Urban Potential of the Fortified Objects of Kaunas and Alytus Fortresses According to the Space Syntax Analysis

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The article focuses on the evaluation of architectural-urban potential of military architecture in the contemporary cityscape. Kaunas and Alytus fortresses were chosen for analysis. Evaluation of the potential was performed in two steps. The first step: potential of the locations of the former fortified objects was identified. Space syntax analysis of the axial maps of Kaunas and Alytus was used as the main tool for evaluation of the potential of sites. The second step: inner structure of the objects was analyzed on the base of the maps of convex spaces. In a result attempt to identify potential significance of the fortified objects for the city or its neighborhoods was made. On the base of analysis of convex spaces the archetypical architectural patterns for the each object were named. They can be used as a background for architectural interpretation and scenario making for utilization of the analyzed objects.

Keywords: *military architecture, forts, urban potential, space syntax, Kaunas Fortress, Alytus Fortress, Lithuania.*

1. Introduction

Military architecture is a technological, historical and cultural phenomenon. In various forms it is present in all stages of urban development since the appearance of the first cities until today. The essential architectural-urban features of the code of military architecture are the following: logical asymmetry; hidden parts of the structure; labyrinth like structure, architectural demonstration of power. In different periods these features could be demonstrated in different ways but as a code or genotype they are present in all defensive objects. The above mentioned features reflect the strict technological requirements of the war and are not often met in a civil architecture. The last statement is even truer if we speak about all the mentioned features together. Because of the unique architectural-urban code the objects of military architecture have a huge meta-functional potential to become iconic, functional, natural, conventional, historical symbols of the cityscape (Zaleckis et. al. 2011). The cityscape here is understood as a combination of matterscape, mentalscape and powerscape or socioscape (Tress 2004). Fortification of Modern times because of the special architectural features can easily perform various functions of the urban green structure. Because of the relation to urban genesis fortification often can become important nodes of urban frame. Because of the character, alien to civil architecture, fortified objects can help to create mysterious, coherent, complex and legible urban environments. These features are essential for the preferred environments (DE Jung 1999). Here appears the main problem: the above mentioned unique features in the context of civil architecture not only create a distinguishing character of fortification in the contemporary urban context but make their integration into context quite problematic. Of course, there is no problem to create a museum in former fortification, but a full integration of the object or big number of the objects into urban life is a more challenging task. This task requires a systematic approach and analysis of functional but not only meta-functional possibilities of military architecture. The article focusses on analysis urban potential of forts and some other fortified objects of Kaunas and Alytus fortresses. Fortified objects as objects for analysis were chosen because of their above mentioned uniqueness and iconic meaning for the fortresses. Other elements of former fortresses, such as barracks, stations and roads, are integrated into cityscape in much easier way. Kaunas and Alytus were chosen because of the same period of fortress construction, different character of the fortified objects, different size and character of the cities. As the result conclusions should be more complex and versatile.

2. Methods

Space syntax methods (Hillier 2007) were used to evaluate the functional potential of some objects of military architecture in Kaunas and Alytus. The above mentioned choice was made because of complexity of space syntax models and possibility to apply this method at both levels of urban structure and a single object. The second argument: space syntax analyzes the environment from the point of

view of its users but not formal spatial features. During the research the axial maps of both cities were created. Location of the forts of Kaunas and Alytus fortresses within the maps was analyzed from the point of view of global integration, local integration and global depth. According to the results of analysis conclusions regarding the city and local level functions, multi-functionality and mono-functionality, everyday or more episodically uses were made. E. g.: closeness to the global integration axes suggest the functions of the city level; local integration axes offer functions related to the neighborhood centers; axes with low integration values identify more specialized object; location in shallow zones of the city identify higher level of public interests and multi-functionality while location in deeper zones – specialization and mono-functionality; etc. Structure of convex spaces of the following single typical objects of the both fortresses were analyzed: Fort No 1 in Kaunas, Battery No 1 in Kaunas, Redoubt on the right bank of Nemunas in Kaunas, Artillery ammunition depot in Panemune in Kaunas, Forts No 1a and 1b in Alytus, Fort No 4 in Alytus. Analysis was performed in the terms of depth, control, integration of the inner structure of the objects. Attempt to identify archetypical urban-architectural model or a type of the object was taken. The identified archetype or pattern can be used as a background for architectural interpretation and scenarios of usage of the analyzed objects. Names for the patterns were given by the known typical objects that can have similar structure of the convex spaces. The named patterns represent the essence of logic of possible uses of the buildings. Additional note: structure of the objects was analyzed according to the original plans. Later destructions or amendments were not considered at the moment. In such a way it was aimed to identify the original, primary potential of the fortified objects. In the following research the evaluation of the present situation and later changes will be done. Mindwalk software was used for the analysis of axial maps. Hand drawn convex maps were used for the analysis of the inner structure of the objects.

