

Title of paper

Layered Morphology of Gdansk: Past, Present and Future.

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Abstract.

This study aims to analyze the urban fabric and form of the city of Gdańsk based on the Muratorian and Italian school of urban morphology, to deepen the understanding of the morphological process of the urban fabric. It can be seen that the urban fabric of the city is a juxtaposition of all these layers, and based on Muratori's approach these are indicative of not just the past, present but also the future. The study sample is of the oldest areas of Gdansk that are identified to be dated from 10th to 16th Century and is known as Stare Miasto meaning Old Town. Analysis is based on the study of existing literature, historical archives, cartography and maps.

It is seen that the surroundings of the Gdansk city center have changed, and a number of elements that were destroyed were not reconstructed. Minor shifting of matrix routes and development of new poles and nodes are visible, but the primary formation of matrix route visible from the 16th Century remains constant. The research identifies that the nodes, as well as, the edges of the historic city play an integral part in the shaping the urban tissue and form. Furthermore, the river and its shape act as edges as well, and the changes in the shape of the river influence the shape of the urban form.

Keywords: Urban morphology ; Gdansk ; Muratori ; Italian school of planning typology

1 Introduction

This study of historical territorial formation is based on the tools and methodology of the Italian School of Planning Typology developed by Muratori, and his contemporaries like Caniggia or Maffei (G Cataldi, 2003; Giancarlo Cataldi et al., 2002). The research is meant to understand the process through which human settlements have formed as a consequence of spontaneous and critical consciousness, and not for the recreation of traditional building techniques. It also yields the information through which modern and contemporary cities form, and the decision-making process of man in relationship to its environment. In this regard the historical traces of the city facilitate the interpretation of its morphological and territorial changes (Maretto, 2013; Sadeghi & Li, 2019; Trisciuglio et al., 2021).

The historical city of Gdansk in Poland, offers an interesting reading and application of this methodology for two main reasons. Firstly, because the majority of application of the theories of Muratori have mostly been analyzed in cities of Southern Europe and Africa. Hence, Gdansk offers an opportunity to apply this approach in a city located in Central Europe. Secondly, the city has a complicated and interesting history, and most of its urban fabric was completely demolished after the World War 2, and then rebuilt. This offers a unique study to read the reconstruction of the routes and fabric based on critical consciousness process. Lastly, the urban fabric of the city is a juxtaposition of all these layers, and based on Muratori's approach these are indicative of not just the past, present but also the future (Maretto, 2013; Marzot, 2002), and a prediction can be made based on the formation process of the past and present on how the future city could develop.

1.1 The study area Gdansk

The major territory of Poland is considered as having a relatively flat topography, and water bodies or rivers play an integral role in the shape of human settlements. This is also evident in the environment around Gdansk, a historical city whose origins seems to date as far back as the 10th century (Śliwiński & Możejko, 2017), and archeological remains from the 12th century have also been discovered near the old city center (Możejko, 2017). The city is located close to the Baltic Sea, and the Martwa Wisła (the Dead Vistula River) that is a branch of the Vistula River. The Vistula River is one of the largest rivers of the world, and connects Poland to Central and Western Europe. Hence, trade and commercial activities are the main reasons for the initial growth and development of Gdansk, owing to its strategic location as a harbor city, and its land and water connections (Davies, 1933).

By the 14th century the city of Gdansk can be identified as a medieval town complex, that is composed of different quarters or zones like the Stare Miasto (Old Town), Głowne Miasto (Main Town), or Young Town, and the Granary Island.

From the 15th century up to the 17th century the port of Gdansk gained immense importance as 80% of corn that arrived from river transport was exported to other areas of Europe from its port. It is not until the 19th Century that with the advent of the industrial revolution and improved railway transportation system that there was a sharp decline in the use of river transport (Niemiryecz, 2018). From the 18th century onwards, the city faced wars, political upheavals and changes. Gdansk came under the rule of Prussia around the early 19th Century, then gained independence as a sovereign state in 1919. It faced strong control by German forces until 1949 when it became a part of Poland once again. A large part of the urban fabric of the historic city center was completely destroyed in the World War 2 and very little remain of the original urban tissue, and much of the areas were rebuilt again (Almeida-García et al., 2021).

