

## **Organic Transportation Networks: Human-Oriented Renewal of Modern Megapolises**

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### **Abstract**

Studies related to the growth of the transportation networks from the second half of the 20th century have constantly been focused on the topological complexity of motorized & public transportation network (internal geometry & dynamics, occupied space, and geographical settings), or the structural properties (complexity of network structure). However, those studies have failed to incorporate the concept of an integrated public-soft transportation network, and the human-oriented transportation system, and its structural elements: soft transportation network, accessible nodes called Transit-Oriented Developments (TODs), healthy neighborhoods and, most importantly, its attributes. Additionally, the relative location (urban geographical settings) haven't been conceptualized in their models.

In this paper, the ontological frameworks of an integrated public-soft transportation network and human-oriented transportation system will be proposed. Secondly, the attributes of those networks will be determined by comparing the integrated public-soft transportation network in Finland (Helsinki) with ordinary one in Italy (Rome) through the human-oriented transportation system framework. Thirdly, the applicability of the concept of human-oriented transportation system in Bozcaada (Tenedos) Island will be discussed. Thus, a new conceptual model of the human oriented transportation system will be proposed.

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### **Keywords**

*human-oriented transportation system, organic transportation approach, logical categories, integrated public-soft transportation network, socio-ecological system*

## **1. Introduction**

Major studies during second half of the twentieth century have been focused on the public transportation network conceptualization in accordance with topological complexity or network structure (Xie & Levinson, 2007). However, it is easy to trace among those studies that only economic sphere of sustainability was incorporated into the research. Environmental and social sphere were never utilized to represent the ontological complexity of transportation networks (Xie & Levinson, 2007). Not to mention that from the standard elements of organic city and transportation policy only physical regulations were incorporated directly into the analysis mode of transport networks (Ustundag, 2012, pp. 2-9). In other words, only standardized car and rail dominant contexts that encompass economical and

technological dimensions were studied (Xie & Levinson, 2007), (Ustundag, 2012, pp. 2-9). Considering the fact that those studies weren't subjected to the criticism in this direction this work would be a first to advertise the urgency of reconceptualizing the transportation network as a ontological framework.

To provide a fundament for a building the ontological framework for transportation system corresponding to the needs of sustainable megalopolises. After a major drawbacks and strong points of each ontological representation to define the crucial processes and outcomes in the specific context will be explained, the integrated public- soft transportation network concept (Galychyn & Ustundag, 2017) will be developed in accordance with the spatial transformations (Lehmann, 2015, pp. 10000–10006). Then, an integrated public-soft transportation network concept will be linked to a sustainability concept (Lehmann, 2015, pp. 10000–10006) and organic transportation approach (Ustundag, 2012, pp. 2-9), (Galychyn & Ustundag, 2017) to introduce a human-oriented transportation system framework . The case studies of Helsinki&Rome will allow to determine the type of each system: public-soft transportation network or motorized transportation network and to assume about how an integrated public-soft transportation network concept can be developed in these settings. Lastly, the human oriented transportation system ontology will be tested on Bozcaada (Tenedos) Island, an extraordinary case due to low population&density, tourism-oriented specialization and the presence of exogenous influences (climate and hydrology) (South Marmara Development Agency, 2012). Thus, a new ontological framework for the human-oriented renewal of modern megalopolises will be developed.

## **2. Criticism of five main streams of studies aimed on modeling transportation network growth**

### **2.1. Geography of transportation networks**

The criticism of the studies that introduced a transportation network as a research object within the geographical settings(1962-1969) is attributed to the Haggett&Chorley (1969) (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014). However, they failed to detect any foundations of the sustainability, not to mention any elements of organic transportation policy in the observed motorized network with the simplest topology like in the models of the Taaffe (1963), Lachene (1965), Pred.(1966) and Rimmer (1967) (Tolley & Turton, 2016). To put it simply, those models don't include anything except the topology and basic geographical constraints that undermine the last phase of the network development. The simplification of links and nodes to the level of scheme of physical circuits left out of study focus the dynamic network attributes, built environment, and external geography (Tolley & Turton, 2016), (Cartwright, 2012, pp. 1-14). In addition, the studies in this stream have focused on the regional transportation network as a main object of analysis leaving of range large scaled urban transportation networks (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014), (Tolley & Turton, 2016). As this assumption was confirmed below, network is more complex than a basic topology (simple evolution of geometrical shape evolving in accordance with basic geographical constraints) on basis of which was evaluated along the historical pattern. Therefore, networks created during this movement fail to address the complexity of all scales that form a complex&sustainable transportation system: geography (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014), (Tolley & Turton, 2016), regional economy (Sasaki, Ohashi & Ando, 1997), sustainability (Lehmann, 2015) and organic city&transportation policy scales (Ustundag, 2012, pp. 2-9), (Galychyn & Ustundag, 2017). Moreover, it's only possible to identify settlements as elements of regional railroad system (Tolley & Turton, 2016). Lastly, network is a part of more complex and a wide concept-system (Newman, 2011, pp. 800-810), (Bagliani & Dansero, 2011). To create at least a basic concept of systems all elements and their attributes should be known in order identify their functions, methods to extend life cycle, and possible drawbacks that undermined not only the operational but also the network's pattern.