3. Short Description of Analyzed Fortresses

Genesis of Alytus is related to the wooden castle that was built to block one of the main war roads of the Crusaders to Lithuania. After the war with Napoleon in 1812 west bank of Nemunas was included into Russia and the attempts to fortify the western border of the empire were started. Processes of fortress construction became more intensive when bigger garrisons of Czars army were brought to Lithuania after the appraisals in 1831 and 1863. In the face of growing military power of Germany in 1873 Czar Alexander II created the program for fortification of the western borders. There it was planned to build or modernize fortresses in Kaunas, Demblin, Warsaw, Modlin, Osoviec, Dubno, Rovno, Luck, Brest, etc. Fortresses in Kaunas, Modlin, Brest, and Warsaw did belong to the highest first class (Яковлев 1998). Geodetic measurements and preparation of the projects stated at the same year. After Russian-Turkish war the political relations between Russia and Germany became worse. As a result decision to build

fortresses not only in the most important strategic urban points but to reinforce the most important bridges close to the border was taken. In 1883 commision chaired by Russian minister of war Vanovski decided to build additional fortifications in Alytus, Pultusk, Rozany, Ostrolenko, Lomza, Zegze. The above mentioned fortifications were made of few forts or redoubts, few permanent batteries, belts of ramparts. These fortifications as earlier mentioned big fortresses were located at the banks of big rivers, in the areas curved by small hills, valleys, streams, ravines. Fortifications in Alytus received the third (penultimate) category. Because of the construction of Kaunas Fortress beginning of the construction of fortification in Alytus started in 1887 and lasted till 1900. To the west from the city defence line made of 4 forts (one double fort) and battery was constructed on the hilly terrain (Генеральный 1887). It covered city and the forest within the Nemunas belt from the west. In the forest complex of artillery barracks was placed. Two other complexes of the barracks (Pontoon and Saratov) were built on the left bank of Nemunas (Генеральный 1887). All forts were connected by military road. At the end of the 19th century it was planned to expand and reinforce Alytus fortification but thee plans were not realized because of the reconstruction of Kaunas and Gardinas fortresses. After WW1 the forts in Alytus were abandoned, barrack were used for the needs of Lithuanian army and other needs, e. g.: industry, schools, hospitals, and living houses. After WW2 Soviet army used part of the barracks. Other buildings of the complex were demolished. Forts No 2 and 3 were destroyed during construction of industrial enterprises. Alytus as a city lacks a stronger urban identity. Unused forts and other remaining elements of the fortress can help to increase attractiveness of the city and strengthen its genius loci.

Decision to build the first class fortress in Kaunas was taken because of the huge strategic importance of the city caused by the confluence of two big rivers and important crossroads. Deep walleyes of the water streams and small rivers created relief favorable for construction of the fortification. Construction of the fortress started in 1882 and was continued till 1915 in few phases. It was planned to build 7 forts and 9 batteries according to the initial project (Обозрение 1906). Circle of the forts surrounded the city. Central rampart was constructed closer to the city center. Network of roads and railroads connected elements of the fortress. In 1889 the first stage of construction was finished. During the last decade of the 19th century the military towns with administrative buildings, orthodox churches, barracks, storage depots, workshops, and stables were built. At the same time reconstruction of the forts and other fortified objects of the fortress was conducted: brick constructions were reinforced with concrete, earth ramparts were mad thicker. In 1889 construction of the Fort No 8 was started. The reinforced concrete was used during construction for the first time in Kaunas. In 1903-1913 the Fort No 9 was constructed according to the typical project. In 1912 project of expansion of the fortress was prepared (Orlov, 2009). There it was planned to build 12 concrete forts and 9 reinforced points in the second circle of defense in the project. Attempt to implement the project was started in

