

## THE LINE – THE SAUDI-ARABIAN LINEAR CITY CONCEPT AS THE PROTOTYPE OF FUTURE CITIES

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„THE LINE” – KONCEPCJA MIASTA LINIOWEGO W ARABII SAUDYJSKIEJ JAKO PROTOTYP MIAST PRZYSZŁOŚCI

### Streszczenie

Ogłoszenie rozpoczęcia budowy nowego, futurystycznego, bezemisyjnego miasta w Arabii Saudyjskiej w postaci 170-kilometrowego *The Line*, urbanistycznego układu liniowego Mohammeda bin Salmana, księcia koronnego i prezesa zarządu NEOM Company, wzbudziła dyskusję na temat miasta idealnego, jego geometrii oraz słuszności. Sprowokowało to także pytania, czy miasto zbudowane w ten sposób będzie właściwą odpowiedzią na współczesne i przyszłe problemy urbanistyki, jak przewidują to autorzy i entuzjaści projektu. W takich okolicznościach nie sposób pominąć historię urbanistyki, gdyż próbowano wprowadzić podobne rozwiązania przez ponad 150 lat. Pomimo, że dotychczas nie udało się w pełni zrealizować założeń miast linearnych według pierwotnych koncepcji, dziś okazuje się, że utopia może stać się rzeczywistością. Istnieją ku temu istotne przesłanki. Celem artykułu jest zapoznanie czytelnika ze współcześnie zinterpretowaną ideą miasta liniowego, które może stać się prototypem kompozycyjnym dla urbanistyki zrównoważonych miast w przyszłości.

### Abstract

The launch announcement of the construction of a new, futuristic, emission-free city in Saudi Arabia in the form of a 170-kilometer line – *The Line* – by Mohammed bin Salman, Crown Prince and Chairman of the Neom Company Board of Directors, aroused a discussion about ideal cities, the geometry of a linear city and its legitimacy. It provoked questions whether a city built in such a way could provide an appropriate answer to contemporary and future urban problems, as its authors and promoters expected. On this occasion, it is impossible not to refer to the urban history to look at similar ideas of linear cities and the attempts to implement them for over 150 years. Although it has not been possible to fully realize the linear city in accordance with the initial assumptions of the concept so far, today it may turn out that the utopia will become a reality. There are quite significant reasons for this. The aim of the article is to familiarize the reader with the contemporary interpretation of the idea of a linear city, which may become a compositional prototype for the urban planning of sustainable cities in the future.

Keywords: architecture; town planning; ideal city; linear city; Neom; sustainable city; urban geometry

Słowa kluczowe: architektura; geometria miejska; miasto idealne; miasto liniowe; miasto zrównoważone; Neom; planowanie miast

## INTRODUCTION

The aim of this study is to describe the contemporary interpretation of the idea of a linear city, which may become a compositional prototype for the urban planning of sustainable cities in the future. The reason

for re-examining the linearity in the composition of new urban developments was the announcement at the beginning of this year of the launch of the 100-mile (170 km) linear city project in the western part of Saudi Ara-

bia. The concept of a linear city announced by Mohammed bin Salman, Crown Prince and Chairman of the Neom Company Board of Directors, is an interesting attempt to find answers to the practical questions of a modern city by introducing the theoretical model of a linear city for implementation.

At the same time, the inspiration for research on linear cities was its noticeable biomimicry. Firstly, the resemblance to oases, with its array of “city modules”, where people would gather in small habitats; secondly, its overall geometry that well mimics the tracks of birds, flying every day to and from water sources; or finally, a geometrical resemblance of a spinal structure, at first looking topologically inorganic, yet mimicking the idea of a functional sustainability of Nature. In this perspective the linear city is analyzed not only as a city intended for the “pleasure of living” but particular importance is attached to the widely-understood “safety of living”, considering urban consciousness for sustainable development. In order to understand the idea of linearity in urban design, the presented study reveals the problems of typologies of linearity in urban design, the historic development of linear urban formations, the organic development aspects (mimicry) and opportunities which linear urban forms can create for future urban developments – in relation to the announced “Line” project in Saudi Arabia.

The urban planning of linear cities is a complex research area in which a number of issues can be distinguished. They reflect problems of cities both in the past as well as today. The idea of a linear city includes the paradigm of ordering space, creating an image of a city that can be designed in a “theoretically ideal” way. There are several aspects of the analysis of linearity in urban design, which can be divided in three most important typologies:

- Typology of various scales of linear urban compositions
- Typology of functional, social and aesthetic aims of using urban linear systems
- Typology of contemporary threats and problems of urbanized areas which could be solved by the linear urban formation.

The description of these typologies are the subject of further chapters of this article.

The publicly presented project *The Line* in Saudi Arabia became a pretext to analyze the linear system of urban composition and re-evaluate its value in the context of the scale of assumptions, goals to be achieved and future development opportunities. The research is based on historical research, in particular with regard to references to selected realized ideas of linear cities or only their theoretical forms and visualization, as well as

to functional and spatial effects obtained as a result of a settlement structure with a linear structure. In the light of historical analysis and experiences resulting from the theoretical struggle with the “matter of linearity” to date, one can look at the proposed concept of *The Line* by comparing this project with other ideas and realizations based on the idea of a linear spatial arrangement. As a result of the applied comparative method, the value of an innovative approach to the problem of housing as well as potential problems *The Line* project can generate, can be assessed.

Thus, the concept of *The Line* city implements the assumptions that have always been put before builders of “ideal cities”. The idea of a linear city presented by the Saudi Prince should be approached with respect and attention, since it offers a unique opportunity to test many theoretical assumptions that arise around the idea of a linear city, a city without cars, in practice. The linear city model proposed by the Neom Company may turn out to be an experimental field in the futuristic linear urbanization, extremely important for the future of world urbanism.

## 1. MATERIALS AND METHODS

### 1.1. The brief history of linear city idea development

Linear urban forms have been known since the beginning of urban design history. The topic of linear and strip cities appeared in the second half of the 19<sup>th</sup> century and has a very rich scientific literature. There is a quite large list of articles concerning linear cities. Architecture historian G.R. Collins, particularly interested in the literature and philosophy of the linear city, was a collector of literature on the subject and the author of many publications. According to him, the discussion about the essence of the linear city was started by Ch. Bouilhet in 1912, who supported the ideas of the linear development of cities existing along rivers and transport routes, while stressing that the rope plans of the cities would lead to “disappearance of cities as nuclei of human activities” [G. R. Collins 1959]. Another promoter of linear cities was Georges Benoit-Levy, who advocated the concept of the linear city in Madrid as one of the types of the famous Ebenezer Howard’s garden city. These two types of city development as a linear and concentric system were the subject of comparisons and discussions [G. R. Collins, Oct. 1959]. Other valuable inputs into the subject and interesting overviews were done by [C.A. Doxiadis 1967], *On Linear Cities*, [T. Tufek-Memisevic, E. Stachura 2015], *A linear city development under contemporary determinants* and by the same authors [A. Tufek-Memisevic, E. Stachura, 2019],

*Linear megastructures. An eccentric pursuit in tackling urban sustainability challenges* and by [A.V. Antyufeev, O. A. Antyufeeva 2019], *Linear Cities: controversies, challenges and prospects*. The research concerning the links between the “ideal” and linear cities was conducted by Z. Paszkowski, in his book *The ideal city in the European perspective and its relations with contemporary urbanism*, where he devotes a whole chapter to the linear city idea [Z. Paszkowski 2011]. [T. Tufek-Memisevic, E. Stachura 2019].