### **2.2. Optimization and design of networks (1970-1987)**

The second scientific movement that lasted for a longer time was focused on economic dimension of transportation networks (Xie & Levinson, 2007) summarized that this scientific direction was aimed to predict traffic flows (outcome of processes) in realistic way by designing an optimal demand forecasting models, such as studies of Newell (1980) and Vaughan (1987) (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014). Those models were shifted from regional space to the urban area. Namely, first urban transportation planning models have been entered a stage. This

is the first step into the direction of organic transportation networks, which are urban transportation networks (Galychyn & Ustundag, 2017). Moreover, those models were based on social data (human behavior and needs)-main generators of demand. However, the both physical and social data are required for successful integration of soft modes to the public transportation system (Ustundag, 2012), (Galychyn & Ustundag, 2017). Social sustainability represent multi- dimensional social networks that must correspond to the socially optimum decision elaborated by an organic unit (by means of Kaleidoscopic Method) (Galychyn & Ustundag, 2017), (Costa Lobo & Ustundag, 2007) to generate optimal design (combination of spatial&physical regulations) narrowed by social constraints: standard of living (physical regulations) (Tokyo Metropolitan Government, 2007), education and training (Thorne-Lyman, Wood & Zimbabwe, 2011), community (public participation) (Galychyn & Ustundag, 2017), (Bagliani & Dansero, 2011) and equal opportunity (spatial regulations) (Galychyn & Ustundag, 2017). Although many criticism was addressed to the actors involved into the network growth process, (McGinnis & Ostrom, 2014), (Tolley & Turton, 2016), a critics never been mentioned that even with the fully-developed public participation mechanism the basic level of sustainability would be unreachable.

### **2.3. Stastistical analysis of the network growth (1975-present)**

This stream has been aimed to calibrate the optimization models to investigate in change in the supply based on the accumulated GIS data (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014). At the beginning the authors were trying to use transit demand as an impute data like Gaudry (1975), Alperovich et al. (1977), Peng et al. (1997) and Taylor & Miller (2003) (Xie & Levinson, 2007). Although, the generated demand models had been more accurate in comparison to the optimization stream, the major problems indicated above hadn't been taken into consideration. However, according to that Xie & Levinson (2007) the recent studies such as Levinson& Chen (2005), Levinson & Chen (2007), Levinson (2007) were based on mutual causality between a transportation network and diversity (mix of land uses) (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014). Those works haven't touched sustainable design and broader settings in which the processes associated with public & soft transportation network development can be identified ( sprawl, integration, perception, optimization and management & maintenance) like the socio-ecological system (Bagliani & Dansero, 2011).