1913 and continued until 1915 when the fortress was taken by German army. The biggest amount of works was done in Marva, Romainiai, Domeikava, Gelezinkelio forts. After beginning of the WW1 concrete shelters, reinforced fire positions, trenches with small hideouts were built between the forts. In 1916 German army continued construction of these objects in the northern and eastern sections of the fortress. After WW1 the fortress buildings were used for the needs of Lithuanian army and Kaunas municipality. After WW2 military towns and the biggest part of the forts were used by Soviet army. Only in the Fort No 9 the museum was established. In 1993 Soviet army abandoned its positions in Lithuania. Forts (except the Fort No 7) belong to the state or municipality but are unused and slowly destroyed by nature's forces. Despite the time and not favourable historical conditions objects of Kaunas fortress still represent an integrated system. It increases urban-architectural potential of the fortress significantly. As unique object forts can and do create identity of some neighborhoods; as regularly repeated similar objects they increase integration and legibility of the cityscape; they can become significant elements of the mental city image; they function as parts of the Nature frame; because of attractiveness and location of some objects they can become the important nodes of urban frame; etc. Despite the variety of potentials for utilization, the relatively big number of the objects (if compared to Alytus) requires versatile architectural-urban ideas of use.

4. Results

Results of the analysis of axial maps

Alytus global depth map (Fig. 1). Three clear zones could be identified in the map: central or shallow, peripheral or deep and middle or interim. All forts are located in the middle zone between the deep periphery and shallow center. AS it was described earlier, shallowness means multi-functionality, intensive and probable everyday use, common use, etc. Deepness means specialization, mono-functionality, more episodically or occasional use, special interests of the members of society, etc. Location in the middle zone of the map allows identifying the forts as potentially multifunctional but specialized objects or parts of the complexes with one dominant function.

Alytus global integration map (Fig. 2). Global integration shows reachability of the urban spaces. The most integrating space is the most reachable one from all other spaces. All forts are located on the clear edge between integrating center and periphery. It could be concluded that the forts do not have the potential to become the elements or objects of the city center. At their best they can become parts of the integrators of the neighborhoods surrounding the city center.

Alytus local integration map (Fig. 3). Local integration identifies reachability of the urban spaces from other spaces within restricted distance or number of conditional steps, e. g. number of turns or changes of direction. Local integration should be considered when pedestrian movement is modeled and the most convenient places for local centers or central streets identified. Forts No 2 and 3 are located close to the