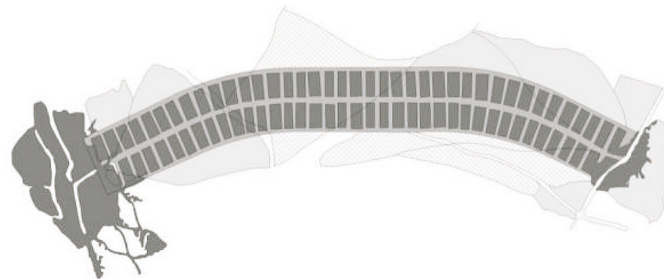
### 1.2. The Ciudad Lineal by Arturo Soria y Mata

The concept of the linear city of Ciudad Lineal was published in the Madrid periodical *El Progreso* in 1882. It was a period of triumphant development of railway communication. The concept of line cities by A. Soria y Mata assumed the emergence of urbanized systems along communication lines composed of roads, rail- and tramways. He saw such a linear city not locally, but in a global context – from Cadiz to St. Petersburg and Beijing. He wanted to connect linear systems into triangles, thus creating an urbanized network of connections covering the whole of Spain. Soria started implementing the idea of a linear city 10 years after the publication of his first concept. On the outskirts of Madrid, a 50 km long belt of the city’s peripheral artery with residential buildings and recreational areas was to be built. Railroad tracks were to be used for passenger transport during the day and freight transport at night. The strip system was to be cut at regular intervals by transverse streets. In the thus created quarters, Soria provided for the location of detached buildings, placed in greenery. The project started in 1894 through the Compañía Madrileña de Urbanización, a joint-stock company founded by Soria. However, the project encountered implementation difficulties in acquiring land on the one hand and selling shares on the other. As a result, only a 5-km-long section of the linear city was completed. The spatial development of Madrid caused this part of the city to be absorbed into the growing organism of the Madrid metropolis, eliminating the green areas inherent in the project.

The linear city of Soria y Mata was also a manifestation of the idea of organicity outlined by him. He believed that the city should be guaranteed the right of constant development, characteristic of the works of Nature. The core of the linear city was to be a communication artery 40 m wide with a tram line running in the middle (initially on horseback, and electrified since 1904).

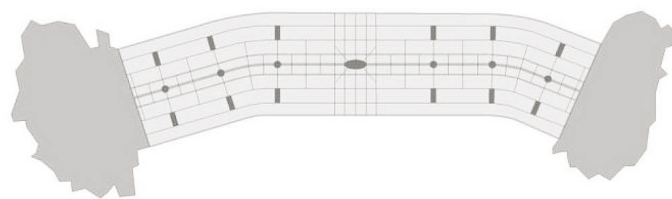
The idea of a linear city by A. Soria y Mata found many followers. H. Gonzalez de Castillo presented at the Exhibition of Reconstruction after World War I in

Brussels in 1919 a developed version of a strip city with a strip of buildings much wider than in Soria y Mata’s, with five parallel streets divided into functional zones and a clearly outlined focal center. The range was to connect two existing medieval towns in Belgium.



**Fig. 1a.** The concept of a linear city near Madrid, designed by Arturo Soria y Mata. Scheme of the spatial layout; source: Z. Paszkowski 2011.

**Ryc. 1a.** koncepcja miasta linearnego w okolicach Madrytu, projektu Arturo Soria y Mata. Schemat układu przestrzennego; źródło: Z. Paszkowski 2011



**Fig. 1b.** The concept of a linear city according to H. Gonzalez de Castillo. The model of the linear city by Gonzalez de Castillo, presented at the Reconstruction Exhibition in Brussels in 1919. In relation to the linear model of the city of Arturo Soria y Mata, based on the functioning of the railroad, the range was extended and enriched with a network of cross streets and an extensive system of squares and green areas; source: Z. Paszkowski 2011.

**Ryc. 1b.** koncepcja miasta linearnego wg. H. Gonzalez de Castillo. Model miasta linearnego Gonzalez de Castillo, zaprezentowany podczas wystawy Rekonstrukcji w Brukseli w 1919 r. W nawiązaniu to linearnego modelu miasta autorstwa Arturo Soria y Mata, bazującego na funkcjonującej linii kolejowej, zakres został rozszerzony i wzbogacony o siatkę ulic przecinających oraz rozbudowany system skwerów i przestrzeni zielonych; źródło: Z. Paszkowski 2011

### 1.3. Edgar Chambless’ Roadtown

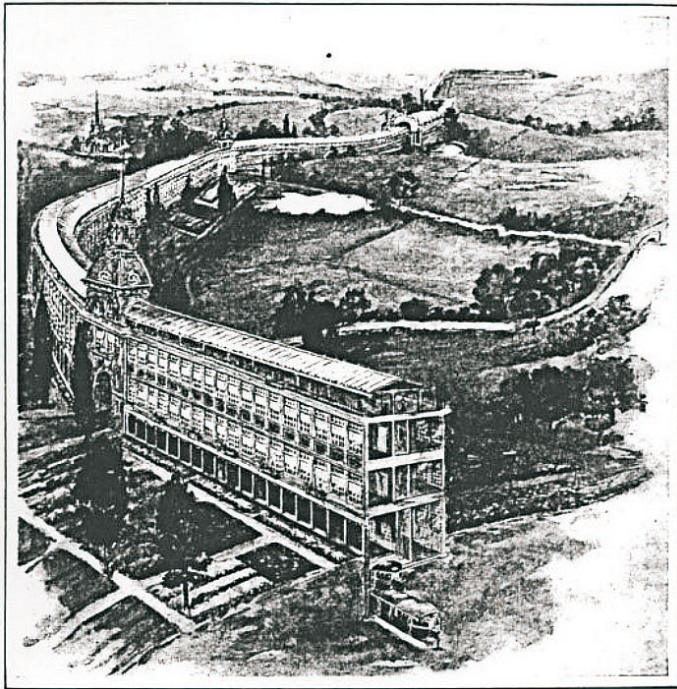
In 1910, Edgar Chambless presented in “The New York Times” an American vision of the Roadtown strip city. Similarly to Soria y Mata, it was associated with the development of railway communication and was to provide easy access to communication, while directly using green areas and landscape free of buildings. Chambless’ vision is a “lying skyscraper”, unlimited in spatial development, which was supposed to solve basic problems related to communication and healthy living. The continuation of this urban and architectural

thought was developed by G. Gautier in Canada in the 21<sup>st</sup> century by proposing the Linear City project.