### **2.4. Economics of network growth (1996-present)**

This stream can be separated two aspects of economics (transportation economics and fiscal federalism) in the same way as it has been done by Levinson (2007) (Xie & Levinson, 2007). Due to similar nature of those aspects, it was decided to merge them for the purpose of more sophisticated analysis. In the same way as the previous stream this scientific movement have limited to the economic feasibility of the network structure with a regard to the space occupied by a transportation network and its geography (related ecosystems) (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014), (Tolley & Turton, 2016). In the same time, the first-tier category: management& governance on the local level has entered a stage with work of Knight (2002), and Humplick & Moini- Araghi (1996a,b) (Xie & Levinson, 2007). In this context, an ownership structure as an attribute of the management&governance (Galychyn & Ustundag, 2017), (Steffen, 2010, pp. 4-9), (Carvero & Kockelman, 1997). This means that the transportation network became the input-and-output from the governance system. However, it can be argued that it's without all elements and attributes ready available for the analysis it's impossible to evaluate the change in a state of the network in accordance with the governance model instead of a jurisdiction-centered political economy (mixed-use transportation system of ownership forms) (Galychyn & Ustundag, 2017), (Steffen, 2010, pp. 4-9), (Carvero & Kockelman, 1997) such as works of Levinson et al. (2007), Montes de Oca&Levinson (2006). Those studies simply indicate a causal relationship between jurisdiction (ownership) and supply (provision) (Xie & Levinson, 2007). The way other economical properties such as network effect, path dependence, and jurisdictional organization influence the network structure still hasn't been proven yet despite being an important factor to the network growth (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014), (McGinnis & Ostrom, 2014). The last observed attribute in this stream was already mentioned before as it was underpinned by economic dimension of the network growth (Xie & Levinson, 2007), (Rodrigue, Comtois & Slack, 2017). In addition, the studies of Jackson & Wolinsky (1996), and Marini (2007) imply that path dependence issue has been introduced in this stream. The diversity (jurisdictional control) was the

primary attribute of spatial dimension (Galychyn & Ustundag, 2017), (Bagliani & Dansero, 2011), (Carvero & Kockelman, 1997, pp. 199-2019), the other attributes ( network effect and path dependence) have simply referred to the economical feasibility without understanding their true empirical value (Xie & Levinson, 2007), (Bagliani & Dansero, 2011), (Rodrigue, Comtois & Slack, 2017). Particularly, the network effect was the primary attribute of the economic dimension of sustainability (Xie & Levinson, 2007), (Bagliani & Dansero, 2011), (Rodrigue, Comtois & Slack, 2017) since the transportation geography.

## **2.5. The network science (2002-present)**

This is the last stream, dedicated to the study of the complex systems, namely power-law distribution that occurred in the biological, social and technological “scale-free” networks (Barthélemy, 2011). This stream signifies the concluding phase of exploration of network structure. Topological attribute called hierarchy of nodes have been finally proved by network science (Barabási & Albert, 1999) (Xie & Levinson, 2007). However, later was discovered that a 'preferential attachment' can be applied only to the vaguely defined and delimited transportation networks, without self-organization mechanism (Barthélemy, 2011), (Batty, 2009). In other words, it can't be applied to the surface transportation network due to existence of strong geographical constraints (Csanyi & Szendrői, 2004) and those networks exhibit distinct structure (Gastner & Newman, 2006). Only urban street (Jiang, 2007) and subway networks were found to be scale-free, or separated from geography (Derrible & Kennedy, 2010) (Barthélemy, 2011), (Batty, 2009). Barthélemy (2010) has summarized effects of spatial constraints on structural properties of network (degree distribution, betweenness centrality, hub and spoke structure, and closeness) (Barthélemy, 2011), (Kujala, 2016) - the effect that all transportation geographers had failed to explain despite being modeled and named by them (Xie & Levinson, 2007), (McGinnis & Ostrom, 2014), (Tolley & Turton, 2016). It can be argued that a density, agglomeration, hierarchy of node and links (and traffic flows attributed to them) would be the same properties supplied by theoretical meaning (Xie & Levinson, 2007), (Tolley & Turton, 2016), (Barthélemy, 2011), (Kujala, 2016). To put it simply, a spatial effect measured quantitatively without any meaning attached to it. How those effects influence an evolution of the transportation network still remain a mystery, especially, in the theoretical plain (Barthélemy, 2011), (Batty, 2009). Those constraints is only one of the spatial attributes (density, diversity and design) (Carvero & Kockelman, 1997, pp. 199-209), (Rodrigue, Comtois & Slack, 2017) that characterize socio-ecological system (McGinnis & Ostrom, 2014), (Bagliani & Dansero, 2011) - the system that contains the transportation network, the subsystem influenced by its operation. In other words, the structure urban transportation network, its function and an exogenous influences from the related ecological systems (McGinnis & Ostrom, 2014) and broader socio-economical context (McGinnis & Ostrom, 2014) as well as to predict outcomes of these interaction haven't been observed outside of complex science.

