of



(a) Area selection (b) Information retrieval

Fig. 7. Design concept of a participatory mapping tool: (a) selection of an area and (b) information retrieval about a plan or a project [Authors' illustration].

(a) Adding a suggestion (b) Getting feedback

Fig. 8. Design concept of a participatory mapping tool: (a) adding a suggestion and (b) getting feedback [Authors' illustration].

the area with an icon in the center (Fig. 7 (b), the orange markers). When clicking on the icon, the tool opens a pop-up window with a brief description of the proposed planning solution, including the address, public discussion period (dates), information about the proposed solution outlining the most significant changes, and a link to complete information package in the national geospatial information portal (geolatvija.lv). The descriptive information is complemented with visual material, e.g., photographs of the existing situation, visualizations of the proposed changes, 3D models, sketches, and other graphic material that facilitate understanding of the proposed planning solution. The participants also expressed a wish to access the information about the land-use zoning, ideally combined with the 3D model of the planning solution. The land-use zoning map for the specific area could be activated using the toolbar at the bottom of the screen. Additionally, the user can also see pins (the pink markers) that show locations about which other users have already submitted suggestions or comments. It is possible to click on each one to view the opinions.

Adding a suggestion. If an authenticated user wants to add a suggestion or comment, he/she can access the relevant function from the main menu. It will activate a grey toolbar underneath the search field (Fig. 8 (a)). The toolbar provides three options for marking an object on the map – point, line, or polygon. It ensures that users can be as precise as possible in selecting an object (e.g., a building, a street, or a block). When a user has marked an object on the map, it opens a pop-up window to write a suggestion or comment and add other materials, e.g., an image or a document. The user completes the task by pressing the 'Submit' button at the bottom of the pop-up window. The successfully submitted suggestions are displayed on the map as a pink pin icon (the icon is grey while the user writes their suggestion).

Getting feedback. The tool provides several feedback options (Fig. 8(b)). The users can easily trace the status of their comments or suggestions based on the color of the pin icon on the map. The newly submitted suggestions are shown as pink icons that change the color to blue when the municipality starts reviewing the suggestion. It turns green when the municipality has provided feedback. When clicking on the green pin, a pop-up window will show the suggestion, including descriptive text and any other submitted material. The municipal feedback shows as a highlighted comment placed directly underneath the original suggestion. The survey respondents emphasized the importance of getting feedback from the municipality; therefore, it is prioritized and highlighted among other comments.

The contributors can also receive feedback from other authenticated users either as a like/dislike vote or comment. The voting allows the municipality to see the overall support for individual contributions. The users can also vote on each other's comments extending the feedback loop beyond the original contribution. All the information about status changes of the original contribution or interactions appears as a notification symbol on the profile icon in the upper left corner of the screen. The response from the municipality is delivered not only in the form of a comment but also as a direct message to the contributor.

The suggested design concept primarily emphasizes simplicity and an intuitive user experience that can be adapted for both mobile and web applications. Each step is based on the start page view allowing one to perform basic functions, e.g., search, switch between base maps, or determine one's location. Exploring other engagement scenarios could reveal a need for additional functions or

options. These should be integrated and displayed visibly and understandably to an average user who typically would choose the functions shown on the screen.

The design elements (symbols, icons, pop-up windows) and colors shown in the sample design concept can be adjusted. However, each element has to be simple and noticeable, while ensuring that the application's overall design is clean and easily perceptible. The most important elements indicating the next steps or providing primary feedback should be highlighted (e.g., with color) so that users do not have to guess or search for what they are supposed to do and can easily accomplish the desired action.

VI. Discussion

The obtained generic design concept allows drawing tentative conclusions about the expectations and wishes of citizens as the end-users of the proposed generic participatory mapping tool. The users expect (1) familiar, simple, uncluttered, and intuitive design; (2) diverse functionality that allows using one tool for different purposes and provides integration with other (external) services; and (3) different engagement and interaction formats. By comparing these expectations with already existing tools used in Latvian municipalities, we discuss the main similarities and differences.

The design of the generic participatory mapping tool is simple and intuitive, which is achieved mainly through the use of familiar design elements chosen by the end-users. Although most existing tools incorporate similar design elements (e.g., simple base maps from other services), they rarely ensure an intuitive user experience, especially for inexperienced users. It could be mitigated through customization and improvement of the initial design based on user feedback or use patterns. However, such an approach poses challenges for those municipalities that have developed their tools within EU-funded projects and lack resources for further tool development. In rare cases (e.g., terGIS), we have observed gradual improvements in the design and functionality, but there is still room for further enhancements and simplifications.

The current practice shows that existing participatory mapping tools are predominantly employed for one planning project or provision of one primary function (e.g., problem reporting, informing, or idea collection). It creates challenges for the end-users required to navigate different tools and services. A step in a different direction are municipal mobile applications that provide various functions, including participatory mapping options, but those are not yet employed for public engagement in spatial planning. In contrast, the citizens expect diverse functionality that would allow using one tool for different purposes – getting information, expressing opinions, communicating, and collaborating. The proposed design concept demonstrates such a multifunctional solution that would allow employing one participatory mapping tool for different purposes or projects. However, it requires further exploration of other typical planning scenarios (e.g., public engagement in strategy development) to assess its applicability in different planning situations.

The use of one solution with diverse functionality allows ensuring a continuous public engagement process (as opposed to project-based or irregular involvement). Nevertheless, such a participatory mapping solution still has its limitations. We explored only one planning scenario that anticipated reactive engagement to an ongoing government-led planning process characteristic of top-down approaches. Moreover, although the proposed generic participatory mapping tool envisages different communication and interaction formats, it does not facilitate bottom-up engagement. Therefore, future studies should address other proactive or citizen-led engagement scenarios to explore the potential applicability of participatory mapping tools for citizen empowerment.