#### 1.4. Strip cities

The concept of linear settlement systems found its place in the post-revolution urban changes in the Soviet Union. The idea of combining the city and the countryside was taken up in communist philosophy and was reflected in the concepts of strip cities developed in the Soviet Union in the 1920s and 1930s by Soviet architects. At that time, many concepts of linear cities were created. By implementing the assumptions of the Communist Manifesto, the Soviet urban planners wanted to eliminate the differences between the city and the countryside and to organize the hitherto chaotic system of urban development. The most radical ones opposed the creation of agglomerations or new cities, and postulated the construction of "settlement lines".

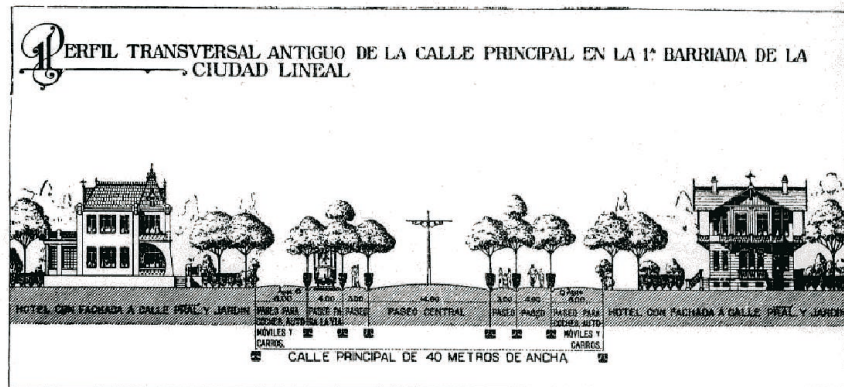
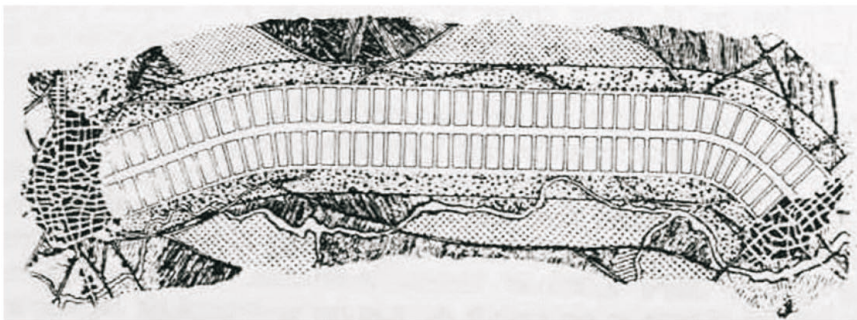
It was assumed that both working-class and agricultural population would live in the area of settlement lines. The settlement line would be neither a town nor a village, but a self-sufficient settlement unit 25 kilometers long. Such "settlement lines" would converge at the industrial conglomerate that would be the main workplace. It was a "de-urbanist" concept developed at the turn of the 1920s and 1930s, represented by the Association of Contemporary Architects OSA, represented by Milutin, Leonidov, Okhitovich and Sokolov. The concept of "settlement lines" was partially implemented in the construction of new industrial plants. It was a response to political demand – the socio-political idea was transposed into the idea of spatial development.



**Fig. 2.** Roadtown – Edgar Chambless' sketch from *The Independent*, 5<sup>th</sup> May 1910.

**Ryc. 2.** Roadtown - szkic Edgara Chamblessa z *The Independent*, 5 maja 1910

Source / Źródło: [http://en.wikipedia.org/wiki/File:Roadtown\\_Sketch.jpg](http://en.wikipedia.org/wiki/File:Roadtown_Sketch.jpg) (access: 10.04.2021)



**Fig. 3.** Ciudad Lineal by Arturo Soria y Mata, 1913, **a.** plan, **b.** transverse section.

**Ryc. 3.** Ciudad Lineal projektu Arturo Soria y Mata, 1913 **a.** plan, **b.** przekrój poprzeczny

Source / Źródło: **a.** <https://madridonthemove.weebly.com/executed-projects.html> **b.** <https://cityeu.wordpress.com/urbastructure/> (access: 10.04.2021)

At the beginning of the 1960s, the concepts of strip cities, abandoned in the 1930s, returned to the consideration of Soviet urban planners. W. Ostrowski draws attention to the theoretical project of a new city for 175,000 inhabitants developed at the Central Institute of Town Planning in Moscow [W. Ostrowski, 1975]. In this project, the city was designed along the river in a strip pattern. Recreation areas adjoin its shores and are bordered by residential areas with services and insulation greenery with a car and rail communication system. The area for non-burdensome industry adjacent to the railway area is separated from the area of large industry by another strip of insulating greenery.

Architect N.A. Ladovsky proposed a parabola-city model growing along a dual axis. He argued that the city center should be a dynamic point of the city – its axis, not a static point [A. V. Antyufeev, Antyufeeva 2019]. In the early 1930s, the Soviet urban planner N.A. Miliutin published the book *Sotsgorod - The Problems of Planning Socialistic Cities*, in which he presented “the basic principles of planning and building housing estates in the Soviet Union.” He explained the urban concept of the band compositional system of cities, including the examples of Magnitogorsk and Stalingrad (now Volgograd) development projects [N. A. Miliutin, 1930].

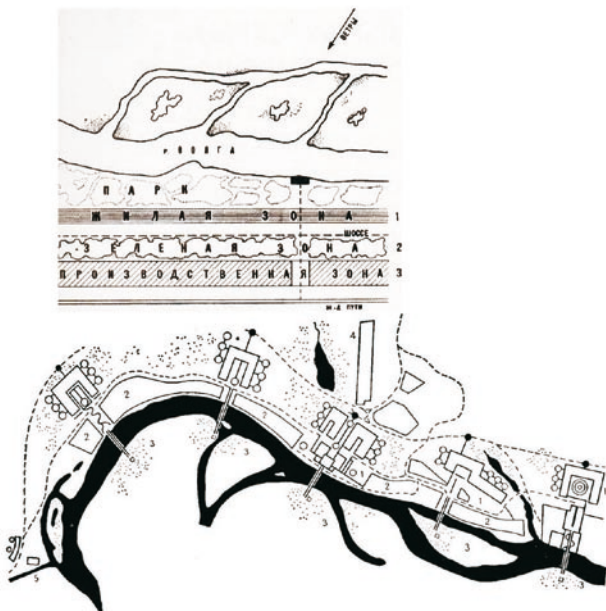


Fig. 4. Miliutin Strip City - Sotsgorod.