1.2. Limitations and delimitations of the scope of work:

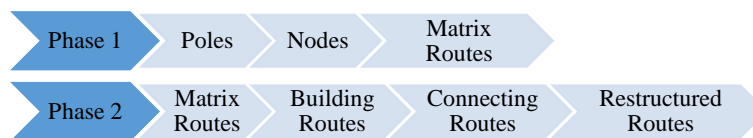
As it is the first phase of research for the city of Gdansk using Italian school of planning typology, this study begins by only analysing the oldest known areas of Gdansk as identifiable from maps and historical data. The sample area considered, appears to have been the first moment of settlement development as far back as the 10th century (Śliwiński & Możejko, 2017), and is known as Stare Miasto, meaning the 'Old Town', where archaeological remains dating from the 12th Century were also found during excavations (Możejko, 2017).

The authors are aware that socio-political and economic changes influence the morphology of cities, however, these changes are outside the scope of this work. Firstly, because the primary aim of this research is to analyse the urban form using tools of the Italian school of planning typology that comprise of the identification of poles and nodes, and formation of the routes and urban fabric around them. Secondly, a lot of time would be needed for such an extensive and detailed urban analysis and the influence of socio-political or economic factors in morphological changes to the urban tissue. These aspects could be explored in future studies once the first phase of analysis is complete. Furthermore, due to the extensive destruction of the city during the World War 2, there is no existing urban tissue of any residential neighbourhood available for detailed analysis of understanding the progress of morphological changes.

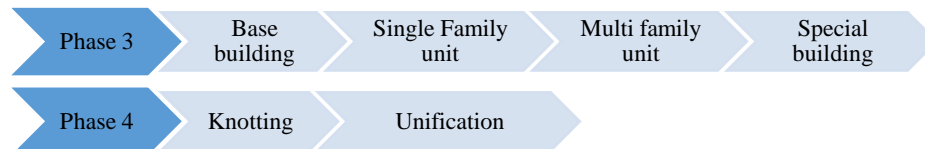
2. Methodology :

Analysis is based on the study of existing literature, historical archives, as well as, cartography and maps that show the form and plan of Gdansk from the years 1520, 1600, 1720, 1866, 1938 and 2019. The paper roots its study on the notions of *type*, *typological process*, and morphological transformation of a city in its urban fabric structure, and its two main components, namely, routes and fabrics as established in the Italian school of planning typology by Muratori, Maffei, or Cannigia (Maretto, 2013). This research focuses on the route formation and is made possible by the identification of routes based on the existence of pertinent strips that developed as the result of the formation of building lots or plots. According to Muratori, the routes come before the formation of the land parcel formation, or lots. When the land is purposely divided in a jurisdiction or municipal governance it is known as a plot. And when it is topographically divided and is a spontaneous result of human settlement it is called a lot.

The process of analysis is divided in two phases, and based on the identification of the following important elements in the language of the urban fabric:



For future studies:



The identification of each of these elements was used after understanding the concepts of terminologies as explained in the book “Interpreting basic building”(Gianfranco & Luigi, 2017) written by Gianfranco Caniggia and Luigi Maffei. The understanding for each is as follows:

2.1. Pole : A point in space which is the beginning and end of point of multiple continuous spaces or routes in the urban fabric. It can be seen as a point where multiple routes converge or originate from. The pole is greater in hierarchy than a node in urban or even territorial networks, and is considered as the “sublimation” of a node. In the base urban fabric, the pole fabric can be formed as a consequence of a base building, whereas in a special urban fabric it is formed as a result of a special building that has advanced in its formation to the extent that it has undergone the knotting process.

2.2. Node: A node is a singular point of continuation or intersection between two continuations. This could be in the form of two routes coinciding, or their axes. It can also be the point from where a connection (route) is starting while intersecting or perpendicular to it, or forming a Y-junction. It is lower in hierarchy than a Pole.