## **3. Back To The Future: Integrated Public-Soft Transportation Network And Human-Oriented Transportation System**

The summarized attributes of the transportation networks during the review of previous streams will be linked to the related systems mentioned before (that influence transportation networks and ultimately been influenced by them) (McGinnis & Ostrom, 2014) to finalize ontologies. Additionally, the physical transformation of space requires both the the design of surface urban landscape: artificial landscape corridors (pedestrian-oriented design (Galychyn & Ustundag, 2017), (Puget Sound Regional Council, 2014)) and the fragmented patch areas of different sizes ( TOD nodes (Calimente, 2012) and healthy neighborhoods (Calimente, 2012)) surrounded by artificial urban matrix, and the underground urban landscape ( metropolcenter) - multifunctional underground complex of transport and pedestrian facilities at different levels centered around the subway station (Popov & Siganchin, 2019) (patch of artificial area), and spatially linked with the upper level, or station entrance on the surface (patch of artificial area) . The structure of healthy neighborhoods includes the following elements: micro-district (landscape matrix) defined by mix of affordable housing of octagonal blocks chambered in the corners that shared among residents ( artificial patch area) and the area where local materials are recycled and clear water utilized, danish method of capturing energy in organic waster streams (patch of natural areas) separated by low volume streets with only soft transportation modes allowed (landscape corridor) (Galychyn & Ustundag, 2017).



pedestrian-oriented design (Galychyn & Ustundag, 2017), (Puget Sound Regional Council, 2014). The aim is to transform sprawling area into the compact area (Carvero & Kockelman, 1997, pp. 199-209), and simultaneously to optimize design and pattern of bicycle & pedestrian paths (Galychyn & Ustundag, 2017), (Bagliani & Dansero, 2011), 22 within the socio-ecological system (Lehmann, 2015), (Bagliani & Dansero, 2011). The optimization procedure of design and pattern of bicycle follows the specific procedure characterized by the social transformation of bicycle. Public bicycles are simple in design and produced from the local materials, namely old bicycles within community; therefore, complicated security systems like utilized in gated communities aren't required (Galychyn & Ustundag, 2017). The security costs are borne by local government (Abe-Kudo, 2007), and together with a cheap locally-produced bicycle can generate a decision in favor of the gates and fences to detect intruder (Grant & Mittelsteadt, 2004). During the second stage the logical relationships change due to the addition of these terms. The changes occur during the first stage, and the attributes refer to properties that emerge on the upper level of aggregation depend on the distance relative to the other attributes, nature of scale (Mirkin, 2005), and hierarchy of nodes and links (dash type) (Barthélemy, 2011), node centrality (Barthélemy, 2011), (Kujala, 2016) and other typical topological attributes (Rodrigue, Comtois & Slack, 2017). The integrated public-soft transportation network concept consists of three structural elements: scales, nodes (attributes) and links (relative distances). The scales are labeled as the upper-tier attributes while the nodes are referred to as the second-tier attributes surrounded by the lower tiers (features of second-tier attributes). Therefore, the second tiers undergo physical and social transformations due to the change of the characteristics of their attributes and connections between them as well as under exogenous and endogenous influences (Bagliani & Dansero, 2011). Each of the nodes ( second tiers) the network connects to a group of interrelated nodes (third-tiers). Some of the second-tiers are the central nodes in their respective scales. These node affect more the third-tiers within their scales than the third-tiers that belong to the other scales. The same rule applies to the relationships between the third tiers of one scale and the central nodes (one per scale) of the other scales. In other words, the secondary nodes are fully dependent on central node oaf the same scale and less dependent on the central node of the neighboring scale (Bagliani & Dansero, 2011), (Barthélemy, 2011), (Mirkin, 2005).

The next stage of the network growth is aimed to fully transform a motorized transportation network (Ustundag, 2012) to the organic one (Figure 2).