Ryc. 4. Miasto Pasmowe Milutina – Socgorod

Source / Źródło: <https://alchetron.com/Nikolay-Alexandrovich-Milyutin> (access: 10.04.2021)

The strip city system developed by him with a clear separation of urban industrial, transport, city-wide, residential and recreational functions was the basis for the interest in city strip systems by the German architect Ludwig Hilberseimer, lecturer at the Bauhaus in Weimar [L. Hilberseimer, 1955]. In his concept, band circuits were a combination of A. Soria y Mata's concept with that of Miliutin. Le Corbusier showed an interest in linear and streaked urban compositions, expressing it in the Obus plan for Algiers and plans for Rio de Janeiro. In his approach to the linearity concept, the composition was made up of megastructures with road infrastructure associated with residential buildings – typologically similar to the form of an aqueduct.

### 1.5. Linear megastructures

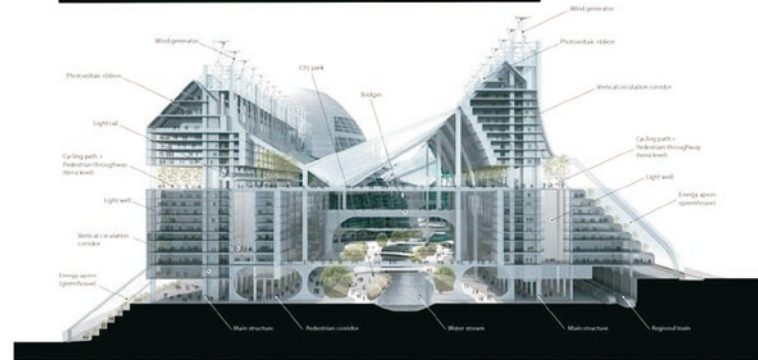
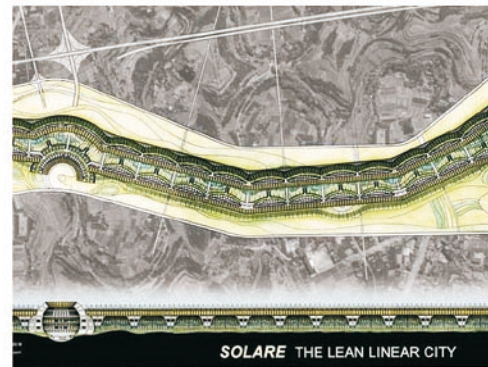


Fig. 5. Paolo Soleri project - The Lean Linear City (LLC).

a. plan. b. 3D model, Source / Źródło: <http://legacy.arcosanti.org/taxonomy/term/140> (access 01.04.2021).

Ryc. 5. Projekt Lean Linear City arch. Paolo Soleri.

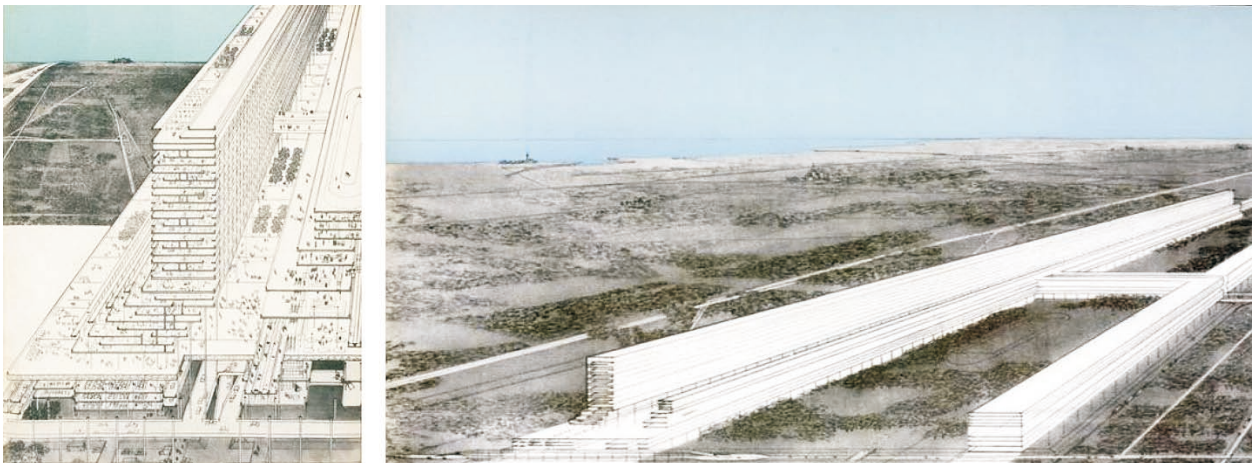
a. plan założenia, b. model 3D

Source / Źródło: <https://line.17qq.com/articles/ccipomopcv.html> (access 01.04.2021)

The world fame was gained in the 1960s by the concept of Tokyo Bay mega-development with a floating, banded megastructure designed by the famous architect Kenzo Tange, as well as The Lean Linear City project by the visionary Paolo Soleri. The Lean Linear City (LCC) proposes a continuous urban ribbon of twenty or more storey's high, extending for many

kilometers. Two main, parallel structures are built in modules measuring 200 meters (600 feet) in length. Each module accommodates about 3,000 residents and spaces for commercial, industrial, educational, cultural, recreational, and health maintenance activities. LLC suggests a possibility of sustainable urban development within its structure and the environment beyond. While carbon neutrality is within its reach through innovations in building technology and energy conservation, the most important contribution of LLC is perhaps, its logistical approach to define and control the growth pattern of the existing and future cities. Interesting in this project is not only the idea of linear communication, but also the creation of a friendly architectural environment and attractive forms of architectural space.

At the beginning of the 1960s, Peter Eisenman and Michael Graves became professors at Princeton University. They collaborated in several projects and competitions, from which the Linear City Project has become the most remarkable. The New Jersey Linear City project by M. Graves and P. Eisenman from 1965 “attempted to create a continuous urbanism that would go through the west coast, from Boston to Washington DC. They chose a specific urban void of 22 miles in the New Jersey State to locate this megastructure. Linear City is defined by two large horizontal strips: one of them for industry, and the other for housing, offices and stores. The proposal, unlike being an utopia, it is featured by its viability within the urban and cultural framework of the United States because it is defined by a large infrastructure that supports the project itself” [Hidden Architecture, 2016].