local integration axe. Having in mind the relatively small size of the city, these forts ore their locations (the forts are practically destroyed) can become the specialized centers of local community with everyday use. Forts 1a and 1b as situated far away from the axes of local integration can perform more specialized, oriented to the special interests groups or occasional users (e. g. weekend) urban functions. Because of the relatively small size the forts should be more mono-functional then multifunctional ore make a part of bigger urban complex.
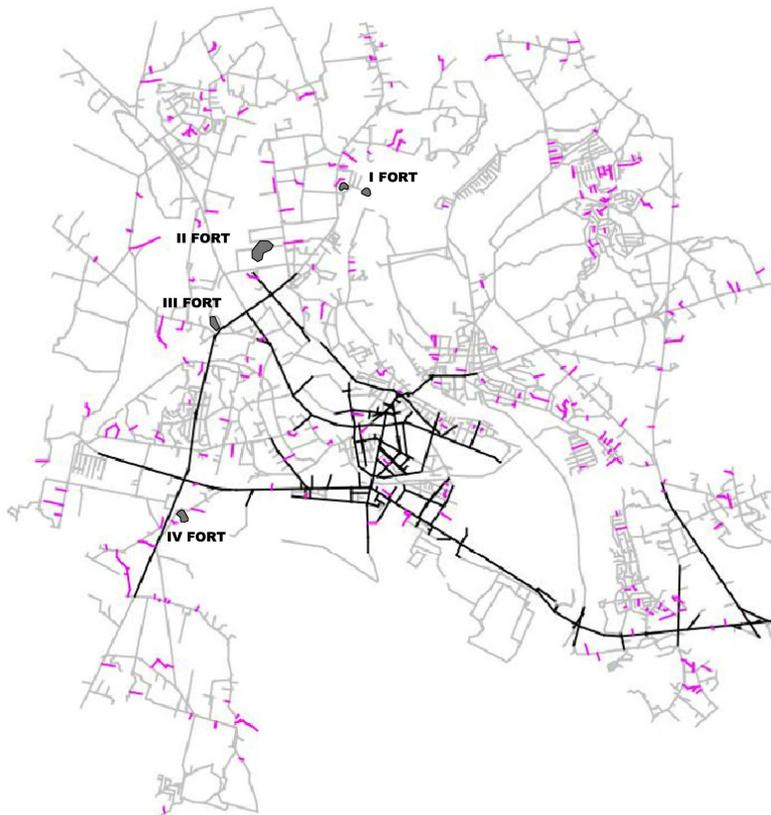
Kaunas global depth map (Fig. 4). The tree zones were identified as in Alytus and the following groups of the forts could be described: Forts No 7 and 6 located in the shallow zone of the city; partially the same is true for the Forts No 8 and 9. Shallowness of the periphery of the city around Fort No 9 corresponds quite well to the noticed reflections of peripheral city model in Kaunas. The mentioned forts have a potential to become multifunctional, intensively used objects of city importance. Forts 1, 2, 3 and 4 are located in middle zone and can perform functions of multifunctional but specialized complexes of lover social interest (e. g. just local community). All other forts or their remains (No 5, Marva, Romainiai, Domeikava, Gelezinkelio.) are located in deep periphery. These could be specialized, mono-functional objects of special interests.

Kaunas global integration map (Fig. 5). Forts No 6 and 2 are very close to the main axes of global integration of the city. Forts No 7, 8 and 9 still can have a good connection to the main integration axes. All other forts are close to the axes with low values of global integration. The results make a little correction to the above proposed identification of the city and local significance of the objects: Fort No. 2 is close to one of the main integration axes; because of its middle zone of deepness it can be a specialized objects of the city level.

Kaunas local integration map (Fig. 6). The main axes of local integration do not differ very much from the global integration axes. It could be related to the grid type structure of the street network. The higher differences in the maps of global and local integration should be expected in the tree type network of the streets. Nevertheless some medium value local integration zones besides the two main axes of Veiveriai and Savanoriai prospects could be related to the Forts No 6, 7, 8, 2. This result proves the multi-variety of the utilization possibilities and potentials of the big part of the forts in Kaunas: they can be a city level centers, local centers, specialized centers. In wider context it could be concluded that Forts No 7, 6, 8, 9, 2, 3, 4 have a complex potentials of central places if speaking in terms of Christaler (Leslie 1984). Statement of the theory of Central Places if applied to the cityscape could be formulated as following: Forts (central places) of the higher rank can perform all functions of the forts (central places) of the lower rank. Coincidence of different possibilities according to performed analysis only confirms potential of some forts as central places. At the same time we can agree that forts that are not integrated into city life (at least potentially at the moment) have a big potential for outside users, e. g. turism, recreation, etc. As a good example fort No 5 could be mentioned.