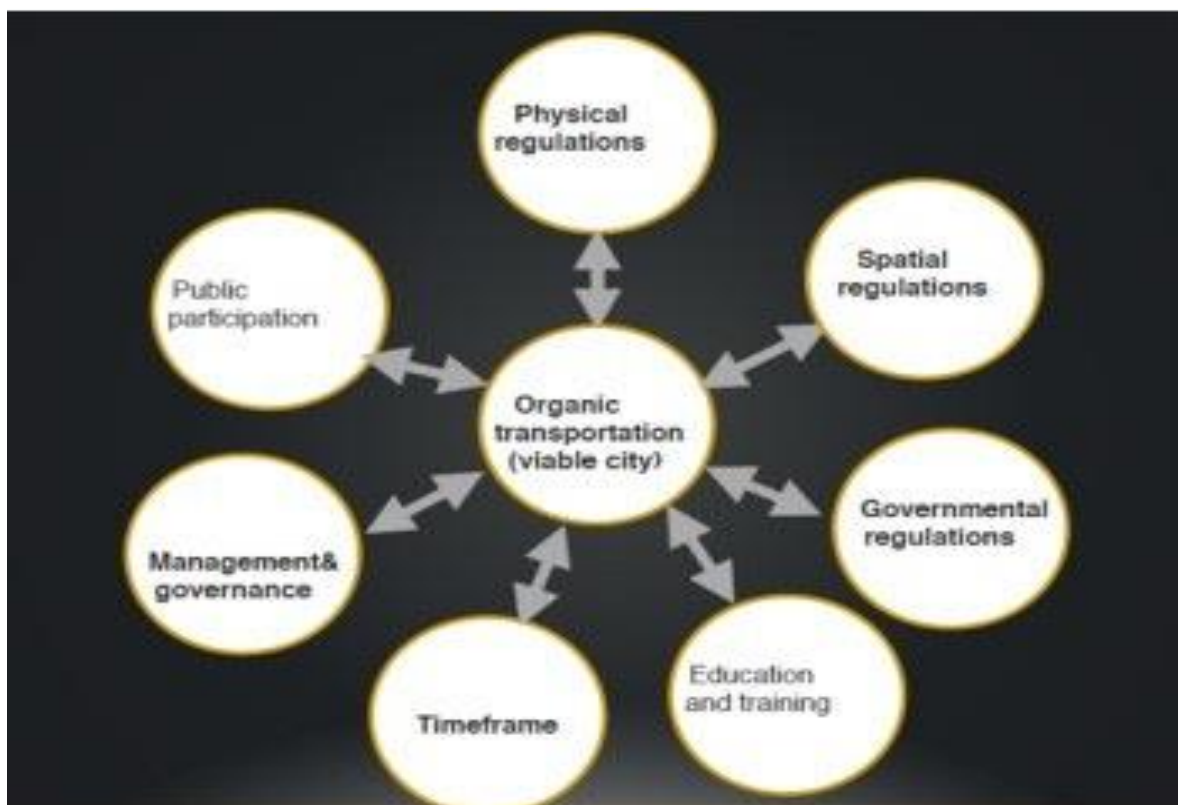


Figure 2. Standard elements of Organic City&transportation policy

The title indicates a transition from market-oriented transportation to human world (Ustundag, 2012), (Galychyn & Ustundag, 2017). Here more scales and nodes are added to the integrated public-soft transportation network concept. Here TODs (second-tiers) and healthy neighborhood (second-tiers) that both input and output of the endogenous socio-economical process that realized in the scope of these nodes (second-tiers) (McGinnis & Ostrom, 2014): 1) the education and training of staff in the related businesses (TODs) and the TOD residents on joint initiatives such as greening of TOD space (production of nursery trees) (Bagliani & Dansero, 2011) 2) voluntary activities of private companies to provide affordable housing for businesses through BOT transfer to enhance ownership structure and management&maintenance of TOD; 3) improvement of regulations regarding the access of healthy communities within TOD: a) BRT equipped with bike rack service between TODs (Galychyn & Ustundag, 2017) connecting healthy neighborhoods along the way or by metro till the center of TODs, pedestrian paths (300 m till the public bicycle station) designated for anyone to buy one-way tickets, weekly or monthly passes from the station kiosk or beforehand online system on public bicycle authority online to use any of the bicycles available within city . Economy of energy resources (economical &ecological scales) (Galychyn & Ustundag, 2017), (Codoban & Kennedy, 2008) and time savings (social scale) as well as a preservation of historical heritage in the central part of the city (built environment scale) are the most noticeable advantages of TOD.