**Fig. 6.a., b.** Graves+Eisenman – New Jersey Linear City Project.  
**Ryc. 6 a., b.** Graves+Eisenman – projekt Miasta Liniowego New Jersey  
Source / Źródło: <http://hiddenarchitecture.net/linear-city/> (access 01.04.2021)

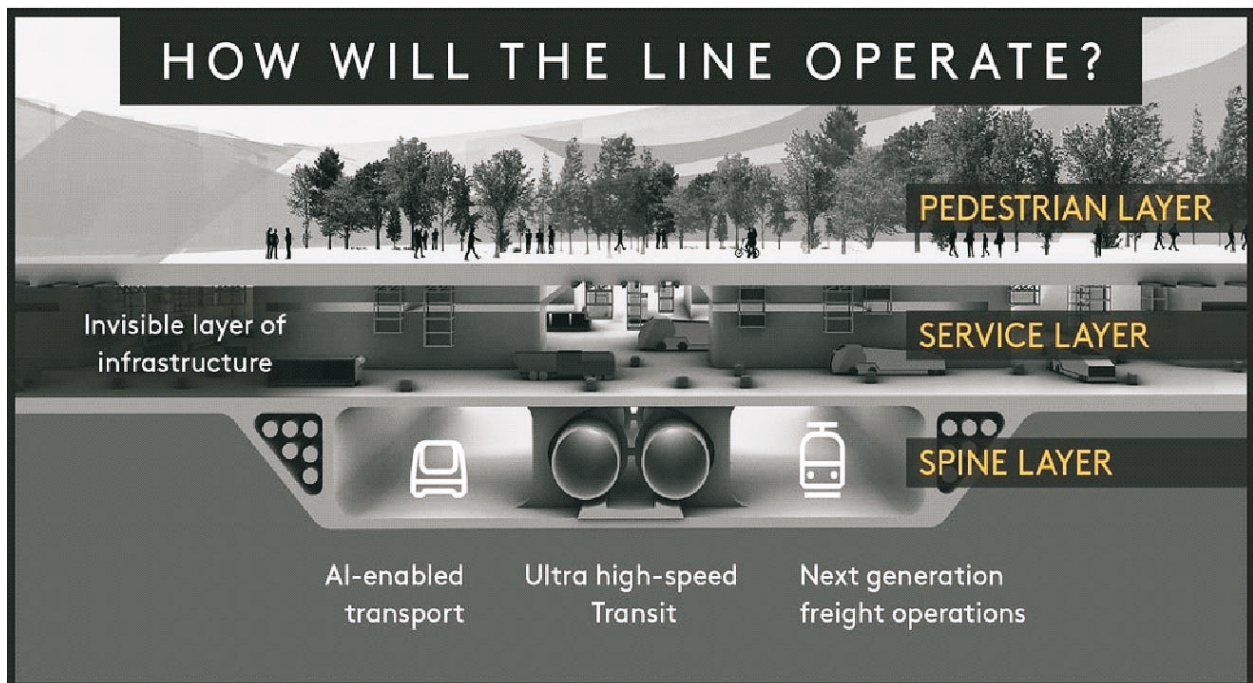


**Fig.7.** G. Gauthier's Linear City Project – rendering.  
**Ryc. 7.** Projekt Miasta Liniowego G. Gauthiera – wizualizacja projektu koncepcyjnego  
Source / Źródło: [www.linearcity.ca](http://www.linearcity.ca), [www.linearcity.ca](http://www.linearcity.ca) (access 01.04.2021)

Recently, the Linear City Project, redesigned in Canada by the architect G. Gauthier, repeating the similar idea of the megastructure of Graves and Eisenman, also belongs to a similar type of architectural and urban mega structural way of thinking. A significant contribution was brought in the 1960s to the theory of linear cities by the Polish architect Oskar Hansen, author of the concept of band development of Poland “from the Tatra Mountains to the Baltic Sea” in the form of four strands of buildings, implemented in accordance with his idea of a Linear Continuous System (LCS). He managed to realize only a few blocks of flats, which illustrate his idea of LCS – in Lublin (Slowackiego Living Estate) and in Warsaw (Przyczolek Grochowski Estate).

The highlights of the Line City Project (The Line) are following:

- The Line will be an international city, inhabited by a number of more than 1 million people from all over the world.
- The location of the Line-City will cross and connect four distinctive landscapes and ecozones: Coastal, Coastal-Desert, Mountain and Upper Valley.
- The needed electrical energy will be totally produced from renewable sources (solar energy, wind energy and hydrogen-based power generation). This arrangement will ensure zero carbon emission resulting in clean and pollution-free environment of the Line-City urban area.



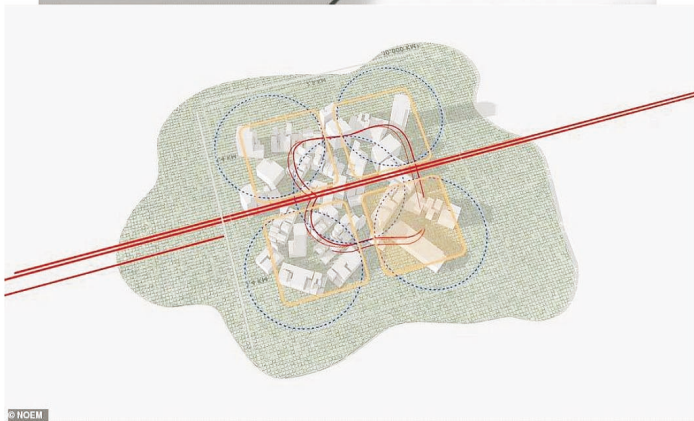
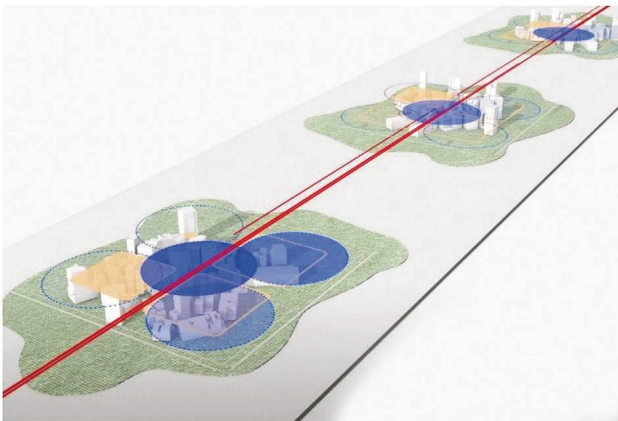
**Fig. 8.** Three layers of *The Line* – operational scheme.  
**Ryc. 8.** Trzy poziomy *The Line* – schemat funkcjonalny  
 Source / Źródło: neom.com

There are many other interesting examples of applications of linear and band geometry in urban projects around the world.

