

The Ladder of Emotional Mapping: Visualizing Emotions for Planning Inclusive Cities

Mennatullah Hendawy¹, Maria Carmela Valverde Gonzales², Hend A. Elhawry³

¹Faculty of Engineering, Department of Urban Design and Planning, Ain Shams University, and Impact Circles e.V. in Berlin –

mennatullah.hendawy@eng.asu.edu.eg

² Impact Circles e.V. in Berlin, – [email:mvalverde@uni.pe](mailto:mvalverde@uni.pe)

³ Faculty of Engineering, Department of Architecture, Ain Shams University and Impact Circles e.V. in Berlin – email :hendelhawry@gmail.com

Abstract- Many countries in the modern era strive to keep up with the world's rapid development in many economic, environmental, and social aspects, particularly on the urban scale and city planning, as well as competition for access to the highest levels of luxury in terms of buildings, designs, and iconic buildings that distinguish each country in the media from its counterparts from neighboring countries. In the region, and possibly internationally. Some countries were forced to relocate a number of their cities and capitals, as well as develop new alternatives for them in new places. In the context of implementing these strategies, decision-makers overlook the social and emotional dimensions of citizens, making it difficult for planners and those involved in the design process to understand the human requirements and needs of the user, resulting in the neglect of many aspects that citizens require, such as the design of the urban environment, planning of public areas, and green open spaces.

This paper aims to highlight the importance of taking the emotional side of the user into consideration and integrating them into the decision-making process through participatory planning to develop decision-making strategies that include the preferences of all stakeholders in the planning process.

Keywords: Participatory Planning, Decision-Making, Emotions, Inclusive Cities

I. INTRODUCTION

This article examines participation in urban planning through the lenses of emotional mapping and public perception. Using perception to examine processes of participation allows us to examine the emotional sphere of civic motivation, civic engagement, and collective decision-making in urban contexts [1]. The perception of the urban environment and the planning process from an emotional approach is the integration of the views, perspectives, and experiences of the urban environment from the public. In urban studies, Zeile [2] suggests an approach of “urban emotions” to explain the integration of human perception into planning processes.

Not understanding the significance of integrating public perception into the decision-making process can pose difficulties for planners and organizations concerned with the implementation of public space-making and meaning-making [3]. In the context of urban projects, ignoring public perspectives can lead to public discontent and implementation problems [4]. This is the case of the planning of new cycle lanes in which pedestrians or cyclists may emotionally respond differently to the city depending on a variety of contextual factors such as personal mood, environmental conditions like weather, traffic density, or road conditions.

Within the literature on participatory planning, it is emphasized that meaningful community participation involves having citizens in the decision-making process [5]. The diverse research methods initiated by planners or councils, therefore, ideally

develop strategies that include the preferences of all stakeholders.

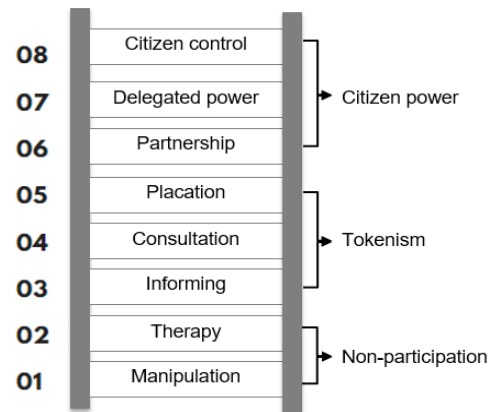


Figure 1: Ladder of Citizen Participation. Arnstein's ladder is one of the most prominent models used to understand the degrees of citizen participation in planning processes. Source: Arnstein (1969)

Many theories and concepts highlight the significance of including the different views of the public and the ways in which the opinions of minority groups are considered, such as participatory development [6], participatory governance [7], democratic local governance [8], and community development [9]. In this article, we investigate the ladder of citizen participation by Sherry Arnstein as a practical framework for understanding participatory planning.