Finally, we want to emphasize that developing a multifunctional participatory mapping tool is complex and expensive. Therefore, there has to be an agreement among decision-makers and planners on development and implementation objectives. It only makes sense to invest time and resources in development when the tool is foreseen to be fully integrated with the everyday planning processes and used regularly. Alternatively, the municipalities should choose one of the existing and adaptable services for short-term or project-based usage.

Acknowledgments

This work has been supported by the European Regional Development Fund within the Activity 1.1.1.2 "Post-doctoral Research Aid" of the Specific Aid Objective 1.1.1 "To increase the research and innovative capacity of scientific institutions of Latvia and the ability to attract external financing, investing in human resources and infrastructure" of the Operational Programme "Growth and Employment" (No. 1.1.1.2/VIAA/3/19/387).

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RIGA TECHNICAL UNIVERSITY
Architecture and Urban Planning
2022, Vol. 18, Issue 1, pp. 43–56
https://doi.org/10.2478/aup-2022-0005
https://content.sciendo.com
Online ISSN 2255-8764

Urban Form and the Role of Urban Morphological Characters in Town-Plan Regionalization: A Systematic Review

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Received 2022-01-20; accepted 2022-07-14

Keywords

Built form, emergence and evolution, morphological characters, morphological region, urban form.

Abstract

Urban morphological characters have implications for town-plan regionalization but have received little attention. This paper systematically reviewed urban form aspects, built form and morphological characters. The review highlighted built form is a reference aspect that coordinates other aspects of urban form and contains hierarchical plan-element complexes. Such complex relationship within the built form is vital to give urban form its morphological characters. Since urban morphological characters regionalize town plans, this role merits more study to establish relationships among morphological characters, town-plan regions, and sustainable development. There is also a shift to study town-plan regionalization in support of urban landscape management.

Introduction

Urban form is among the misunderstood concepts in urban morphology because it is seen as constituting only an urban area's physical or built elements on one hand [1], [2], [3] and as comprising physical and non-physical features on the other hand [4], [5]. In addition to this reason, the concept is considered synonymous with urban morphology in some quarters [6], [7], [8]. Poon et al. [3], for example, mentioned explicitly that urban form appears complex and contains several physical components. This definition tends to limit its usage, thereby ignoring its complexity. Therefore, this concept's view of comprising both physical and non-physical constituents presents a more adequate basis for understanding urban form.

Regarding this, Kropf [4] provided three broad categories (based on spatial, human-spatial, and temporal relations) in which eleven urban form aspects reside (see Section II). Among the fundamental urban form aspects is the built form, which constitutes the physical features and is also called the built environment [9], [4]. Also, it is considered a reference aspect that coordinates the other aspects [4]. Since several morphological characters appear within the built form, they play an important role in town-plan regionalization. They are patterns that define the built form and present its unique nature. However, their emergence and evolution, and how they shape the town plan into regions have received little attention in urban morphology. Urban morphological characters are the built form's important features. Understanding how they emerge and evolve has implications for regionalizing the town plan.

Therefore, this paper aims to systematically review how urban morphological characters emerge and evolve and their role in town-plan regionalization. Answers to the following questions will help to achieve this aim: (1) What are the aspects of urban form, and why is the built form significant? (2) What are the built form components, and how do they describe its morphological characters? (3) What distinct morphological characters emerge and evolve when these components interact? (4) What is the future agenda on urban form research?

Subsequently, Section I describes the method: systematic literature review. Sections II–IV are the qualitative synthesis: (1) urban form aspects; (2) built form and its significance as a reference aspect; and (3) morphological characters and their emergence and

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evolution in built form, respectively. While Section V discusses the role of urban morphological characters in town-plan regionalization, the final section provides the conclusion and future research agenda.

I. Method

A. Systematic Literature Review Process

This study employed a systematic literature review process as illustrated in Figure 1 (Fig. 1). This approach involved four stages (identification, screening, assessment and inclusion) based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [10]. Firstly, in the identification stage, a search was conducted utilizing a broad topic and the Boolean operators as follows: "urban form" OR "urban morphology" search by article title and publication date from 1 January 2015 to 22 September 2020 in Scopus and Web of Science (WoS) databases. This returned 1059 research and review articles (n = 559 from Scopus and n = 500 from WoS), which were then further limited by keyword search within the results.

The keywords employed were "aspect*" (n = 181), "built form" OR "built landscape" OR "physical landscape" OR "physical form" OR "spatial form" OR "built environment" (n = 387), "morphological characters" OR "morphological character areas" OR "morphog*" (n = 13), "town plan" OR "ground plan" OR "town-plan element*" OR "ground-plan element*" (n = 32), "urban landscape" OR "townscape" AND "town plan" AND "building fabric" AND "land and building utilization" OR "land use" (n = 158), and "morphological region*" OR "town-plan region*" (n = 101). Overall, this stage returned 550 and 322 articles from Scopus and WoS, respectively, to provide a total of n = 872 articles.

Secondly, the screening stage involved the duplicate removal and screening of articles. After duplicate removal, 436 articles were included. Furthermore, these articles were screened considering their titles' relevance and abstract information. Therefore, 248 articles were included while 188 were excluded.

In the third stage, the 248 full-text articles were assessed based on their relevance and contribution to this study, and 160 full-text articles were excluded for not meeting the eligibility criteria. These criteria were: (1) relevance to the topic "built form" in the urban form or urban morphology context; (2) relevance to the topic "urban morphological characters" in the built form context and its components; (3) full-text article accessibility; and (4) full-text article in Scopus or WoS indexed sources. Finally, 88 articles were included in this qualitative synthesis.