The TOD like any other governance system defines the rules for actors that act within its boundaries (Galychyn & Ustundag, 2017). For instance, each pass can be utilized in any of the TODs within a city without any restrictions. Management&governance of TOD is effectuated by organic unit, namely by the agents of local administration, scientists, planners and residents (Galychyn & Ustundag, 2017), (Costa Lobo & Ustundag, 2007) during a meeting at community center. Each TOD include single organic unit is a countermeasure against the social conflicts caused by social separation or/and environmental degradation within TOD (Calimente, 2012) . The organic unit manages services and security within TODs. This unit also has an authority to devise rules for administrations of healthy neighborhoods (management office of private companies). Each healthy community has its own administration that perform the same function as organic unit (Galychyn & Ustundag, 2017),. In this case an issue about TOD as a uniform system arises. The TOD not only a single tiers category but also one of the numerous a heterogeneous socio-ecological communities surrounded by the artificial urban landscape (McGinnis & Ostrom, 2014), (Galychyn & Ustundag, 2017). The healthy community, unlike the TOD, can have the the natural or artificial patch in the geometric center (Galychyn & Ustundag, 2017). It can be autonomous governance system (McGinnis & Ostrom, 2014) or be a margin, a transitional zone between the closest TODs, that is more dense and mixed in terms of social status, ownership, nationality and age (McGinnis & Ostrom, 2014). The distance and mode of transportation makes a difference, especially for the residents of the healthy neighborhoods. Subway - bicycle/walking option is much better than BRT-bicycle/walking because of overall decrease in distance, pollution, crashes, and deficit of space for housing, business and recreational spaces (Galychyn & Ustundag, 2017). Compactness indicators will improve quickly if healthy communities will be formed from each 3-4 affordable residential groups (Galychyn & Ustundag, 2017) within TOD not to mention more optimized pattern for waste disposal and energy accumulation within every community (Codoban & Kennedy, 2008).

The education&training scale is added to develop a cooperation between residents and private developers&related businesses on the affordable housing projects. The cooperation will produce the following results: 1) the reduction of a social and physical separation between TODs residents and an outer city (Grant & Mittelsteadt, 2004), (Abe-Kudo, 2007) to facilitate transition towards mixed -use of housing types, prices and ownership forms within healthy neighborhoods (Steffen, 2010, pp. 4-9). 2) establishment of a fundraising scheme for social and physical infrastructure and facilities (Tokyo Metropolitan Government, 2007) not only to maintain current infrastructure but also to periodically enhance the remote facilities accordance with a density, diversity, design parameters and compactness indicators (Carvero & Kockelman, 1997, pp. 199-209) as well as social design such as access for disable, walking&cycling space, pollution and safety control (Thorne-Lyman, Wood & Zimbabwe, 2011, pp. 54-57), (Bagliani & Dansero, 2011).

After the governance model at the community level was explained, the governance model at the level of urban system2 will be described (Figure 3 & Figure 4).