2.3. Matrix Route: This is the route formed in the first moment of the development of a human settlement, before any construction begins. It forms as a result of polarity of poles, and aims to take the shortest possible

route to connect two poles. It is seldom straight and is often visible as a curvilinear path, as it runs its course while avoiding obstacles along the way.

2.4. Building Route: This route develops in the second moment of the route formation. It precedes the matrix route, after the tissue has begun to form around it. The building route usually forms at right angles to the matrix route and in the depth of their matrices.

2.5. Connecting Route: This is the third moment of route formation, and follows after the development of building route. It connects the building routes and completes the formation of the tissue into an urban block. As the urban tissue matures along a building route, it does not grow indefinitely and instead stops growing at a point where it is feasible to provide connection and access between two parallel growing building routes. A route forms, connecting them which is known as the connecting route.

2.6. Restructured Routes: These routes are formed after the urban fabric has already matured, and when new poles have developed at a later stage, and the city deems it necessary to connect them. It is formed as a result of the demolition of existing built fabric, and develops a new fabric along its route.

3. Findings:

The analysis of the Old City area can be divided into distinct layers that depends on the formation of its edges and territorial changes: 1. medieval city and wall. 2. pre-and post-formation of the fortified wall., 3. Pre-World-War, 4. After the destruction of World War 2.

3.1. Layer 1: Medieval city and wall

The first analysis is done using the Kleoppel map made in the early 20th century, and is a reconstruction of Gdansk in the 1500. Based on this map the pole, nodes and routes have been identified (see fig. 3). It is evident that the first moment of formation of matrix route has happened along the river that flows through the city. It is along this matrix route that the first Pole (P1) is visible that is established to be a church. P1 is visibly acting as a catalyst for the further growth and development of matrix routes that connect the route network towards gates of the city walls. A total of 9 nodes are identified, of which 2 of the nodes N8 and N9, are in front of the gates to the city, and form part of the matrix route that is an extension of the territorial connection of the city with the neighbouring settlements. Furthermore, 3 Nodes (N1, N4, N5) intersect at Pole P1, and the matrix route of Node 5 extends into the building block as a building route into the dense urban fabric around P1. Interestingly Pole P1 is not located in the centre of the urban fabric and is towards the south quarter of the fabric, that is the direction in which future expansion takes place.

The fabric grows outwards from P1, in a grid like manner to form new urban tissue that connects routes towards the gates of the city. The urban fabric is denser within the space formed between the matrix routes of Nodes N1, N2, N3 and N4, simulating the formation of a block in close proximity to P1. The fabric thins out as it grows away from the pole and gets closer to the river banks, especially along the east and west sides of the river. This indicates that at later stages the urban fabric is more likely to grow towards the north and south.

Furthermore, the urban tissue has developed within the confines of the river which flows around the city, and the water acts as an edge that contains the urban growth in the first phase. The matrix route in this particular fabric also clearly divides the tissue into segments, according to their density variations. With the higher density being close to the Pole and Nodes.