Arnstein's ladder is one of the most prominent models used to understand the degrees of citizen participation in planning processes. Arnstein's model is a metaphorical ladder that highlights eight ascending levels of participation in relation to the authority of decision-making. The ladder includes three general structures or rungs of participatory power, starting from (1) nonparticipation (no power) to (2) degrees of tokenism (counterfeit power) to (3) degrees of citizen participation (actual power) (as seen in Figure 1. Later, Arnstein's model influenced Elizabeth Rocha's Ladder of Empowerment and Roger Hart's Ladder of Children's Participation.

However, 'Arnstein's ladder has been criticized for the strong juxtaposition in the ladder between the universally positive stages- the upper levels of recognized power for the have-not citizens- and the universally negative stages-with the lower levels of power holders' dominance. The juxtaposition fails to address the participants' heterogeneity existent at the ladder's level. According to Arnstein herself [6], this juxtaposition limits the recognition of divergent points of view, knowledge, and heterogeneous perceptions within both groups.

In this article, we reflect on the limitations of the ladder of participation and conceptualize a typology of citizen participation by integrating emotions into the general structure of the ladder. We propose that engaging the senses and emotions of the public can enhance participatory planning processes. Emotions are viewed as the affective dimension of perception [1]. Foremost, in this article, we would like to shift attention to the influence of emotions and urban perception on structuring the process of participation in planning. In particular, we address how emotions shape the process of participatory planning. This is to broadly reflect on the often neglected relationship between emotions and cities that is widely referred to in literature [10], building on the studies that advocate for the employment of emotional mapping as a methodology in public participatory planning processes to collect data from quantified emotions in the context of citizen participation and to approach the different perceptions of participants [11].

The article first highlights the importance of including emotions in the participatory processes. Then, we propose a framework that enables the acknowledgment of emotions in participation and their impact on approaching more effectively the dynamics of real-world participatory processes and participant engagement. The results indicate how this framework could help create collectively inclusive cities.

II. THE NEED FOR CONSIDERING EMOTIONS IN (PARTICIPATORY) URBAN PLANNING

Planning theories acknowledge the value of community participation, arguing the potential of community involvement to achieve a more sustainable outcome. Responsive public input is subsequently encouraged for transparent and efficient decision-making and by stimulating information [4]. In this sense, participatory decision-making is sensitive to issues of legitimacy, and the role of information and evidence to promote good communication among participants, especially when bringing the voices of broader audiences [12]. In a similar plea, van Empel (2008) argues for the effectiveness of public participation by suggesting the importance of prioritizing a participant's common interest in their public perception of the built environment in order to focus on the big picture rather than their own self-interest.

The importance of public involvement relies on the role of the general public to promote "informed and collaborative dialogue among stakeholders holding diverse interests and values." [12]. From this perspective, the importance of participation has become a tool for developing ownership, partnerships, understanding, and commitment. Similarly, the role of consensus, issues of power, quality of interaction, and democratic participation, as well as representation of the views of those traditionally not included, are key to a good participatory planning process.

However, the value of emotional perception is little considered within the research and practice of community participation. The studies by Benediktsson & Pajet (2017) and Zeile et al. (2015) show that participation is dealt with as a tool for decision-making. Simultaneously, many studies acknowledge that public input may be biased by risk or by the perception of not feeling secure in sharing opinions in the decision-making process [13]. A situation often overlooked in community participation is the feeling of being uncomfortable working with the group [4]. In this article, we propose the inclusion and mapping of emotions felt by the public in order to address the challenges faced in participatory planning processes.

The concept of urban emotions [2] refers to the integration of human emotional responses to the urban environment into planning processes.

This concept highlights citizens and their perceptions, thus encouraging a human-centered perspective in planning processes. Zeile et al. (2015) argue that approaching humans as "the main sensing element of a city enables the understanding of human behavior in the urban environment". Thus, considering emotion in participation enables drawing the social geography of the city, especially considering marginalized groups not traditionally included [15].