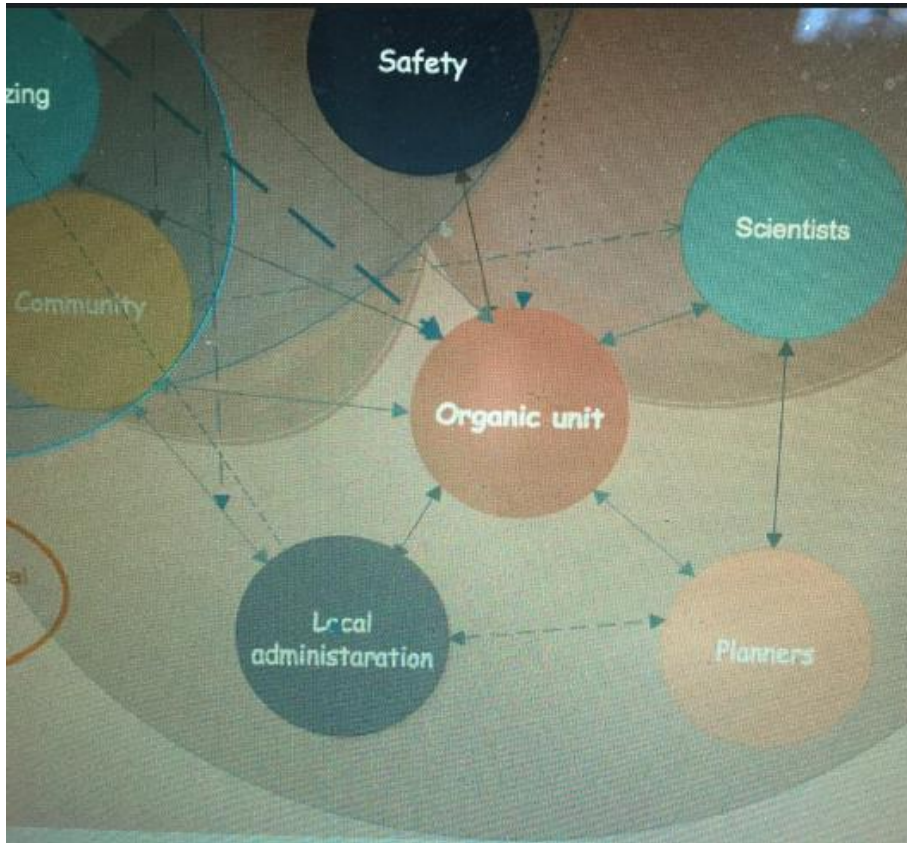


Figure 3. Local public participation (TOD)

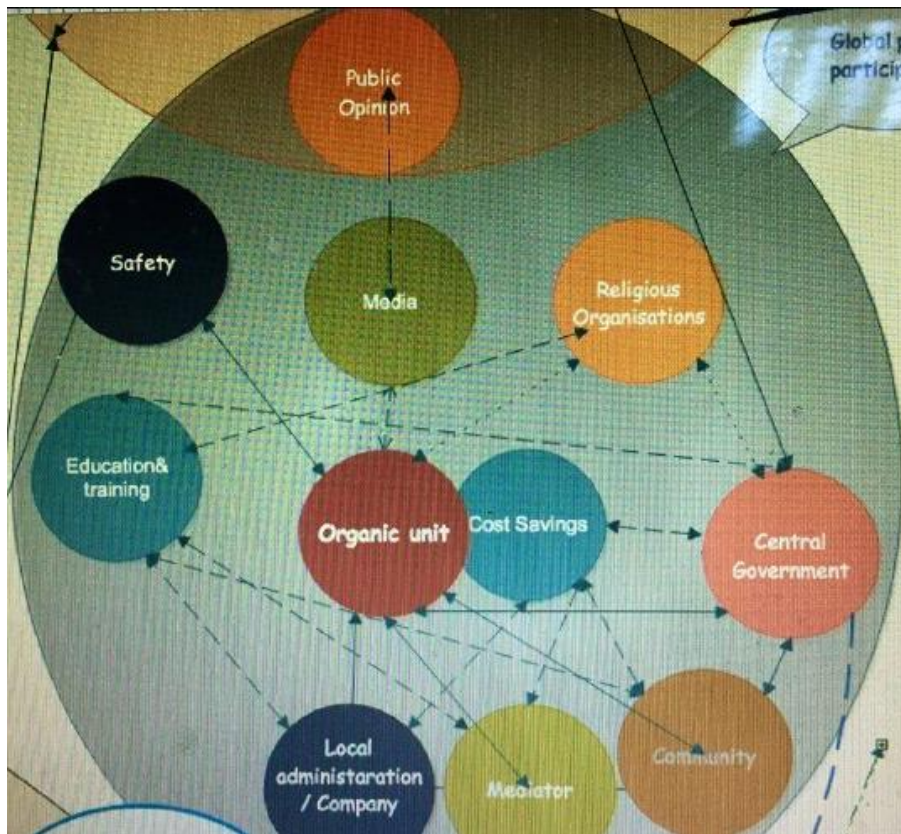


Figure 4. Global participation (Urban socio-ecological systems)

Public participation dimension in urban socio-ecological system (McGinnis & Ostrom, 2014) is effectuated by an intervention from beneath (private company), above (government) and the exogenous influence (sustainable development associations) (Bagliani & Dansero, 2011). The model applied for socio-environmental conflict resolution applying a compass design where each tracks has an equal value is derived from the multi-track diplomacy (Bagliani & Dansero, 2011). In the global participation model organic unit (first track) takes role of mediator of conflict between citizens (second track) and private company or local administration (third track) (Bagliani & Dansero, 2011). Fourth track of this process involve cost savings through the collaboration between residents, private companies/local government, central government and sustainable development associations- (Bagliani & Dansero, 2011). Fifth track involve education for young people and training for employees towards the joint conflict management (Bagliani & Dansero, 2011). Sixth track consist of non-profit organizations that perform a role of mediator during the earliest stages of conflict (between private company or local administration and citizens) (Bagliani & Dansero, 2011). Seventh track involves an intervention of churches and the other formal religious organizations if the conflict emerges on their territory (Bagliani & Dansero, 2011). During the eight track the cooperation between all mentioned above parties and organic unit archived to enhance a safety of the system against market failure (Galychyn & Ustundag, 2017). The ninth track consists from free media as a countermeasure against the popular culture images towards one-sided (government-oriented) public opinion (Agnese & Rondinone, 2011), (Tuathail, Routledge & Dalby, 2006). Finally, the feedback to the organic unit for generation of an optimal social decision about safety (Galychyn & Ustundag, 2017) influenced by above mentioned endogenous forces (Grant & Mittelsteadt, 2004). The global participation model, government regulations, management & governance, cultural, and economical&social scales (top-tier categories) influence each other and provide with a feedback (McGinnis & Ostrom, 2014). The aggregation of these top-tier categories defines the higher logical category (Galychyn & Ustundag, 2017). In this paper this category is referred to as societal system (organization of human scales that interact with each other). The feedback paths link outcomes of operation of scales, or the logical relationships (inputs-outputs) between the second-tiers within the scales to each other (Bagliani & Dansero, 2011) (Figure 5).