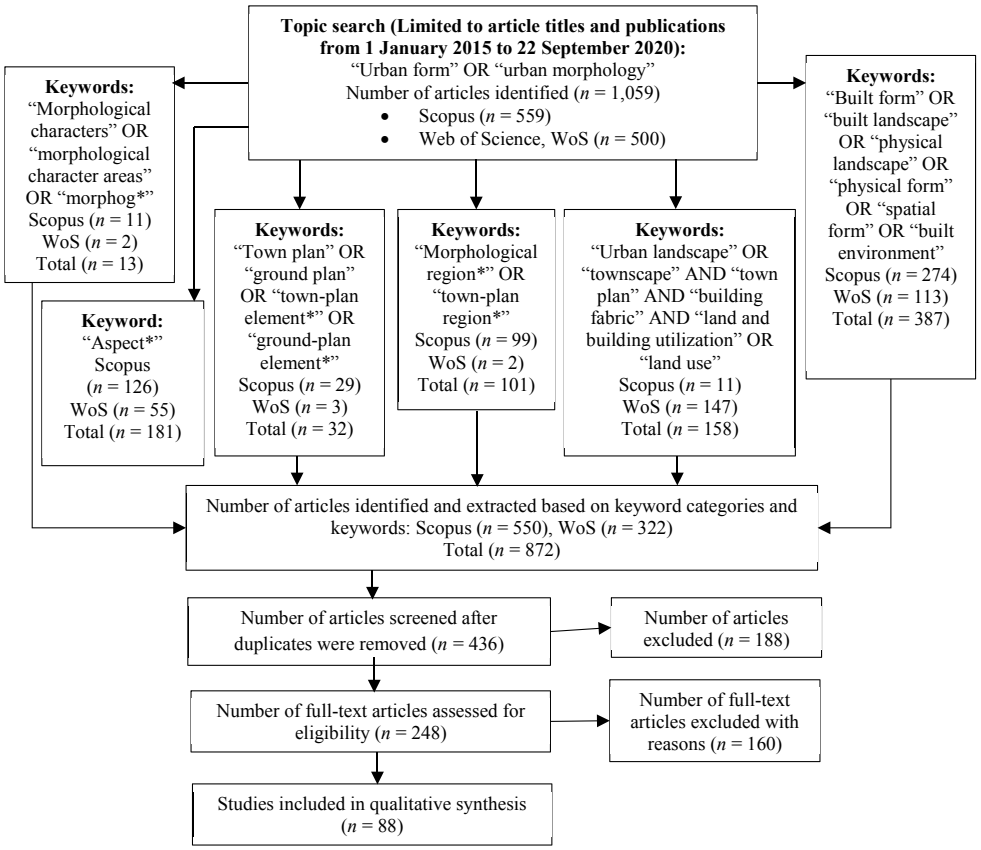

Fig. 1. Stages of the systematic literature review protocol [developed by authors].

B. Keyword Occurrence

Figure 2 shows the article distribution by keyword occurrence. The urban form had the highest occurrences of the 88 articles reviewed. It was sometimes interchanged with urban morphology. The built environment (mostly interchanged with "built form," "built landscape," "physical form," or "spatial form") had the next highest occurrence with about 70 articles. However, keywords like morphological characters and morphological regions or regionalization showed the lowest occurrence with less than 5 articles each.

Figure 3 shows the frequency of keyword occurrence in articles by year. The urban form occurrence frequency rose from about 100 in 2015 to approximately 1300 in 2019 and reached 1200 in 2020. Also, urban morphology and the built environment exhibited similar patterns. The urban morphology occurrence frequency rose from 41 in 2015 to 255 in 2019 and attained 216 in 2020. For the built environment, it increased from 42 in 2015 to 361 in 2019 and achieved 82 in 2020. Although Figure 3 indicates a drop in some keyword occurrences in 2020, as mentioned above, it only applied to data from January to September. However, other keyword occurrences indicated little or no changes, which were all below 200 from 2015 to 2020. Morphological characters and morphological regions or regionalization, in particular, showed very low occurrence or even non-existence during these years.

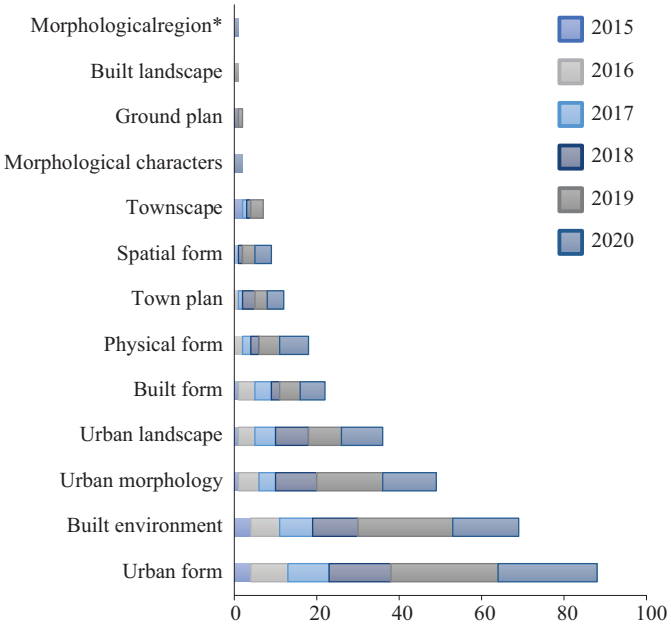

Fig. 2. Distribution of reviewed articles by keyword occurrence [developed by authors].

II. Urban Form Aspects

This paper focuses on the notion that urban form constitutes both physical and non-physical elements. Some studies, for example, Bielik et al. [11] and Dibble et al. [12], expressed this notion. Considering this notion, Kropf [4] gives a comprehensive list of the urban form aspects. Therefore, this list is utilized as the organizing principle in this section. Eleven aspects are identified based on three relation types: physical constituents' spatial relations (spatial aspects), human-physical constituent interrelations (spatiotemporal aspects), and temporal relations or temporal aspects [4], [13].