Fig. 1. *Alytus global depth map (Black color shows the 5 percent of the shallowest axes)*

Fig. 2. *Alytus global integration map (Black color shows the 5 percent of the most integrating axes)*
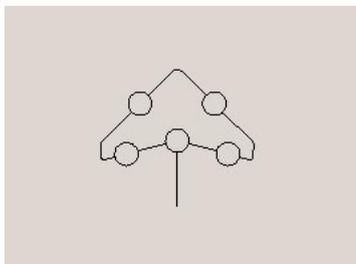
Fig. 3. *Alytus local integration map (Black color shows the 5 percent of the most integrating axes)*

Fig. 4. *Kaunas global depth map (Black color shows the 5 percent of the most shallow axes)*

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Fig. 5. Kaunas global integration map (Black color shows the 5 percent of the most integrating axes)

Fig. 6. Kaunas local integration map (Black color shows the 5 percent of the most integrating axes)

It could be stated that Forts in Alytus, according to their locations, have more potential to be transformed into specialized, more mono-functional objects of the neighborhoods or peripheral objects of special interests of the inhabitants. Locations of Kaunas forts demonstrate more diverse potentials: from central places to community centers and specialized mono-functional objects in deep periphery.

Results of the analysis of convex spaces

As it was mentioned earlier the most typical fortified objects of two fortresses were selected. Circles in the schemes represent convex spaces; lines show direct connections between the spaces. The structures of the convex spaces of the analyzed objects were classified as shallow, medium shallow/deep and deep. Shallow structure can act more as integrating mono-functional space. Deep structures can act more as a system of specialized spaces. Medium shallow/deep structures appear somewhere in between the above mentioned two types.
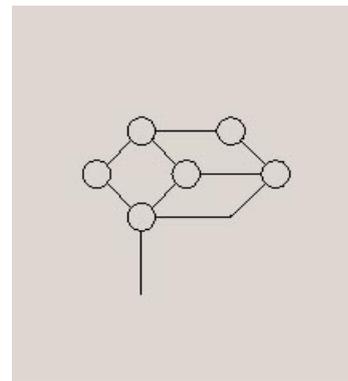

Fig. 7. *Alytus Fort No 1a*

Alytus Fort No 1a. Structure of the lined convex spaces one controlling entrance space and the only path of movement represent the "gallery or corridor type" structure. Maximal depth of the structure is equal to 2 conditional steps and it could be considered as shallow. Activities within the objects should be based on linear sequence of activities or experiences. Because of the small number of spaces (5) the fort could be perceived as a one object very easily. Because of the mentioned features the fort can act as mono-functional object of integrated activities.
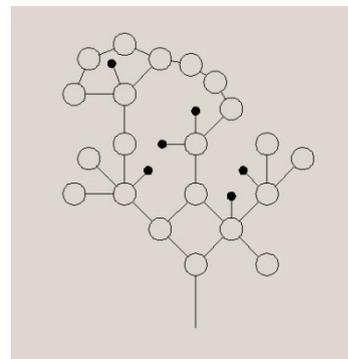

Fig. 8. *Alytus Fort No 1b*

Alytus Fort No 1b. The maximal depth of the structure is equal one and the object could be considered as shallow. Structure represents the simple "Bachelors flat" model used for outdoor spaces. Small number of the spaces creates a possibility to perceive and use the object as one integrated mono-functional convex space with autonomous sub-parts.
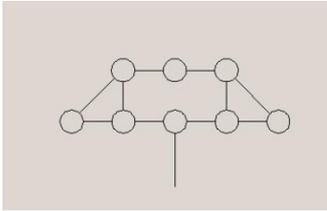

Fig. 9. *Alytus Fort No 4*

Alytus Fort No 4. The structure is simple enough, yet number of the convex spaces (6) and at least two possible ways to reach each space make this fort the most complex and allow attracting few related but autonomous activities at the same time. The type of the fort could be described as "Big family house" plus "Hide and seek" model (Hillier). The firs one means integrated but autonomous activities or experiences; the second one – potential for some unexpected, hidden activities and surprises. The maximal depth of the fort structure is 3 steps and the structure could be considered medium shallow or medium deep. This feature and the existence of alternative routes to each convex space allow identifying the fort as mono-functional with some potential for variety and specialization within the dominating function.
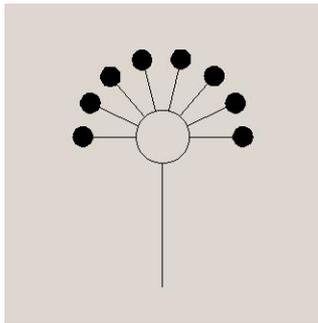