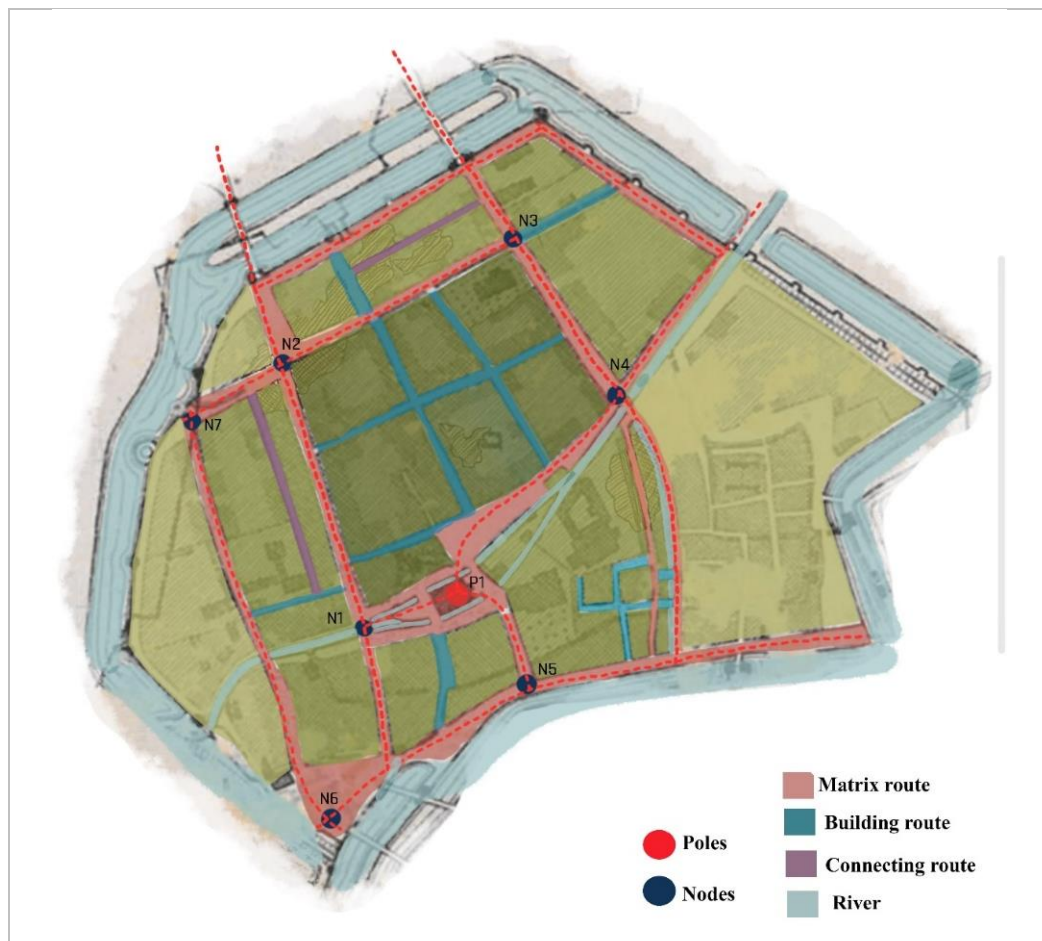


Figure 3. Analysis of Old City of Gdansk as it would have been in 1500 using the Kloepfel map.

Analysis from the Kloepfel Map of 1520 shows that towards the north and south of Pole P1 there has been rapid transformation of urban fabric, and the node N6 has evolved to become a Pole (P2), and a new Pole P3 has developed altogether between Nodes N8 and N9 that are the main gates to the city (see fig.3). This is in line with the prediction of growth that was visible in the north and south regions of the city in the 1500 c map. So, not only did the concentration of the tissue increase, but they changed the hierarchy of the routes. The nodes have been converted from points of intersection on the matrix route, into points that provide stimulus and orientation for the further growth of the urban fabric. It is pertinent to note that nodes are a continuous space along the matrix route, whereas the poles are spaces of pause that push and pull the growth of the tissue. There is a building route developing from the matrix route along the South node, which does not connect with any other matrix route, and turns back to reconnect to the point of origin. This is a very unusual, and it is likely that the existence of the river played a role in exerting a force in the shape of the route. It appears that the edges formed by the river could be the reason for this unusual loop of the building route. The connecting routes then follow a typical pattern of growth. Although an in-depth analysis of the urban fabric of building formation is not part of this research, it appears that the majority of the building tissue has developed following the conventional patterns of growth in the Old City.



Figure 4. Analysis of routes, poles and node formation of the Old City area of Gdansk as it would have been in 1520, using the Kloepfel Map.

3.2. Layer 2: The formation of new fortification wall around the Old City:

Analysis of the “Stockholm plan” from 1601, the 1688 map of Dantzig (Gdansk) by Janssonius van Waesberge (see fig.5), and 1783 map (see fig.6) by Glassbach, Carl Christian all clearly show the construction of a new fortified city wall, that has extended the city boundaries. Densification of existing and formation of new urban fabric that has expanded beyond the Old City walls and the sample area is visible. This new fortified wall also follows the shape of the existing water bodies, and enlarges and extends the river to create a moat, which acts as a natural defence system for the city.