C. Spatial Aspects

Based on physical constituents' spatial relations, the site or natural environment and built form are considered urban form aspects. While the unaltered physical element combinations forming a place and their relationship patterns belong to the natural environment and can be

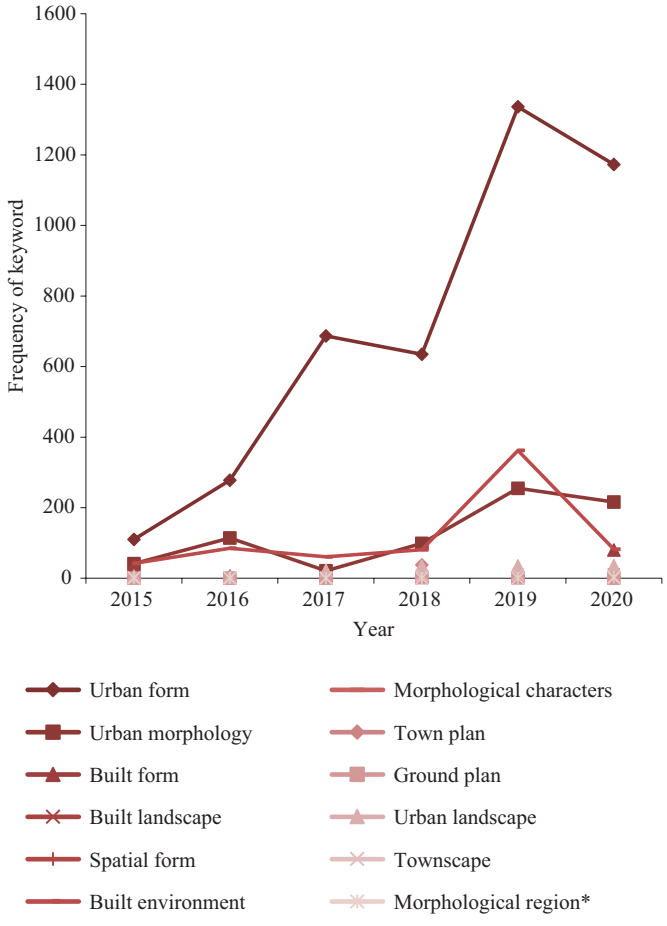

Fig. 3. Frequency of keyword occurrence by year from 2015 to 2020 in the reviewed articles [developed by authors].

viewed as a built form substrate [4], [13], the human-transformed physical elements embedded in the natural environment and their relationships comprise the built form [4], [13], [14]. This review reveals some studies that consider these aspects together with or separate from other aspects.

1. Site or Natural Environment: The natural environment is the unavoidable setting from which urban form is essentially shaped; urban form tends to emerge and evolve when the natural environment is transformed in response to certain conditions in a specific locality [13]. The elements that make up the natural environment fall into geological, topographical, hydrological, biological and climatic categories [4], [15]. These elements form the starting point for analysing the urban form. However, these elements do not exist in isolation. Green space, for example, is provided in many cities to play an important role in maximizing the benefits of urban living while minimizing its negative effects; these natural urban areas can provide ecosystem services such as carbon sequestration, aesthetic pleasure, flood mitigation and on-site pollination [16].

2. Built Form: This belongs to the urban landscape [17] that Conzen [18] referred earlier to as the townscape. Town plans, land-use patterns and building fabrics comprise the urban landscape [15], [19]. As the town plan is subdivided into plan-element complexes (street system, lot pattern and building pattern) [13], [20], the basic built form elements are the streets, lots, buildings and open spaces [14], [21]. Certain studies appear to use urban form instead of built form [22], [23], which creates ambiguity [14] in understanding the two terms. The built form remains this review's fulcrum because it is the reference aspect that connects all other aspects as discussed in Section III.

D. Spatio-Temporal Aspects

Based on interrelations between human and physical constituents, six aspects are identified:

1. Activity, Function, or Use: Function or use refers to people's activities that give rise to and are accommodated by certain built landscape constituents. This can occur in two ways: occupation and movement [4]. Garnica-Monroy and Alvanides [24] undertook a study aimed at investigating spatial accessibility index potential that will benefit the greater resident population in Mexican cities. The study on spatial accessibility was based on research that touched on the two concepts (occupation and movement) under the function or use aspect. Spatial accessibility is the physical access measured from the residences' locations to public goods and service destinations [24].

2. Sociocultural and Economic Context, or Local Culture: This is the way various functions and activities interact and are combined over a broader area [13]. To understand urban form and apply it judiciously, a study has to be positioned in a definite context to clearly describe, explain and apply the issues associated with its aspects [4]. For example, in the research by Hosni and Zumelzu [25], an empirical case study was undertaken to evaluate the public spaces' quality based on the users' perceptions. The study used the nodal concept as a sustainable urban form dimension defined by its size, level and type [25] to arrive at a new perspective for better design. This aspect entails recognizing the tenets, notions and intentions of the larger population and the ensuing cultural behaviours, structures and technology that they produce [4], [26].

3. Control: This involves a link between individuals or groups and a land area [4]. This relationship occurs due to full or partial ownership, which could be either by social convention or physical occupation [4], [13]. Control has legal precedents in the land tenure system, which can be in the form of leasehold, occupation, total ownership, regulation or sovereignty [4]. The land tenure system has a connection with the lot system [27]. This aspect has played a vital role in shaping the urban form as it emerges and evolves over time.

4. Intention or Design: This aspect is interlinked with control. The type and degree of control [4] play important roles in determining what goes on the land, thereby influencing the building designs or features in the urban area. "Design features are related to how pleasant the urban environment is, thus indicating the potential for using soft modes instead of motorized ones" [28, *359*]. While socioeconomic, political and psychological changes influence the environment, the physical spatial features are produced through design and planning processes [29]. This aspect has diverse connotations, as the urban morphology field is interdisciplinary in nature [30]. Intention or design cuts across different fields depending on the context scale, detail and resolution level expressed. To challenge the existing spatial and social conventions, openness, transparency, interconnection and mobility infuse design [29]. When any urban feature design is finalized, its actualization through construction is next.