Fig. 10. *Kaunas Battery No 1*

Kaunas Battery No 1. The essential features, if comparing the objects with the above analyzed forts, are the following: relatively big number of the exterior convex spaces (21); presence of the convex spaces of interior; combination of grid, tree and line networks. The maximal depth of the structure is 6 and he battery could be considered as deep. There are at last two groups of the spaces that can function fully autonomously at the same time in the battery. Type of the objects could be identified as "Closed small town" and "hide and seek spaces". Definitely it is the most multi-functional object from all analyzed until this point. Unique feature within the analyzed context: known here and known there relation between convex spaces in four small amphitheatric sections. According to Gordon Cullen (Cullen 2007) there could be two types of relations between visual spaces: here is always known, and there

could be either known or unknown. The first relation is more presented in regular, open, integrated spatial structure, the second one – in labyrinth like, fragmented, not legible structures. Appearance of known here and known there relation between convex spaces enables to use them as a kind of theater, especially when more than one known there are connected to one known here as it is in the battery.
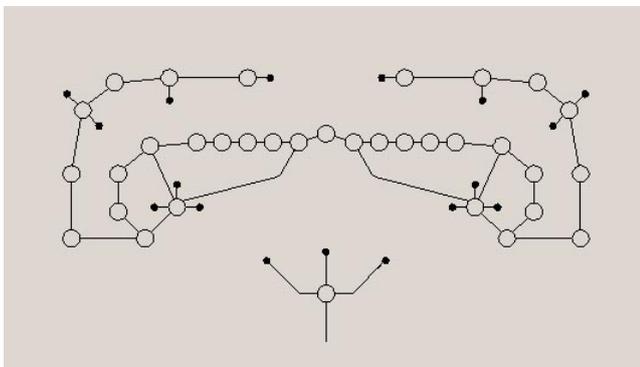

Fig. 11. Kaunas redoubt

Kaunas Redoubt. Structure is similar to the Fort No 1a in Alytus except the additional alternative links between convex spaces presented here. Model could be identified as "Gallery with storage spaces or control rooms". Maximal depth of the structure is 3 steps. Some variety of the functions is possible in the redoubt.

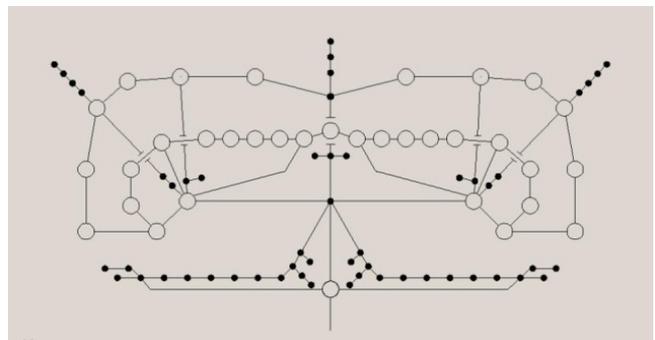*Fig. 12. Kaunas artillery ammunition depot*

Kaunas artillery ammunition depot. One central open space with 8 entrances to autonomous indoor convex spaces is represented in the scheme. Depth of the structure is 1 step. Model could be named "City market square".

Fig. 13. Kaunas Fort No 1

Kaunas Fort No 1. Hierarchical convex structure with three controlling dominant big spaces could be seen in the schema. The maximal depth of the structure is 10 steps and it is very deep. If the interior spaces are market