Within these views, in urban and geography studies, tracing emotions has been emerging as a field of research and practice since 2009. One way of acknowledging emotions in the decision-making process for urban spaces is emotional cartography and emotional mapping. Emotional cartography emerges from critical geography and social geography studies where it is used as a method for describing and conceiving urban lived spaces [16], for instance when creating an index of emotional response with a Global Positioning System. Within similar strands of research, emotional mapping emerges as a qualitative methodology, focusing on urban subjects, specific routines, and emotions respecting the places of their everyday lives [15]. In emotional mapping, the methodologies question the experiences of the public to gather information on significantly positive or negative emotions and include them in the public consultation in planning [12].

From the perspective of participatory planning, emotional mapping, emotional cartography, and similar approaches are considered one of the tools that explore the emotional responses of participants while moving through neighborhoods and participating in the decision-making of vibrant communities. These tools and approaches allow an understanding of which areas of the neighborhood feel vibrant and safe. When participating with the tool, the difference in emotions can derive from age, gender, mobility, and experiences in neighborhoods [16].

Additionally, they help in identifying and registering emotionally charged areas and areas used to identify the qualitative experience of cities. For these reasons, mapping, visualizing, and tracing emotions are used alongside other research strategies such as walking to add a layer of qualitative emotional observation.

Case studies using emotional mapping/cartography explore the reactions to routes and places or the negative feelings of endangered experiences from users of new planning of bicycle infrastructure. Klaus & Germes (2015) investigate the case of drug abuse using mapping emotions as a tool to explore and analyze the challenges from the perspectives of the drug users. Using the methodology of mapping emotions, there is an enhancement of feelings of marginalized groups at being heard and recognizing their knowledge being recognized in public consultation [15].

Similarly, the study of places on a microscale has demonstrated that personal emotional appropriation explains individual patterns of use. [16][15]. Broadly, emotional mapping presents a geographical explanation of the emotional appropriation of space, where space is perceived as "...not only location, background, or context, but also a meaningful dimension of social practices" [15]. From this understanding, space (and cities) unfold power relations, organize everyday lives, and are transformed by subjectivities. In the next section, we present our view on updating the ladder of participation to involve reflections and tracing of public emotions in participatory planning processes.

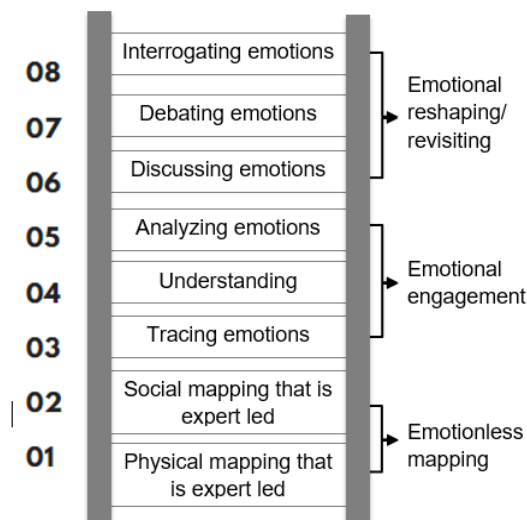


Figure 2: Ladder of Emotional Mapping The proposed ladder designed by the authors defines a hierarchy of engaging emotions that structures and reflects the participation of citizens, proposing three degrees of emotional mapping as shown. Source: Authors (2022).

III. A LADDER OF EMOTIONAL PARTICIPATION

After showing the importance of involving emotions in planning and designing cities, in this section, we propose a ladder of emotional participation. Building on the ladder of citizen participation by Arnstein (1969), presented above in Figure 1, three general rungs of citizen participation: non-participation, tokenism, and citizen-power can be read from an emotions-driven perspective as follows:

The first rung of non-participation can be viewed from a structure where the opinions, emotional thinking, and experiences of citizens are considered, but they are incapable of questioning the decision-making. whereas the second rung of tokenism includes a two-way flow with the power of negotiation but still has the public's emotions, perceptions, and public input overruled by power holders. In contrast, the third rung of citizen power assures the accountability of the have-not citizens with shared planning and decision-making responsibilities [6].