5. Construction: This is the design implementation process to realize the physical features [4], [13]. According to Kropf [13, *116*], construction is about "modifying or constructing a built form". Subject to how elaborate and complex the cultural context is, the construction process can cover some steps, with each presenting possible conditions and limits for built form formation [4]. Having assumed land control, decided on the intention and finalized the design for a project, the next actions may involve statutory approval,

resource acquisition and the construction process [4]. This aspect plays a vital role in the urban form's emergence and evolution because it is the most noticeable process involved in modifying the built form.

6. Perception: Another aspect that has received research attention in recent times is perception. This is the psychological and physiological experience or reaction of being in an area and the sense or image retained in memory [13]. Perception feedback, as the fundamental relationship between human and physical features, enables humans' interaction with the environment, resulting in adaptive behaviour [4]. In his work, Lynch [31] sets the tone for research into this aspect. He mentioned that "most often, our perception of the city is not sustained, but rather partial, fragmentary, and mixed with other concerns". "Nearly every sense is in operation, and the image is the composite of them all" [31, *2*]. After Lynch's seminal work, several works on perception and cognition in the built environment were undertaken. For example, the relationship between public spaces and users' perceptions has been evaluated [25]. Studies on perception can loosely be categorized into "cognition, city image and memory, emotional effect, and interpretation and meaning" [4, *32*].

E. Temporal Aspects

Temporal relations are short-term recurring changes in activity patterns as well as long-term natural and built environment transformations that are primarily described using multiple points in time [13], [32], [33]. Based on these, three aspects [4], [30] are identified:

1. Natural Resource Flows include daylight [34], energy [2], air and its quality or movement [35], [36], the water system [37] and solar radiation [38]. While the natural environment settings essentially extend to the global positioning system and the earth's movement within the solar system, several likely energy sources can be recapped in relation to an energy account, including direct solar and geothermal energy sources, which generate the resultant hydrological cycle, wind and tidal energy types from a local standpoint [4]. This aspect, along with human-induced resource flows, plays a temporal role in shaping the built form, and vice versa.

2. Human-Induced Resource Flows have to do with information, goods, energy and waste movement [13], [39]. It is crucial to fully recognize that the built environment's existence depends on steady human resource flows [4]. Humans design the built form to influence certain indicators like building type, density, neighbourhood layout and landscape elements [40] to control resource flows for climatic control [41]. It is important to note that this aspect is intertwined with all other aspects because human metabolic energy is the primary energy source for producing, maintaining and using the built environment [4], [28].

3. Evolution, Changes, and Historical Development aspect connects all other aspects to time [4], [13], [30] and gives room for contributions from old built form, which have been seen as a reference for fresh interventions in the contemporary urban context [42]. Research in this aspect considers elements and their formation and transformation within the built form over time. Investigation into the relationship between built form expansion and the residential space formation process in a particular context [43], city centre transformation process analysis [44], and neighbourhood typology definition and their transformation over time [45] are studies related to this aspect. Other examples are studies on the urban landscape shaping process under various sociocultural and economic systems [46] and polycentric development's goals and realities with insight into a new urban form [47].

Having described the eleven urban form aspects, Kropf [4] outlined that researchers should employ these aspects as features to describe various places. Every location is unique and has a distinct blend of the various aspects, which may imply that only certain aspects will be applicable in any given context. In most cases, socioeconomic context, historical development and perception supplement the key aspects – the natural environment, built form and use [4]. These relationships normally exist in nested hierarchies.

III. Built Form and Its Significance as a Reference Aspect

In general, physical spaces and built form mediate social, economic and environmental sustainability [48]. There is reason to believe that the built form itself plays a role in fostering the conditions that support societal goals [49], [50]. The findings support claims that aesthetic and historic cultural importance may influence community feelings or increase neighbourhood social use [49]. "As cities develop and transform, its evolution is reflected through the built form" [9, *153*].

F. Significance as a Reference Aspect

Figure 4 shows the number of articles representing combinations of the urban form aspects. From these combinations, one can deduce that the built form is a reference aspect that coordinates the other aspects. As a reference aspect, the built form is significant because it has four important attributes: it is universal, enduring, tangible and accommodating [4], [13]. These characteristics distinguish the built form and show its coordinating role.