just as entrances, we can see three totally autonomous zones of the fort. Two inner zones have the structure of the "amphitheatric theatre". They are made of central integrating spaces with backstage exits and surrounded by the spaces of the "seats". Here the same feature as in Battery No 1 should be pointed out: amphitheatric central space is connected to 9 surrounding smaller spaces as "known here and known there". The entrance space has a little limited code of town square. When the Soviet changes in the Fort No 1 were made (windows of the barracks were changed by the doors) the pattern of town square was realized in a full scale. Unique feature of the fort could be seen in the second scheme where exterior and interior convex spaces are shown together: all transit spaces with the highest control values are indoor spaces. It means that communication between the autonomous outdoor zones of the fort is assurer because of the closed indoor spaces. If such an inside-out pattern would be applied in the park design it would mean that communication between open green spaces would be assured by the underground tunnels. It's a very rare urban-architectural code and it can be met in the constructions or pre-Columbian Huari civilization. Reconstruction of the palace in Pikillacta (sector 1) in South America is shown in the picture. The same inside-out code could be easily identified: spaces of courtyards are connected by the roofed corridors. Indoor spaces serve as transit spaces in this case. Similar code at the scale of smaller object was presented in Roman Coliseum as well: underground passages and tunnels led to open arena there.

Fig. 14. Kaunas Fort No 1 (with shown interior spaces)

Important note: inside-out pattern is not a peculiarity of all fortifications. The earlier redoubt forts had no posterns; the later armored forts put all fire positions and communication spaces underground. In both cases the inside-out code cannot be seen and it is a unique attractive feature of the forts of the analyzed period. The analyzed fort could be named „inside-out congress center with representative square in front" or „Coliseum". Its unique features make it very important actor in creation of mysterious and complex preferred environment. Because of the unique conditions for a serial vision of the convex spaces of the fort it could be more vividly reflected in the long term memory and thus become enlarged in the mentalscape of the city.

General note for the all analyzed structures: they all are closed and can act as autonomous objects in any environment. Demonstrated variety of architectural archetypes-patterns creates a big potential for diverse uses.
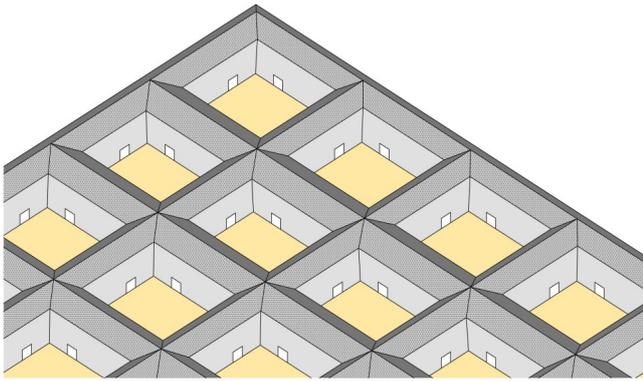
Fig. 15. *Pikillacta, reconstruction of sector 1 (Gordon, 2005)*

5. Discussion

Military architecture represents a unique architectural an urban phenomenon: unique because of its own spatial features and potential for contemporary use. Despite the above mentioned fact investigation of the military architecture is focused on its inventorization and history. Analysis of its utilization possibilities is very often neglected. Earlier authors of this article have performed analysis of urban potential of former fortification of Kaunas fortress. Traditional analysis of urban situation was used there. The research performed now for the first time applies space syntax models in analysis of military architecture. The most important fact is that space syntax analysis was used to evaluate location of the former fortification in the city and inner structure of the objects. As a result the first attempt to describe archetypical patterns of inner structure of the analyzed objects was made. The significance of the results of the performed research is not limited just by Lithuanian context.

6. Conclusions

Forts of Alytus Fortress are located on the edge between city center and periphery. They have potential to become objects of multi-functional specialized local centers of the neighborhoods.

Forts of Kaunas fortress are located in various places of the city. Part of the forts has a potential to become multi-functional central places of the city. The forts from urban periphery are not integrated into city life but can become attraction points for the tourists and objects of recreation.

Convex analysis revealed the following patterns of the fortified objects of the fortresses: gallery, flat, family hose, town, town square, congress complex, etc.

Analysis of location and architectural codes reveals the huge and various potential of usage of the analyzed fortified objects.

In many cases the fortified objects can help to preserve or create urban identity of the place at the city or local level. The unique architectural features of the analyzed objects can help to create preferred urban environment.

7. Acknowledgements

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