These maps only depict the territory, edges, route systems and general of the lots, it proved challenging to analyse the urban tissue in detail. Hence, detailed analysis of the polarity and routes network could not be done for this phase, especially as the existing fabric was completely demolished in World War 2, and it proved challenging to assess it without evidences of the substrate. One significant change that is visible is that there is a matrix route following closely the formation of the Old City wall, and the increase in densification of building lots close to river banks that previously appear to be agriculture lots. Besides this there appears to be no

significant changes or development regarding formation. The edges of the new dense system now appear to define the boundaries up till which the urban fabric could expand.



Figure 5. Map of Gdansk, circa 1687-88 by Janssonius van Waesberge. Publisher Curicke, Reinhold.



Figure 6. Map showing Gdansk and neighbouring territory dating from 1783, made by the German cartographer Daniel Friedrich Sotzmann.

During the analysis of the Buhse Map from 1866(see fig. 7), it is clearly evident that the number of nodes have significantly increased to 12, and nodes N5 and N6 have lost their nodality (see fig.7), and replaced by new nodal formations (N6' and N13), while the number of Poles (P1, P2 and P3) remain the same. A new matrix route has developed connecting nodes N9, N3, N4 to the new node N6'. Along with this the route around old city of the wall is now a matrix route with new branches developing from it furthering the growth of urban fabric.

Furthermore, even though the three poles still exist, pole P1 appears to be reducing in its hierarchy as the matrix route passing through it from Node N4 has now become a building route. Meanwhile Pole P2 has gained more scale and space in the urban fabric, and the new matrix route that has replaced the old city wall, passes through this pole in a continuous loop, increasing its polarity. Changes in land use pattern are also visible, as well as, the densification of urban fabric continues parallel to the matrices of matrix routes. The majority of open land appears to be forming smaller route networks and building tissue, that is primarily of residential nature.