### 1.6. The highlights of the Line City Project in Saudi Arabia

According to the announcements distributed by Neom Company: “...the Line will be a revolution in urban living, which is developed as part of Neom, a planned \$500 billion cross-border city in the Tabuk Province of northwestern Saudi Arabia which will incorporate smart technologies. The site, near the Red Sea, will have borders of Egypt, Israel, and Jordan.”

- The Line will be the five-minute Habitat – spectacular due to the new definition of the role of pedestrian area. Walkability within the five-minute walk will define the settlement area, including essential daily services, schools, medical clinics, leisure facilities, as well as recreational areas with green spaces. Thanks to that idea, no cars or car-planned streets will be needed.
- The Line will be composed of a 170 km chain of settlements (named: modules) hyper-connected by the high-speed underground train and/or hyperloop transportation. The settlements (modules) will consist of mixed-use communities. They



**Fig. 9.** *The Line* by Neom **a.** City Modules along the spine, **b.** single City Module with its 5-min. walkability zones.

**Ryc. 9.** Projekt *The Line* . **a.** Moduły miejskie wzdłuż kręgosłupa „The Line”, **b.** pojedynczy moduł miejski i strefy 5-min. dystansu pieszego..Source / Źródło: neom.com

will be built around the nature with high respect to it, instead of over it.

- The Line transportation system will be divided into three operational levels:
- The top level, called Pedestrian Layer, will be dedicated only to pedestrians. There will be no cars and streets, with green spaces instead.
- The second level, called Service Layer, will contain all daily service facilities such as schools, medical clinics, leisure facilities.
- At the lowest, third level, called Spine Level, there will be ultra-high-speed transit and autonomous vehicles “that will make travel easier and give residents the opportunity to reclaim time to spend on health and wellbeing.” It is expected no journey will be longer than 20 minutes.

The time plan schedules the beginning of the construction of *The Line* in the first quarter of 2021. This investment is said to be one of the most complex and challenging infrastructure projects in the world. It is also worth mentioning that it forms a part of extensive development works, being already underway at the Neom Project. Neom was announced in 2017 as part of Saudi Vision 2030 to develop public service sectors, the diversity of Saudi Arabia’s economy and become less reliant on oil.

The sustainability of the Line-City will be ensured due to facing directly the most pressing challenges for humanity today, such as “*infrastructure, pollution, traffic, and human congestion*”, said Mohammed bin Sal-



**Fig. 10.** *The Line* by NEOM Company as the concept of sustainable city – connecting four distinctive landscape and ecozones.

**Ryc. 10.** „The Line”, projekt NEOM Company jako koncepcja miasta zrównoważonego – łącząca cztery zróżnicowane krajobrazy i ekosystemy,. Source / Źródło: neom.com



man in his launching statement. *The Line* concept is intended to be a response to contemporary threats related to urbanization, implement the latest technological achievements in a model way and to create urban structures for safe and happy living, work and leisure.

## 2. TYPOLOGICAL RESEARCH APPROACH

### 2.1. Linear composition as the predominant pattern in urban developments

Linear cities differ in scale – from the linear arrangement of individual buildings to regional band-development – to the architectural scale to regional planning. From the concentration on one public transport line to more complex multi-line strip systems. This differentiation of scales in which the idea of linearity and banding is implemented may cause misunderstanding, hence it is necessary to introduce systematics in linear geometry and applications of the linearity concept in urban planning.

The scale of linear urban developments can be specified by these characteristics: 1. Coincidental linear urban forms, 2. Linear villages, 3. Linear cities, 4. Linear megastructures, 5. Transit-oriented developments (TOD) and 6. Infrastructure corridors [T. Tufek-Memisevic, E. Stachura 2019].

First of all, linear systems of urbanized areas resulting from the existence of physical, topographically shaped, natural development barriers, such as: mountain valleys, watercourses, sea quays, where there is practically no possibility of spatial development in a different form, should be put into a separate group. An important group of cases (projects) is the planning of architectural and urban layouts in linear or strip forms, where the driving force behind the formation of a linear city is a coherent and homogeneous planning concept. For “linear” cities, such linear city systems can be called “where the ribbon of buildings is narrow enough to limit pedestrian traffic in the transverse direction.”

The linear city as the idea of geometric shaping of urban space occurs in the history of urban planning in many forms and variants. The idea behind a linear city was not only a search for new forms of urbanization in order to obtain a new model of the city in relation to the emergence of various unfavorable phenomena in overly concentrated cities. According to the assumptions of its creators, it was intended to be a remedy for urban and social problems arising in the then urbanized areas, such as water and sewage infrastructure, air pollution, the formation of traffic congestion, introducing public transport into urban systems, ordering chaotic structures of buildings or facilitating the prevention of protests by the urban proletariat and better control of

living in the city. The idea of linear and strip cities was also part of the political class struggle as opposed to the tradition of the capitalist city. One of the first experiences in the implementation of “political linearity” in the refurbishment of urban structures could have been probably the Haussmann reconstruction of Paris in the 1870s. The introduction of broadband, straight alleys with unified classic architectural envelopes put over the existing buildings [P. Pinon 2002], or the Barcelona city extension plan by I. Cerda from 1859, launched with the new linear street urban typologies. The introduction of a new, simplified urban scheme and an innovative (at that times) railway transportation system into the city [F. Magrinya 1994] was an attempt to manage transportation problems of goods and people in the growing agglomerations and between them. The Line Project in Saudi Arabia aspires to solve the same task – but using contemporary knowledge and gathered experiences in the functionality of urban linearity.

### 2.2. The typology of functional, social and aesthetic aims of linear systems in urban development

Another typological division is conditioned by the motivations, causes and aims of linear cities planning. It was Arturo Soria y Mata, who discovered significant dependence of the city’s form on communication. He argued that “*the most appropriate form of a city is where the sum of the times necessary to go from each house to all the others is the smallest. Since the best means of communication for fast, frequent and cheap communication is rail, cities should be linear.*” [A. Soria y Mata, *El Progreso*, cited after: W. Ostrowski 1975, p. 20]. Nowadays his idea has been developed to the extremes, pointing to communication problems within urban areas as one of the most challenging issues: accessibility, free flow of traffic with no congestion, air pollution due to fossil fuel use and traffic safety.

The main motives for developing the linear city concept therefore include the accessibility and safety of traffic and particularly:

- easy access to the transit road,
- equal access to an open landscape, a body of water (rivers, seacoast),
- concentration of buildings between important centers,
- optimal use of the means of public transport (tram, railway lines),
- pedestrian-traffic collision free zones.