Here, we would redraw the ladder, including a reference to emotional mapping. We propose a ladder of emotional mapping that defines a hierarchy of engaging emotions that structures and reflects the participation of citizens, proposing three degrees of emotional mapping (Figure 2), starting from (1) Emotionless mapping to (2) Emotional engagement and (3) Emotional reshaping. In Figure 2, we reconceptualize the above ladder by Arnstein to involve emotions and their mapping.

The first rung of emotionless mapping considers emotions as input, but they are not viewed as part of the decision-making process. The first two levels of the emotional ladder include two levels: social mapping and physical mapping, which are expert-led. Moreover, the second rung of emotional engagement aims at encouraging a two-way flow between emotion-mapping input and the power of negotiation. To give an example, the second rung includes levels of tracing emotions, understanding, and analyzing emotions. Although, the second rung of engagement does not guarantee a balanced decision-making authority. In contrast, in the third rung of the emotional ladder, the emotional mapping input is not overruled by power holders and there is a shared decision-making responsibility. This last rung includes levels such as discussing emotions, debating emotions, and interrogating emotions.

The following Table 1 compares Arnstein's ladder of citizen participation to the proposed ladder of emotional mapping. It is argued that building on a reconceptualized framework from the ladder of participation that includes emotions has a strong impact on delivering suitable research methods for the ethical analysis of people's data and their emotions, especially when dealing with participants in qualitative research. Thompson (2021) presents a case of empathy mapping where the participant is viewed as a sense-making person, and where the interpretation of his or her story is to be first comprehended instead of judged to understand the logic of the participant's actions and words.

Table 1: Comparative Table between the Ladder of Citizen Participation and the Ladder of Emotional Mapping, Source: Authors (2022)

Ladder of participation (based on Arnstein, 1969)		A proposed Ladder of Emotional Mapping	
Citizen control	<i>Citizen power/control</i>	<i>Emotional reshaping/ revisiting</i>	Interrogating emotions
Delegated power			Debating emotions
Partnership			Discussing emotions (interaction and feedback)
Placation	<i>Tokenism</i>	<i>Emotional engagement</i>	Analysing emotions
Consultation			Understanding emotions
Informing			Tracking emotions
Therapy	<i>nonparticipati on</i>	<i>Emotionless mapping</i>	Social mapping that is expert-led
Manipulation			Physical mapping that is expert-led

IV. EMPIRICAL REFLECTIONS ON THE CASE OF THE LINE, KSA

The LINE city - KSA has been selected as a case study to conduct some empirical reflections on the proposed framework on the emotional participation of citizens in the city planning process and decision-making. We selected this case study to reflect on emotional mapping based on the following criteria:

- Modernity and contemporary
- Following the principles of sustainability in the design and planning process
- Adopting new visions within the framework of urban development
- Respect for nature and the surrounding environment
- Innovation

The LINE is a Saudi city that has been launched in 2021, located within the Neom project in the northwest of KSA. NEOM stands for **New Future**. It is made from the Greek word neos, meaning "new," and mustaqbal, the Arabic word for "future." the project is part of Saudi Arabia's strategy to

wean itself off oil money and diversify its sources of income, the country's crown prince unveiled the NEOM project in October 2017. The proposal will transform 50 islands in the Red Sea into opulent resorts. [17]

The LINE was announced by the Saudi government as part of the implementation of the Kingdom's 2030 vision (published in 2016) for urban development, which is a tactical plan to lessen Saudi Arabia's reliance on oil, diversify its economy, and expand public service areas like healthcare, education, infrastructure, leisure, and tourism. Reinforcing economic and investment activity, expanding non-oil foreign trade, and fostering a softer, more secular image of the Kingdom are among the main objectives. It also includes raising government support for the military and producing tools and munitions. [18]

The Line is a linear city that connects the Red Sea coast with the mountains and upper valleys in the northwest of the Kingdom of Saudi Arabia. The compact structure, which is 170 km long, 200 meters wide, and 500 meters high, represents a social and economic experience. The city aims to be carbon neutral by eliminating carbon-intensive infrastructures such as cars and roads and will run on 100% renewable energy, including the operations of its industries [19]. Some general remarks on the Line project:

- Project: Neom
- Project Location: Dammam – Saudi Arabia
- Project Area: 34000 Sq. meters
- Total Population: 9 Million citizens

Figures 3 and 4 show the exact location of the LINE and details about tataol area and DIMENSIONS. On a footprint of only 34 square kilometers, The Line is designed to host 9 million residents. The option to lower the building's footprint reduces the supporting infrastructure as well. The functional units for residential, retail, and recreational spaces are designed according to the five-minute city model so that inhabitants may reach all necessary amenities on foot. In addition, a high-speed rail will run the length of the mega-structure to provide 20-minute end-to-end travel. As shown in the following figure, the city consists of two symmetrical skyscrapers, 170 kilometers long, 200 meters wide, and 500 meters high. Between them are urban spaces used as natural open spaces for users, while the external facades will be clad in a mirror façade. The interior will be built to accommodate buildings, public park layers, pedestrian areas, schools, homes, and workplaces. The concept's creators described it as "Zero Gravity Urbanism"[20].



Figure 3: The LINE location. Source: NEOM.com



Figure 4: The LINE general remarks. Source: NEOM.com



Figure 5: The LINE's twin skyscrapers Source: dezeen.com

The line is promoted as a civilizational revolution that prioritizes humanity by providing an unmatched urban living experience while conserving the surrounding environment. It redefines the concept of urban development and the appearance of future cities. The ideal climate all year round will ensure that residents can enjoy the surrounding nature. Residents will also have access to all facilities within a five-minute walk, in addition to high-speed rail – with an end-to-end transit time of 20 minutes. [21]

To ensure the development of microclimatic areas, the surrounding environment has been meticulously planned to provide an appropriate combination of sunlight, shade, and natural ventilation. Moreover, the green open areas across the city will increase the comfort of residents, workers, and visitors [22].

The planners will use advanced planning technologies and techniques that will ensure effective delivery of the line as planned. Residents will live in harmony with the natural environment and away from urbanization, as shown in the following figures from 5 to 10. [23]

From the presentation of the case line, it is clear the keenness of planners and decision-makers to establish a sustainable city that follows environmental standards in the context of the urban development of the Kingdom.

- Design that harmonizes with nature
- Reduce your infrastructure footprint and carbon emissions
- 95% of the land and sea are protected for nature
- The perfect climate all year round



Figure 6: The LINE marina. Source: dezeen.com



Figure 9: The LINE landscape between the twin skyscrapers. Source: Archdaily.com



Figure 7: The LINE natural open areas. Source: Archdaily.com



Figure 10: The LINE landscape between the twin skyscrapers. Source: Archdaily.com



Figure 8: The LINE gardens and green open spaces. Source: Archdaily.com

- Life and work balance
- Legacy-free urbanism
- Improving Living
- Leisure and Sports
- Next-generation architecture
- Walkable Communities
- Environmental Solutions

But there was no mention of taking into account the emotional dimension of the user, his aspirations and needs, or whether citizens were included in the decision-making process and the planning and design stages for the new city.

This article discussed the role and relevance of involving emotions in participatory urban processes, showing how mapping emotions can help us better understand our cities and the way we organize, design, and inhabit them.

User participation in the planning process at any of the three levels suggested by this article: Emotional reshaping/revisiting, emotional engagement, or emotionless mapping may answer a number of questions that the planners and decision-makers have overlooked in this project, such as:

- It is always known that the horizontal expansion in the desert is what the population has been accustomed to over time, so why the vertical expansion?
- Is this consistent with considering the emotional side of the use?
- Reflective glass facades and their impact on desert climate, energy consumption, and infrastructure
- The population's relationship with the natural world around them and how it duplicates it without the presence of windows viewing the outside, all of them overlooking the inside and the constructed natural environment?
- How will the city's climate be controlled? Will it be fully air-conditioned internally and externally, even in open spaces and parks?
- How to deal with storms and weather fluctuations?
- The impact of isolation from the outside community, psychologically and socially, on the city's residents
- The flexibility of the design and how it will deal with the variables that occur over time in nature, humans, and their dependencies.