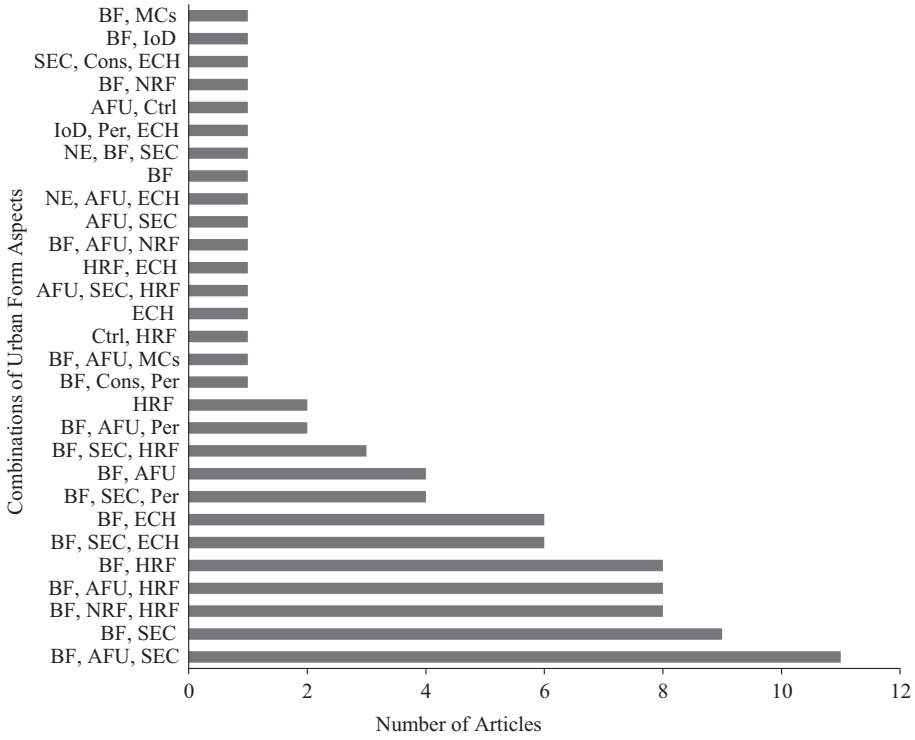

Fig. 4. Number of articles representing combinations of urban form aspects [developed by authors]. Note: NE = natural environment or site; BF = built form; AFU = activity, function, or use; SEC = sociocultural and economic context, or local culture; Ctrl = control; IoD = intention or design; Cons = construction; Per = perception; NRF = natural resource flows; HRF = human-directed resource flows; ECH = evolution, changes, and historical development; MCs = morphological characters [developed by authors].

1. Universality: This connotes that the built form constitutes global elements with similar characteristics irrespective of context. Some attributes that make the built form universal are growth [51] and plan-element complexes: streets, lots and buildings [13]. Built form can foster an understanding of urban form elements, technology, urban design, architecture, aesthetics, etc. [9]. This important attribute makes it easy to graphically represent built form as drawings [4], [13], so that the graphic elements and drawings can be read and understood globally.

2. Endurance: Built form is seen as the most enduring aspect because it takes a longer time to transform, which means that it is slow to respond to changes in comparison to other aspects. Kropf [4], [13] considered this attribute as persistence. The fact that most settlement representations largely reflect physical form is a point connected to the form's general persistence relative to other elements [13]. Hence, the built form's enduring nature can be remarkable [52] as most historic features can be retained as tangible heritage.

3. Tangibility: The built form is considered tangible [8], as it can be seen and touched. Just like its universality, its tangible attributes provide the impetus for representing it graphically as drawings [13]. The built form provides a means of examining a city's physical elements as artefacts [53]. Although the built form's tangibility is significant, processes that are not tangible but happened in the past are important too [54].

4. Accommodation: Accommodation in this sense is significant, being tied to activity, function, or use [4], [13]. It means containing the other urban form aspects. Therefore, most studies relate the built form to one or more other aspects. For example, the relationships between built form and activity, function, or use have been emphasized [55], [56], [57], [58], where built form provides accommodation. In some cases, urban tissues are mostly residential land use, but they also house non-residential land-use elements such as schools, commercial centres and utilities [59].

G. Components: Plan-Element Complexes

Having considered its significance as a reference aspect, built form key components (the street system, lot system, and buildings and their related open spaces) require elaboration [58]. These key elements are not considered separate for urban morphological analysis; rather, they are tied together as plan unit or urban tissue. Being complex and hierarchical, the plan unit is the primary subject of urban morphological emergence, evolution and transformation [4], [18], [60], [61], [62], and object of

morphological analysis [53], [62]. Therefore, it is vital to account for how these elements relate to fully understand their attributes [63].

1. Street System: Streets and street blocks make up the street system and play an important role in making sense of a city's urban form. Their arrangement describes an urban tissue at the most general level [64]. The street system provides an avenue for travelling and recognizing a city; streets outline the diverse street blocks that form a city and differentiate the public from semi-public or private spaces [15]. As receptive components in the built form and because they provide the first contact with the city image, streets give people the first impression of a city [65]. Functionally, street accessibility [66], [67] plays a vital role in accommodating activities through occupation and movement [4], [13], [67]. Also, in terms of the built form attributes, streets are the most universal and enduring because it is difficult to alter their network compared to lots and buildings. The data availability to study street networks [53] and street connectivity [66], [67] has improved drastically due to advancement in computing.

In his study, Esfanjary [68] identified three street patterns in Maibud, Iran as "twisting alley, orthogonal pattern, and geometric system." Each street pattern has a connection to the historical phase of urban growth [68]. The study demonstrated how street patterns are connected to the urban form's emergence and evolution. In another study on Mexican street markets, five street market typologies were identified: linear, circuit, cluster, contour and hybrid [69]. The study tends to demonstrate the functions streets can attain. Moreover, the studies exemplify how the streets and street blocks can be seen and their forms used to accommodate public functions. In the contemporary urban state, there are pedestrian networks that are not defined as streets or sidewalks; these are the urban filaments that interweave into the prevailing flow configurations in historical and modern urban forms [70]. Filaments play an important role in the built form, as do streets and street blocks. Therefore, it is essential to examine these in the study of urban form.

2. Lot System: This is referred to as the lot series arrangement in a street block [18]. Lots can be seen in two ways: as a built form element and as a property by control means [71]. As a built form element, a lot is man-made, while as a property, it is claimed [71], [72]. Taking this relationship into account in defining the lot will aid in the understanding of urban form configuration, emergence and evolution [71]. The lot system has a relationship with cadastral composition, which, in turn, exerts an appreciable influence on urban form [73]. Lots have constantly presented useful evidence in interpreting urban changes; in a market economy, they are valuable land elements concerning investment and play a significant role in urban growth [74].

3. Buildings and Related Open Spaces: Although the Conzenian school divided urban landscape into town plans, building fabrics and land utilization [18], buildings are considered as town-plan unit in this discussion. In this sense, the buildings are viewed as individual units related to the respective lots they occupy and the street(s) through which they can be accessed. Though not only for the reason that buildings belong to town-plan complexes, substantial consideration has been given to the different buildings and urban spaces architecture, "also because building style is perhaps the most visible manifestation of the urban landscape" [74, *122*].

Open spaces and gardens represent the social influence nucleus over domains where value is put on the people's interaction essence to encourage vitality in neighbourhoods [25]. Fundamentally, any urban scheme aims at shaping public space where buildings shape this void and give it character [76]. Open spaces and gardens can serve different functions within the urban form. Although rarely accounted for in urban morphology, burial grounds also function as open spaces [52]. Other functions are recreation [77], parks and green space [78], and public squares and fountains [79].