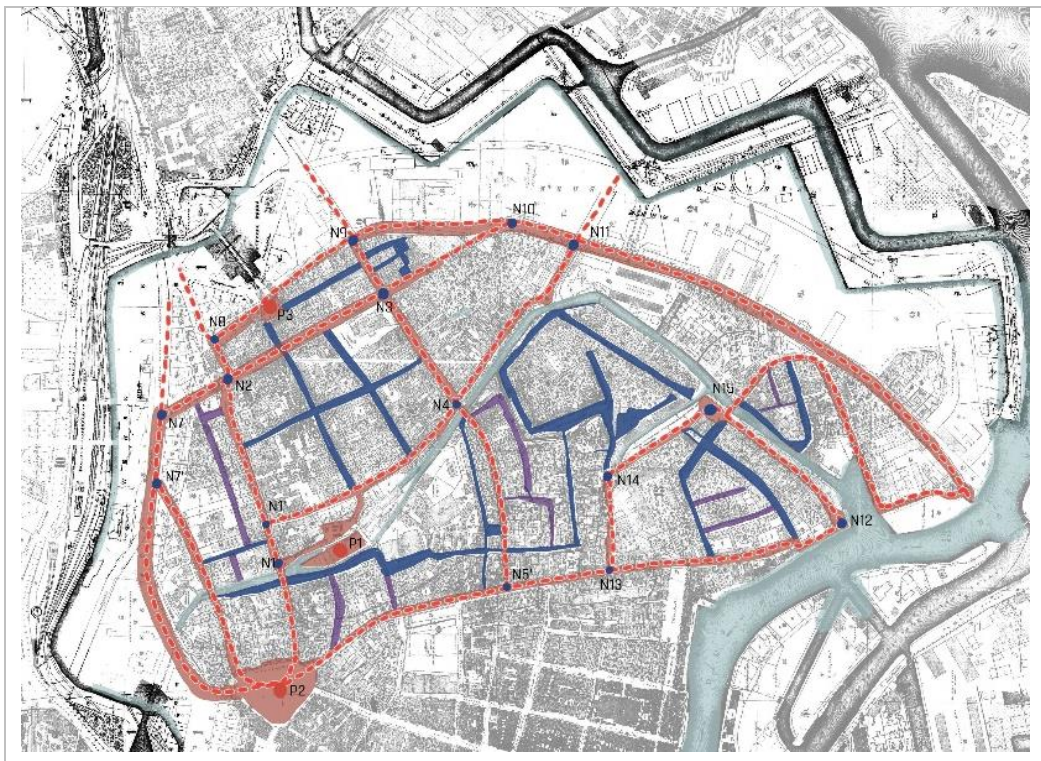


Figure 7. Analysis of pole, node and route formation in Old City (or Old Town) of Gdansk using Buhse map from 1866.

3.3. Layer 3: Pre-World War 2

This part of the analysis is undertaken using the 1938 Gelände map (see Fig.8) most significant changes are that the fortified wall has now been demolished, and Pole P2 and P3 have increased in polarity. P2 and P3 have acted as catalysts for the formation of dense urban fabric in their vicinities. Furthermore, since the development of P3 has grown in scale and part of the built tissue have become part of its space. The existing matrix routes are extending well into the periphery of the old city, and 4 matrix routes now pass through P3, making it an

important point of polarity. P3 has gained significance of polarity, to the extent that it appears to be the primary pole for the first moment of fabric generation, even though, analysis shows that it was a node that evolved to become a pole.

Node N5 visible in the 1866 map is gone, but between it and P2 the formation of a new node has continued. However, since the development of the urban tissue of this space is outside the study area, its analysis could be part for future studies. However, it can be noted that it's position next to a Pole, and along previous tissue of historical importance may not be a coincidence.

Meanwhile, the formation of urban tissue appears to follow a typical growth pattern along their building and connecting routes.

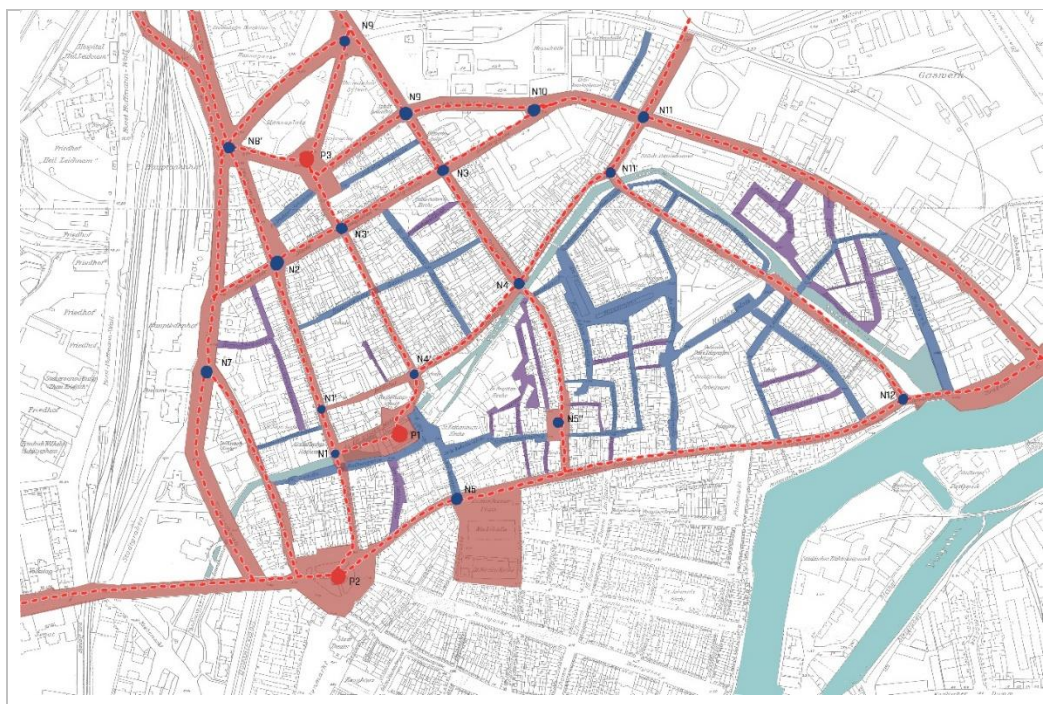


Figure 8. Analysis of pole, node and route formation using “Gelandeplan” from 1938.