Table 2: A conceptual framework for the Ladder of Emotional Mapping Ladder of Citizen Participation, Source: Authors (2022).

A proposed Ladder of Emotional Mapping		Suggested questions to consider
<u>Emotional reshaping/ revisiting</u>	Interrogating emotions	Is city planning consistent with consideration of the emotional side of the user?
	Debating emotions	Does the new city's shape correspond to the user's social and historical background in terms of customs and traditions?
	Discussing emotions (interaction and feedback)	How is the user's relationship with the new surrounding environment around him? How does each of them interact with each other?
<u>Emotional engagement</u>	Analysing emotions	Does the new city respect the social and visual background on which the user is raised?
	Understanding emotions	Does the new city meet the renewable and changing needs of the citizens over time?
	Tracing emotions	How will the new city deal with the variables that occur over time in nature, humans and their dependencies?
<u>Emotionless mapping</u>	Social mapping that is expert-led	What is the impact of neglecting the emotional side of the user in the decision-making process and mapping from a social point of view?
	Physical mapping that is expert-led	What are the elements that are neglected in the absence of community participation in the decision-making process, and limiting it to experts only?

V. CONCLUSION AND A SUGGESTED CONCEPTUAL FRAMEWORK

This article discusses the role and relevance of involving emotions in participatory urban processes, showing how mapping emotions can help us better understand our cities and the way we organize, design, and inhabit them. Summarizing theoretical approaches that link emotions, decision-making, and emotion-driven systems, we began this paper with a conceptualization of the ladder of participation proposed by Arnstein in 1969. Following this, we discussed the objectives of the present viewpoint to propose an argument on the intersections between both. The results provide a framework for the degrees of emotional mapping and how it can affect the engagement of the public in planning urban spaces, affecting the consensual results of participatory decision-making. It contributes to the literature on the evaluation of public participatory approaches. Future research can extend the connection between the degrees of emotional mapping to citizens' decision-making. Moreover, further studies can tackle the role of physical and material space play in how we become emotionally involved and attached in relation to the degrees of emotional mapping. In the following table, we propose a conceptual framework for the ladder of emotional mapping, including suggested questions to consider when planning and designing urban projects and future urban visions.

ACKNOWLEDGMENT

We would like to acknowledge the support of Impact Circles e.V. in Berlin to develop this article.