IV. Urban Morphological Characters: Their Emergence and Evolution in Built Form

This section identifies what urban morphological characters are and how they are defined. It further explains the reasons and the ways they emerge and evolve, and finally, identifies their major types. Firstly, urban morphological characters are attributes that lend a distinct appearance to an urban tissue [19], [80], [81], [82]. Formation and transformation, patterns, hierarchies, and types [4] define these attributes. Urban morphological characters do not emerge and evolve by accident; they pass through formative and transformative processes. These processes give rise to patterns that tend to occur in hierarchies. These relationships produce different built forms and urban morphological characters. Considering the urban tissue, formative and transformative processes depend on human interaction with both the natural environment and built form. Also, the relationships among the streets, lots and buildings occur in nested hierarchies [19]. Within an urban tissue, "there is a pattern of patterns that extends into a hierarchy of interrelated forms" [4, *14*]. Process, pattern, hierarchy, and type are concepts significant to understanding why and how urban morphological characters emerge and evolve.

Secondly, urban morphological characters emerge and evolve to reflect the people's sociocultural and economic identity and their innovative expression and technological advances over time [19]. This emergence and evolution occur due to sociocultural and economic activities within the local context [4], [13], which drive urbanization processes [83] and vice versa. For example, Zumelzu and Barrientos-Trinanes [84] investigated urban form effects on neighbourhood vitality in Valdivia's (a city in Chile) five neighbourhoods. They found that some neighbourhoods have a higher degree of "morphological adaptability" in creating functional diversity. They further emphasized that land-use mix, block size, lot size and adaptability are four attributes that relate to improved human interaction in neighbourhoods. In this sense, their study indicated that urban morphological characters encompass spatiotemporal urban tissue attributes. The formative and transformative processes that combine town plan, building fabric and land utilization [19] result in urban tissue, a key component of transformation and urban growth [4].

Finally, two broad morphological character types corresponding to the organic and planned built forms are identified [85]. Also, sprawling and compact urban forms exhibit the two broad morphological character types. These dichotomies predominate in debates on urban form. However, there are diverse urban morphological character sub-types. For example, having mentioned significant inconsistencies in terminological usage in defining the core urban form elements, Fleischmann, Romice, and Porta [80] proposed a framework for classifying urban morphological characters. In doing this, they presented the "Index of Elements" that permits an unambiguous and non-interpretive urban morphological character description [80]. The index basically defines every urban morphological character matching the measure it calculates called the "Index" and the urban form element it measures called the "Element" [79, *6*]. Based on this, dimension, shape, spatial distribution, intensity, connectivity, and diversity are six categories under which 361 urban morphological characters were identified. This approach is one way they [80] identified urban morphological characters for quantitative analysis. The study provided a comprehensive character list of important urban morphology. Therefore, knowing these characters will aid in the understanding of urban morphological regions.

V. Summary and Discussion: The Role of Urban Morphological Characters in Town-Plan Regionalization

The urban form offers an avenue to analyse a settlement, especially a city. Figure 5 shows the role of urban morphological characters in town-plan regionalization. This represents the summary and discussion on this study. Studies on urban form fall into three broad categories based on relationships among spatial, spatio-temporal, and temporal elements. Firstly, in a spatial sense, the natural environment or site and the built form represent the physical urban form aspects. These are the most tangible compared to other aspects. Secondly, in a spatio-temporal sense, activity, function or use, sociocultural and economic context or local culture, control, design and intention, construction, and perception represent the six aspects dealing with human-environment relations. They are a mix of tangible and intangible elements. Finally, natural resource flows, human-induced resource flows, and evolution, changes and historical development represent the three aspects that are temporal and mostly intangible. This categorization tends to simplify the understanding of urban form comprehensively.

Among these aspects, built form plays the coordinating function. Within the built form, physical and non-physical elements or features interact [53] to produce urban tissue with specific morphological characters. The street system, lot system, and buildings and their related open spaces are all combined in a hierarchical structure to form urban tissue. The street system contains the streets in street blocks, which in turn accommodate the lots in lot series, and then the buildings in block form. This arrangement (a town plan) is part of the urban landscape and nested within it are the building fabric and land and building utilization [82]. These form a complex relationship and tend to exhibit unique attributes in a local context, giving the urban form some morphological characters.

Urban morphological characters emerge and evolve as attributes that give urban tissues uniqueness, thereby presenting different types. Formative and transformative processes, patterns, hierarchies, and types define these attributes. Also, the urban morphological characters' emergence and evolution reflect the local context's sociocultural and economic nature. Furthermore, such a local context reflects innovation and technology. How to precisely describe morphological characters in studying urban tissue is the most difficult endeavour [86]. Since the organic versus planned and sprawl versus compact dichotomies predominate in debates on built form, the role of urban morphological characters in town-plan regionalization is significant for urban landscape management.

As town-plan regionalization connotes the process whereby town-plan regions are identified and mapped [82], the role of urban morphological characters in this process can be seen in three ways: physical characterization, historical stratification and urban landscape management. Firstly, characterizing urban morphological regions physically involves tangible attributes defining urban tissues. For example, considering building footprints and building heights, urban morphological attributes can be calculated; these can include building volume density,