3.4. Layer 4 : Post – world war 2 and the extensive damage to urban tissue

A recent map from 2021 has been used for analysis (see fig.9), and it is visible that despite the massive destruction of the urban fabric, the matrix route that began forming in 1520 and matured in 1886 still exists. It appears to develop in the similar area where the sub strata of the Old City wall exist. The matrix route begins from Pole P2 and loops around back to its point of origin. This is reflective of the circular pattern of the old city wall that is visible in 1500 and 1520 maps. Thus, it can be seen that the memory of the city wall, has remained in all the subsequent layers of the urban fabric. It appears to follow the edges where the sub-strata of the old city wall may have been. Even though the edges are no longer visible as vertical edges, but they remain constant as horizontal edges, and clearly divide the urban tissue.

The urban blocks in the fabric post-world war are no longer following the dense, compact patterns visible before. They are now scattered, and loosely composed into the urban block due to intersection of routes within this new urban fabric.

There is a significant thinning of the route network, and the building blocks have increased in size. This may be owing to increase in land value and the desire to monetize the land. There are no confined pertinent areas in the urban blocks. The urban tissue, its patterns and the visible ratio of open and built space, is not reflective of medieval cities as seen in the map of Gdansk from 1500 to 1938.

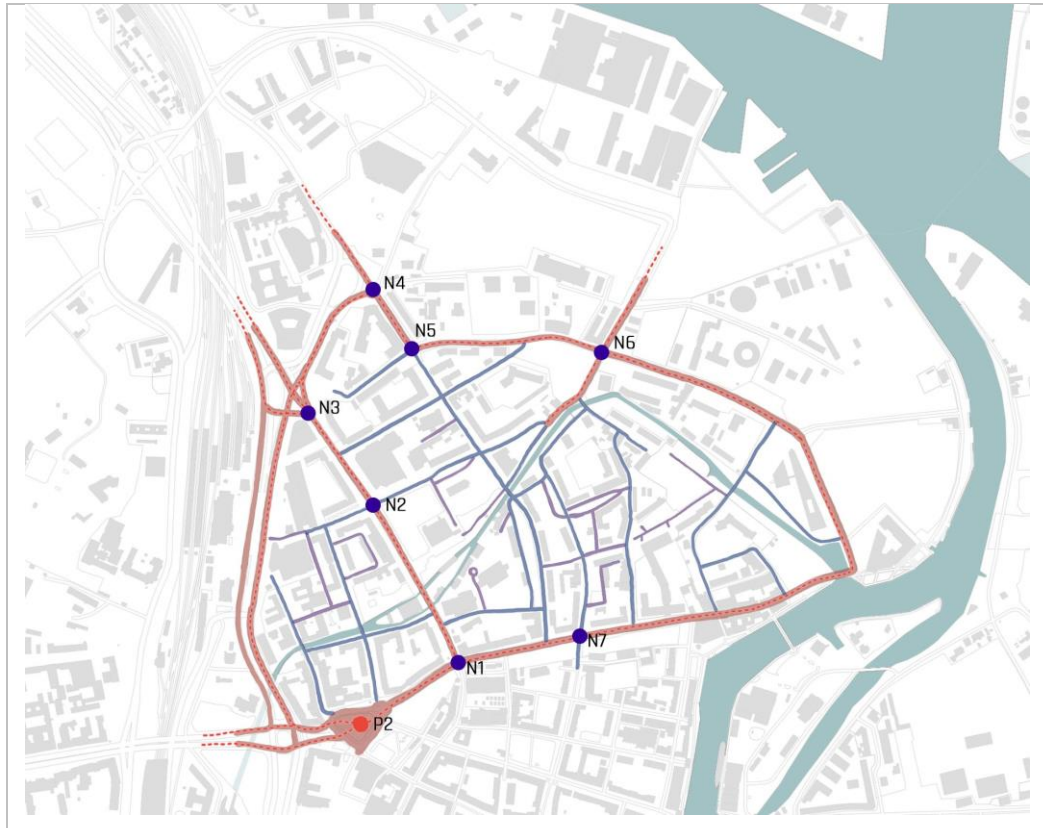


Figure 9. Analysis of pole, node and route formation using 2019 maps acquired from Municipality.

4. Discussion

It is pertinent to note that despite the massive destruction and demolition of the urban fabric, and even after the opportunity to rebuild the road network, the matrix route system remains more or less the same but with significant hierarchical changes overall, especially in building and connecting routes. It is also interesting to note that the first pole formation P1 visible in the Klooppel map of 1500 is around a church. As we know the history of cities makes evident that a neighbourhood is usually distinctly divided into sections known as quarters or districts based on their function and ethnicity. This grouping happens around important public institutions of their time period, like places of religious worship like temples, church, synagogues, or market places, etc (Mumford, 1961), and this division of sectors was visible in the formation of the urban fabric around the pole P1 in the years 1500 and 1520.

During the analysis of the Layer 3 it also became evident, that a pole (P3) can grow to such a significant size and scale that without the analysis of previous plans it would appear as a primary pole in the first moment of

fabric generation. It also identifies that a point that was hitherto a node can become a pole and gain large amount of polarity.