REFERENCES

- [1] Tonello, G. and Bobatto, P., "Emotional Perception of Urban Environments", *Journal of Psychology Research*, vol. 4, no. 03, 2014. Available: 10.17265/2159-5542/2014.03.006.
- [2] Zeile, P., Resch, B., Exner, J., and Sagl, G., "Urban Emotions: Benefits and Risks in Using Human Sensory Assessment for the Extraction of Contextual Emotion Information in Urban Planning Planning Support Systems and Smart Cities, 2015 ISBN : 978-3-319-18367-1 Peter Zeile, Bernd Resch, Jan-Philipp Exner, Günther Sagl", 2015.
- [3] Van Empel, C. "The effectiveness of community participation in planning and urban development", 1991.
- [4] J. Pánek and K. Benediktsson, "Emotional mapping and its participatory potential: Opinions about cycling conditions in Reykjavík, Iceland", *Cities*, vol. 61, pp. 65-73, 2017. Available: 10.1016/j.cities.2016.11.005.
- [5] Caquard, S., and Griffin, A. "Mapping Emotional Cartography", *Cartographic Perspectives*, no. 91, 2019. Available: 10.14714/cp91.1551.
- [6] Arnstein, S., "A Ladder Of Citizen Participation", *Journal of the American Institute of Planners*, vol. 35, no. 4, pp. 216-224, 1969. Available: 10.1080/01944366908977225.
- [7] Hasler, S., Chenal, J., and Soutter, M., "Digital Tools as a Means to Foster Inclusive, Data-informed Urban Planning", *Civil Engineering and Architecture*, vol. 5, no. 6, pp. 230-239, 2017. Available: 10.13189/cea.2017.050605.
- [8] Babu, R., "Editorial", *DECISION*, vol. 42, no. 1, pp. 1-2, 2015. Available: 10.1007/s40622-015-0078-0.
- [9] Hickey, S., and Mohan, G., *Participation, from tyranny to transformation*, 2004.
- [10] Tuler, S., and Webler, T., "How Preferences for Public Participation are Linked to Perceptions of the Context, Preferences for Outcomes, and Individual Characteristics", *Environmental Management*, vol. 46, no. 2, pp. 254-267, 2010. Available: 10.1007/s00267-010-9515-1.
- [11] Barclay, K., and Riddle, J., *Urban emotions and the making of the city*. Routledge, 2021.
- [12] Thompson, M., "Narrative Mapping: Participant-Generated Visual Methodology for Health Communication Research and Pedagogy", *Health Communication*, vol. 36, no. 5, pp. 630-638, 2020. Available: 10.1080/10410236.2020.1733228.
- [13] Tuler, S., and Webler, T., "How Preferences for Public Participation are Linked to Perceptions of the Context, Preferences for Outcomes, and Individual Characteristics", *Environmental Management*, vol. 46, no. 2, pp. 254-267, 2010. Available: 10.1007/s00267-010-9515-1.
- [14] Klaus, L., and Germes, M., "Emotional mapping: towards a geographical explanation of drug use", 2019.

- [15] Germes M., and Klaus, L., "When marginalized subjects map their city: Counter-mapping experiments with drug users in some German and French neighborhoods", *Bulletin of Sociological Methodology/Bulletin de Méthodologie Sociologique*, vol. 152, no. 1, pp. 96-124, 2021. Available: 10.1177/07591063211040234.
- [16] Nold, C., "Emotional Cartography - Technologies of the Self", in *Emotional Cartography - Technologies of the Self*, 2009.
- [17] Neom.com. 2022. About. [online] Available at: <https://www.neom.com/en-us/about>. Accessed: 19 September 2022.
- [18] Kingdom of Saudi Arabia. (2016). Vision 2030 Kingdom of Saudi Arabia. Retrieved from. <http://vision2030.gov.sa/en>. Accessed: 20 September 2022.
- [19] Neom.com. 2022. NEOM: Made to Change. [online] Available at: <<https://www.neom.com/en-us>> <https://www.neom.com/en-us/>. Accessed: 19 September 2022.
- [20] ArchDaily. 2022. Gallery of Saudi Arabia Plans 170-Kilometer-Long Mirrored Skyscraper City - 1. [online] Available at: <https://www.archdaily.com/986129/saudi-arabia-plans-170-kilometer-long-mirrored-skyscraper-city>. Accessed: 20 September 2022.
- [21] Free Press Journal. 2022. "What is The Line? All you need to know about Saudi Arabia's plan for a futuristic zero-carbon city", *Free Press Journal*, 2022. [Online]. Available: <https://www.freepressjournal.in/world/what-is-the-line-all-you-need-to-know-about-saudi-arabias-plan-for-a-futuristic-zero-carbon-city> Accessed: 19 September 2022.
- [22] Chulov, M. "Saudi Arabia plans 100-mile-long mirrored skyscraper megacity", the *Guardian*, 2022. [Online]. Available: <https://www.theguardian.com/world/2022/jul/27/saudis-unveil-eye-popping-plan-for-mirrored-skyscraper-eco-city>. Accessed: 19 September 2022.
- [23] Barker, N., "Sustainability and liveability claims of Saudi 170km city are "naive" say experts", *Dezeen*, 2022. [Online]. Available: <https://www.dezeen.com/2022/08/08/sustainability-liveability-the-line-saudi-170km-city-naive/>. Accessed: 19 September 2022.