Although the main distinguishing feature of the linear city is the geometric functional and spatial orientation in the form of a line, belt, ribbon, etc., the *de facto* idea of a linear city has a clear political and social con-

text, preferring egalitarianism, equal access to means of transport, a flat with a view, access to services and recreation areas. Utopia lies not only in geometry, but in the social idea. The social aspects of the linear city were the basis for the propagation of these ideas by many creators of linear cities, ranging between A. Soria y Mata, E. Howard, Le Corbusier, Miliutin, O. Hansen, M. Graves and P. Eisenmann, and reaching G. Gauthier and contemporary ecomodernists. A linear city is not only a question of geometry, but also the social thought behind it. Ciudad Lineal, developed by architect and philosopher Arturo Soria y Mata, is considered to be a pioneering solution in the field of linear cities and resulted from social thinking of its author. In the developing agglomeration of Madrid, he wanted to provide free access to the city center for people settled in the periphery thanks to the introduction of public rail transport. Soria proposed a vision of a linear city that would consist of a single strip, 500 meters wide and of any length. The quarters located around tram lines in a strip 500 m from the tram line were to be divided into plots adjacent to transverse streets, ensuring easy access to public transport. Quarters in the shape of rectangles or trapezoids were to be arranged symmetrically and on both sides. Only 20% of the area could be allocated for development. Each family could get a house with a garden and an orchard.

The idea of a linear city obviously does not mean its direct impact on the idea of social equity, however, in many theoretical concepts of linear cities an aspect of egalitarianism, equal access to all kinds of goods, services, standard of living, access to light, water, sun and green areas is evidently transmitted. The linearity of urban layouts ensures a better possibility of a fair distribution of these goods. In case of *The Line* project, the 170-km-long infrastructure route with locally concentrated development creates a number of differences in the development structure only due to the diversified topography through which the project runs. Although this is not conducive to egalitarianism in terms of access to the landscape, it creates another, undoubted value, which is the aesthetic diversity associated with the context of architecture related to its natural surroundings. The aesthetics of Arab architecture, with restrained, cubist forms of external architecture, proposed in *The Line*, favors focusing on the aesthetic shaping of public spaces and looking for the right proportions of building structures with ascetic white walls. The high temperatures of the desert climate of the Arabian Peninsula shape the architecture of a minimalist

exterior and highly individual, richly decorated indoors. In terms of aesthetics, the tradition of the Arab house is associated with contemporary tendencies to seek simple and natural forms that meet the requirements of the climate and contemporary aesthetics of formal minimalism.

### 2.3. The typology of contemporary threats and problems of urbanized areas

Linear cities, as ideal cities, have always been an attempt to respond to specific, pressing urban problems appearing in the existing urban layouts, generally shaped in the central form or in the polycentric scheme. The basic motivation behind designing compact development systems focused on the use of mass communication is the need to better organize the getting more and more chaotic existing urban structures in the face of the increasing urbanization of the world and to find forms of sustainable development with higher resilience to the significant challenges of the present day.

The basic contemporary threats and problems of urbanized areas, which could be solved by a linear city, include in particular:

- excessive traffic congestion,
- air pollution by car exhaust and heating with solid fuels,
- traffic accidents involving pedestrians and motor vehicles,
- failures of municipal infrastructure,
- availability of public transport,
- accessibility for residents of basic and higher-order services, jobs, green areas within a 5-minute walking distance,
- deglomeration with simultaneous concentration of buildings.

The Saudi Arabia Ruler is aware of the need to overcome the problems of random developing megacities and proposes a solution, which according to his statements could challenge the problems listed above.

## 3. RESULTS

Table 1 (below) presents the most important features of selected linear city concepts revealed in the history, which are (or could have been) inspirations for new, modern linear urban developments combined with the concept of a smart city. It also shows development toward sustainability, traffic segregation and walkability as important tasks to be solved by those ideal urban structures.

**Table 1.** List of selected design concepts of linear cities, including their most important features..

**Tabela 1.** Lista wybranych koncepcji miast linearnych wraz z ich najistotniejszymi cechami.

No	Year	Author	Concept	Country	Geometry	Realized	Walk-ability	Housing in- tegrated with transport route
1	1882	Arturo Soria y Mata	Ciudad Lineal	Spain	bent line	yes/no		no
2	1898	Ebenezer Howard	Garden City of Tomorrow	Great Britain	concentric	no/yes		no
3	1901-04	Tony Garnier	Industrial City	France	strips			no
4	1911	Edgar Hambless		USA	bent line	no		yes
5	1919	Gonzales de Castillo		Belgium	bent strip	no		no
6	1930	N.A. Miliutin	Sotsgorod	Soviet Union	bent strips	no/yes		no
7	1930	A. and L. Vesnin	Great Stalingrad	Soviet Union	bent strip			no
8		N.A. Ladovsky	Parabola City	Soviet Union	parabola	no		no
9	1944	Ludwig Hilberseimer	The New City	Germany	straight lines	no		no
10		Le Corbusier	OBUS	Algeria	bent line	no		yes
11	1956	W. Schurmann			curvature of the band			no
12	1964	Oskar Hansen	Linear Continuous System	Poland	bent strips	yes/no	10 min.	no
13	1965	Kenzo Tange	Tokyo Bay	Japan	straight lines	no		no
14	1965	C.A. Doxiadis	Dynapolis Islamabad	Pakistan	straight lines	no		no
15	1965	Peter Eisenmann Michael Graves	Jersey Corridor	USA	straight lines	no	15 min.	yes
16	2012	Paolo Soleri	The Lean Linear City	USA	bent strips	no		yes
17	2020	Gilles Gauthier	Linear City	Canada	straight line	no		yes
18	2021	Neom	Line City	Saudi Arabia	straight line	no	5 min.	no

Source: the Author

Źródło: opr. wasne

Table 1 shows that from the selected, most known cases in the history of urban planning, only a few concepts of linear cities have been realized as novel urban structures. There are many more examples of fragmented linear structures as parts of the city: boulevards (Paris, St. German), main streets (London, Regent Street), local band developments (Copenhagen, Amager). In those cases the predominant creative factor is the simplicity of geometry and equal access to

the road for many subjects grouped there. The real “linear city”, meant as the philosophical and urban structure, brings a lot more. It attempts to solve problems aroused around the existing cities over the years – both spatial and social, by creating fully new urban structures. This case is illustrated by the Line City Project.

Table 2 (below) presents *The Line* City Project in different typology contexts: on the investment scale, of functional accessibility and safety, of social context,

aesthetics and the contemporary threats and problems of urbanized areas. The clear presentation of goals to be achieved and methods to be applied reveal that the theoretical idea, well known for centuries, may be realized in *The Line* Project with great success.