Furthermore, the post-war fabric of the old city is completely changed, and does not appear to carry footprints from its previous layer. Further studies and research in this regard can be undertaken to identify which of the urban tissue and fabric can be recovered. As the route network the urban fabric still retains the potential to develop in a manner that could be in line with its morphogenesis. Furthermore, the Poles P1 and P3 are completely lost, but Pole P2 has retained part of its polarity, and there is the opportunity to re-organize the space to regain its polarity and revitalize the growth process such that it follows its historical continuation to arrive at the modern form of the city. As discussed earlier, the aim is not to replicate any of the past historical features or characteristics of the urban fabric or form, but to devise a process at which we can arrive at the future form of the city's urban fabric. However, it is unfortunate that during critically conscious approach of reconstruction and renovation of the city it appears to have devalued the heritage value of the urban fabric that existed before.

It does appear though, that the edges of the old city like its walled city, and river influenced the growth and form of the urban fabric. Poles and their polarity, as well as, the edges of the old city play an integral part in the shaping the urban tissue and form of the historic city. By understanding these effects, architects and urban planners can arrive at more sustainable ideas and solutions for the future growth and development of the historic urban fabric.

5. Conclusions

1. That future urban growth could be based on the continuation of building fabric as it would have evolved respecting the sub-strata in order to keep the heritage value intact.
2. Even though, there appears to be significantly less sub-strata left, the patterns can be used to develop future growth patterns.
3. This research has used a methodology to understand the patterns of an urban fabric over the historical ages of the city. It would be beneficial to use this methodology in the analysis of different areas of the historical city of Gdansk, to identify more patterns. This will deepen the knowledge on the growth of the urban fabric that leads towards the development of Gdansk and other similar cities that have heritage value, and were massively affected by the world war 2, or other significant effects that demolished their original urban fabric.
4. Predictions can be made in the form of proposals for the development of new urban fabric, that revive the heritage value of a historic city that has lost its value due to socio-political, ecological or climatic disasters. It is evident that as a result of the layers formed on the urban fabric, and the discontinuation in its growth, it is challenging to form a straight narrative of the process. This study has attempted to do a first analysis of the routes and the network, and it would be beneficial to combine this with further analysis of the urban tissue. The identification and analysis of the development of basic buildings and special buildings, especially those who have been completely formed through the knotting process would help formulate the notion of the future urban fabric of the historical city of Gdansk, and other similar cities who have suffered a discontinuation in their formation due to catastrophes like war or natural disasters.

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