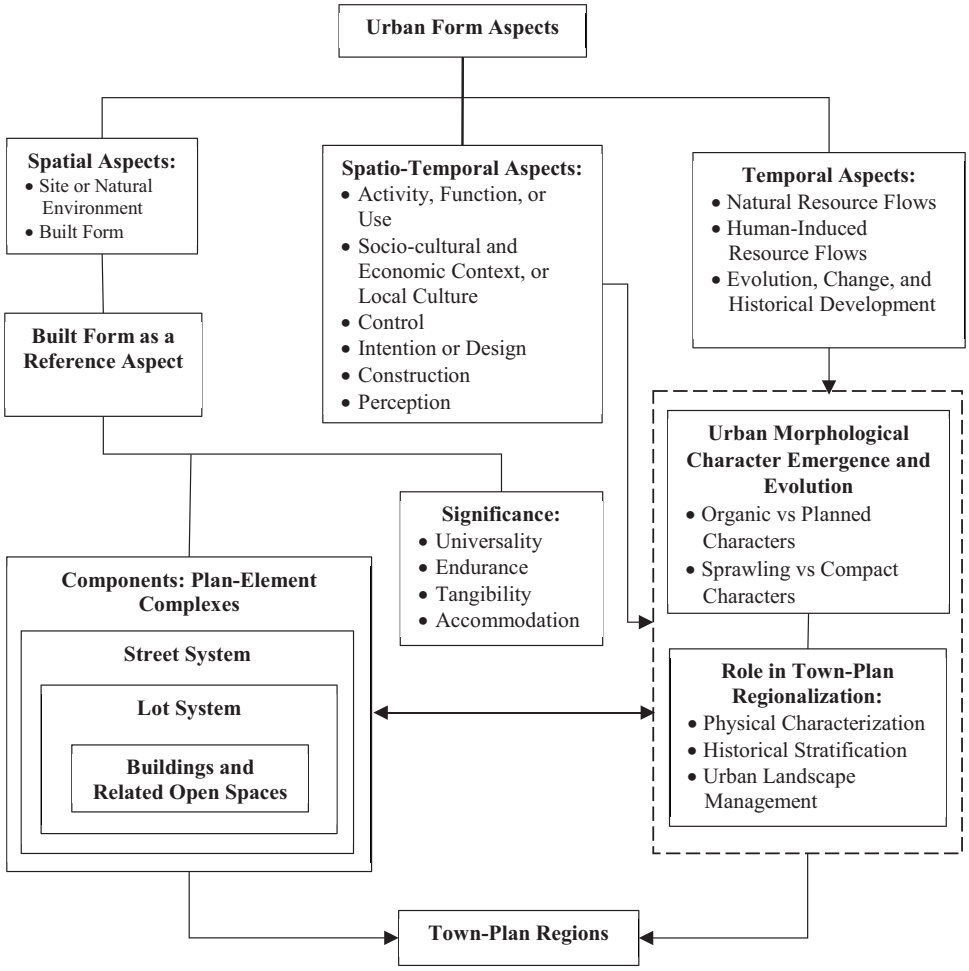

Fig. 5. The role of urban morphological characters in town-plan regionalization [developed by authors].

building coverage ratio, frontal area density and sky view factor [87]. These attributes are a few examples that represent the tangible urban morphological characters that are considered in town-plan regionalization. Therefore, a comprehensive methodological advancement to recognize and isolate the several urban morphological character elements is vital [81] for town-plan regionalization.

Secondly, historical stratification plays a vital role in town-plan regionalization. This is essential because urban landscape management requires inheriting the past urban morphological characters to develop town-plan regions. As the urban landscape is stratified historically, it requires a "genetic perspective" [19]. The urban landscape contains distinct periods, town plans, building fabrics, and land and building utilization with various town-plan regions [19], [58]. These distinct blends exhibit various urban morphological characters. Therefore, it is important to analyse urban morphological characters in terms of the urban landscape's historical development. Recognizing this historical stratification "provides an important basis for an integrated framework for planning, urban design, and urban landscape management" [87, *148*].

Finally, urban landscape management is significant because it ensures conservation planning, successful place creation and urban design control [82], [88]. In conservation planning, the urban landscape's value and perception is a huge attraction source. This seems to rely on urban morphological characters. Also, the success of place creation or modification requires urban morphological character analysis. This process ensures proper town-plan regionalization knowledge for urban landscape management, which is essential for urban design control. In urban form research, the focus has shifted to town-plan regionalization for urban landscape management, which is essential in conservation planning, place-making and urban design control [82], [89]. However, the role of urban morphological characters in town-plan regionalization has received little attention in recent years.

VI. Conclusions and Future Research Agenda

Amidst urban form's growing research, morphological character knowledge is essential to town-plan

regionalization. There is considerable urban morphological character research. However, the existing knowledge of their role in town-plan regionalization is limited. This paper reviewed urban form aspects, built form as a reference aspect, and urban morphological characters, and finally discussed their role in town-plan regionalization. Although urban form has been misconstrued to mean only physical landscape, its aspects are identified to encompass spatial, spatio-temporal, and temporal elements. These elements are analysed within the built form as a reference aspect, and their combination produces urban tissue containing urban morphological characters that play a significant role in town-plan regionalization. Emphasis has shifted to town-plan regionalization in urban form research towards landscape management because of its importance to conservation planning, place creation and urban design regulations.

However, comprehensive research is necessary to expand the link between urban morphological characters and town-plan regions through the lens of evolution, changes, and historical development with a focus on sustainable development. While urban morphological characters and town-plan regions belong to sustainable development's environmental dimension, social and economic dimensions drive it. It is important to understand how environmental, social, and economic factors shape urban morphological characters and town-plan regions towards heritage and conservation planning. Furthermore, this will aid in developing a framework for urban landscape management, which is important for modifying existing and creating new urban tissues with the goal of enhancing future morphological characters and town-plan regions. In addition, perception as an urban form aspect can be seen as belonging to the social dimension. When the relationship between urban morphological characters and perception is studied, the outcome can be used to improve a city's image. Regarding these needs, it is important to examine the built form and map its morphological characters and town-plan regions in certain sociocultural and economic contexts in developing countries. Doing this will conserve the historic urban characters and their embedded local values and wisdom, which may tend to attract and support people, thereby boosting such countries' livability and tourism potential.

Acknowledgements

This research was supported by the Research University Grant Scheme of Universiti Teknologi Malaysia under UTM Fundamental Research Q.J130000.2552.21H73 and Industry-International Incentive Grant Q.J130000.3652.03M43.

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