**Table 2.** List of contextual evaluation of *The Line* City Project.  
**Tabela 2.** Lista oceny kontekstualnej projektu „The Line”.

	AIMS	CHARACTERISTICS/COMMENTS	EVALUATION
<b>A</b>	<b>The context of scale typology</b>		
1	Planned linear city	over dimensioned scale of the plan	-
2	Transit Oriented Development	based on high speed train line	+
3	Infrastructure corridor	linear media supply	+
4	Pedestrian zones	limited to housing groups	-
5	Pedestrian city	leading concept	+
6	Landscape context	ignored	-
<b>B</b>	<b>The context of functional accessibility and safety</b>		
1	Easy access to the transit road	limited traffic	+
2	Equal access to open landscape, to water-line	free access, but structure ignores context	-
3	Concentration of buildings between important centers	no special centers, homogenous structure	-
4	Optimal use of the means of public transport (railway lines)	e-mobility alternatives missing	-
5	Pedestrian-traffic collision free zones	limited to living estates, lack of integrity	+ -
<b>C</b>	<b>The social context</b>		
1	Egalitarianism	no class, religion, sex or rase division in a new mixed international society	+
2	Equal access to public transport	common rules of movement and communication with equal rights to public amenities	+
3	Visual and functional vicinity to the landscape and recreation areas	free visual and physical access to the surroundings and public green areas	+
4	Short distances to services and social amenities	short distances up to a 5-min walk	+
5	Equal, high standard of architecture, building equipment	architectural simplicity with innovative material and infrastructural solutions	+
<b>D</b>	<b>The aesthetic context of architecture and infrastructure</b>		
1	Simplicity of architectural forms	innovative housing and a traditional envelope	+
2	Relation of living estate architecture and the surroundings	incorporation of new architecture into the deserted landscape	+
3	Bioclimatic solution	development of traditional bioclimatic findings in modern materials and forms	+
4	Form and equipment of public/pedestrian zones and facilities	creative, friendly design of common spaces providing shade and humidity	+
<b>E</b>	<b>The contemporary threats and problems of urbanized areas</b>		
1	Excessive traffic congestion	no cars as basic transportation tools in the traditional meaning	+
2	Limited air pollution by car exhaust and heating with solid fuels	forbidden use of fossil-fuel vehicles	+
3	No traffic accidents involving pedestrians and motor vehicles	no roads with classic, diverse vehicle traffic, full segregation of traffic, automatic cars	+

4	Remote and local control of municipal infrastructure and its security	innovative management of infrastructural facilities with emergency solutions	+
5	Availability of public transport	innovative technical achievements	+
6	A 5-minute walking distance to basic and higher-order services, jobs, green areas	nesting the housing groups (modules), supported by basic service amenities and public facilities in a walkable distance, working places (including contemporary "e-nomads")	+
7	Deglomeration with simultaneous concentration of buildings	strip-based urbanization with train stop points concentration with local extensions possible	+
8	Sustainability	modern solutions of infrastructure, minimization of pollution, traffic and human congestion	+

Source: the Author  
 Źródło: opr. Autorka

#### 4. DISCUSSION

New technological achievements in various spheres of technology may become the basis for new, futuristic thinking about the city and the creation of new models of functional and spatial layouts of cities. In these models, the linear city model is one of the most attractive versions of the compositional system, which can be relatively easily subordinated to technological systems that define the clarity of the contemporary spatial form of the city.

The development of modern cities is determined by a combination of factors that have a direct impact on it. These include economic, political, natural and urban, technological, socio-cultural and demographic factors. Any idea of shaping the city of the future must take into account these factors. Only a favorable combination of all these elements influencing the possibility of shaping urban layouts in accordance with ideological assumptions can bring the expected result.

Based on the experiences of strip cities, a number of issues remain to be clarified in order to approve the case of *The Line* Project, including in particular:

- communication system (railway connections, hyperloop, metro, etc. at different speeds due to numerous stops along the route and transit traffic);
- freight transport, delivery of products for residents and for construction, renovation and infrastructure works;
- diversity and potential nuisance of workplaces, especially in the production and services sectors;
- *The Line's* connections with other cities and countries:
  - ◇ systems of roads and highways;
  - ◇ a buffer zone with car parks and transfer stations;

- ◇ airports and airport-related infrastructure;
- ◇ seaports and ferry communication;
- ◇ drone communication system, etc.;

- ground mobility within *The Line* city area, e.g. by using electric mobile devices (bicycles, e-scooters, scooters, electric cars...) that do not emit exhaust gases;
- water energy supply, sewage collection and waste treatment, as well as related water and sewage infrastructure, waste management, alternative energy sources, including electricity and methods of its storage;
- a way to maintain thermal conditions in the temperature range that enables human life and functioning throughout the year;
- a way to maintain greenery in outdoor areas exposed to excessive insulation;
- a way to ensure security in the event of terrorist attacks, war threats, and weather anomalies as a result of climate change.

There are social issues to be clarified in further investigations:

- Who would live in this city, under what conditions?
- Who is this city addressed to?
- As it has already been said, linear cities, through their egalitarianism, are an expression of social equality, homogeneity. How could such a structure exist in a country with a decidedly hierarchical social structure?

This and many other issues are the matter for further discussion in order to better understand the feasibility of this intriguing concept. The Line concept was presented in the range of only the most spectacular aspects of the planned urban layout; it obviously stimulates reflection and provokes questions on how it

would be implemented to ensure the functioning of the new city in all its aspects. It is also interesting to analyze how the experiences of a similar implementation, the city of Masdar in Abu Dhabi, could have influenced the solutions to be applied in *The Line*.

## CONCLUSIONS

The problems presented above and many others that arise when analyzing this unusual project, are probably very likely to be solved. Obviously, a lot of questions have already been defined and successfully resolved during the three-year process of developing *The Line's* construction plan. The results will be seen during the project implementation process that is just about to start.

The announced construction of a linear city in the NEOM province in Saudi Arabia stands a chance of a positive impact of all the above-mentioned factors mainly due to the way in which power is exercised in this country and the available financial resources. The physical realization of ideal cities with a geometrically defined urban composition has always required the emergence of a strong authority that could consistently implement the adopted compositional and technological large-scale urban planning assumptions. Referring to the history of architecture and urban planning, this thesis can be illustrated with many examples from the Roman times to the period of real socialism in the 20<sup>th</sup> century and up to the present day (Chinese cities, cities in the UAE).

Hence, the project of an innovative linear city based on the implementation of the latest technologies announced by Saudi Arabia seems realistic and feasible despite many open questions and problems of economic, social, technical and logistic nature.

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