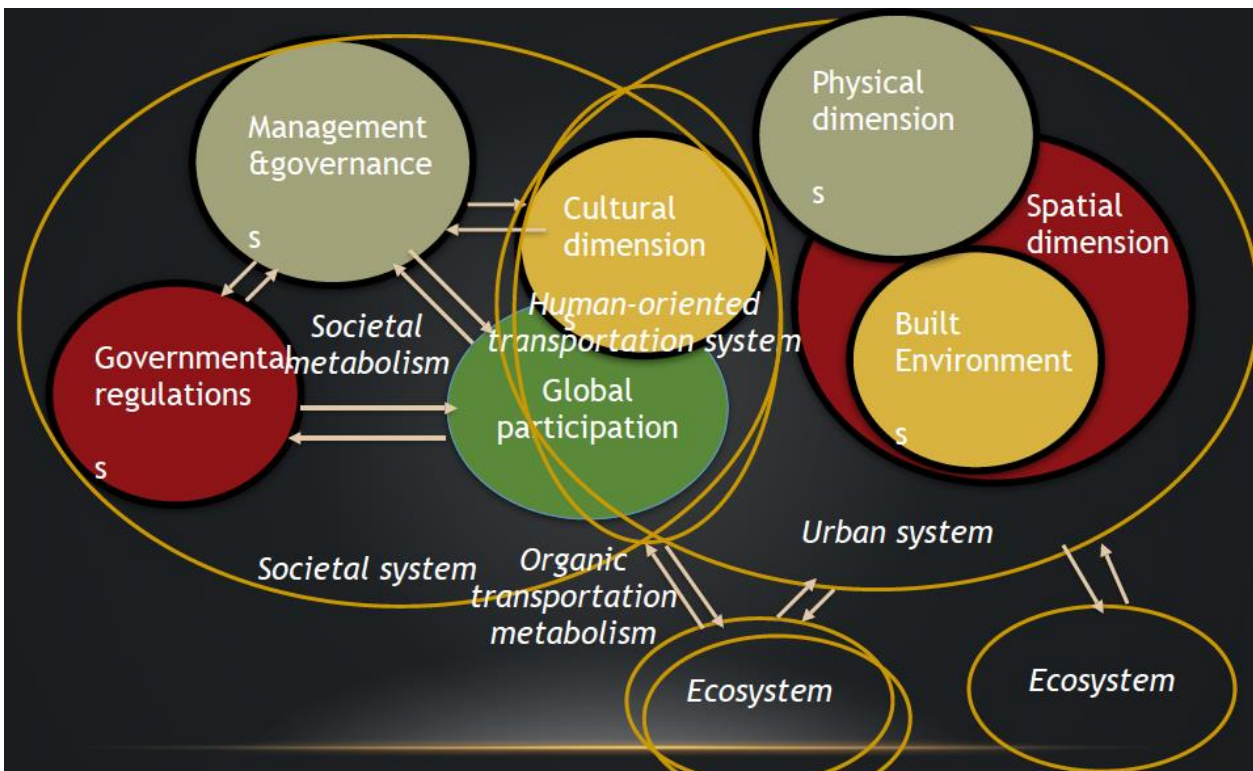


Figure 5. Socio-ecological system and exogenous influences

The discussed above ontological framework of human-oriented transportation system is shown below (Figure 6).

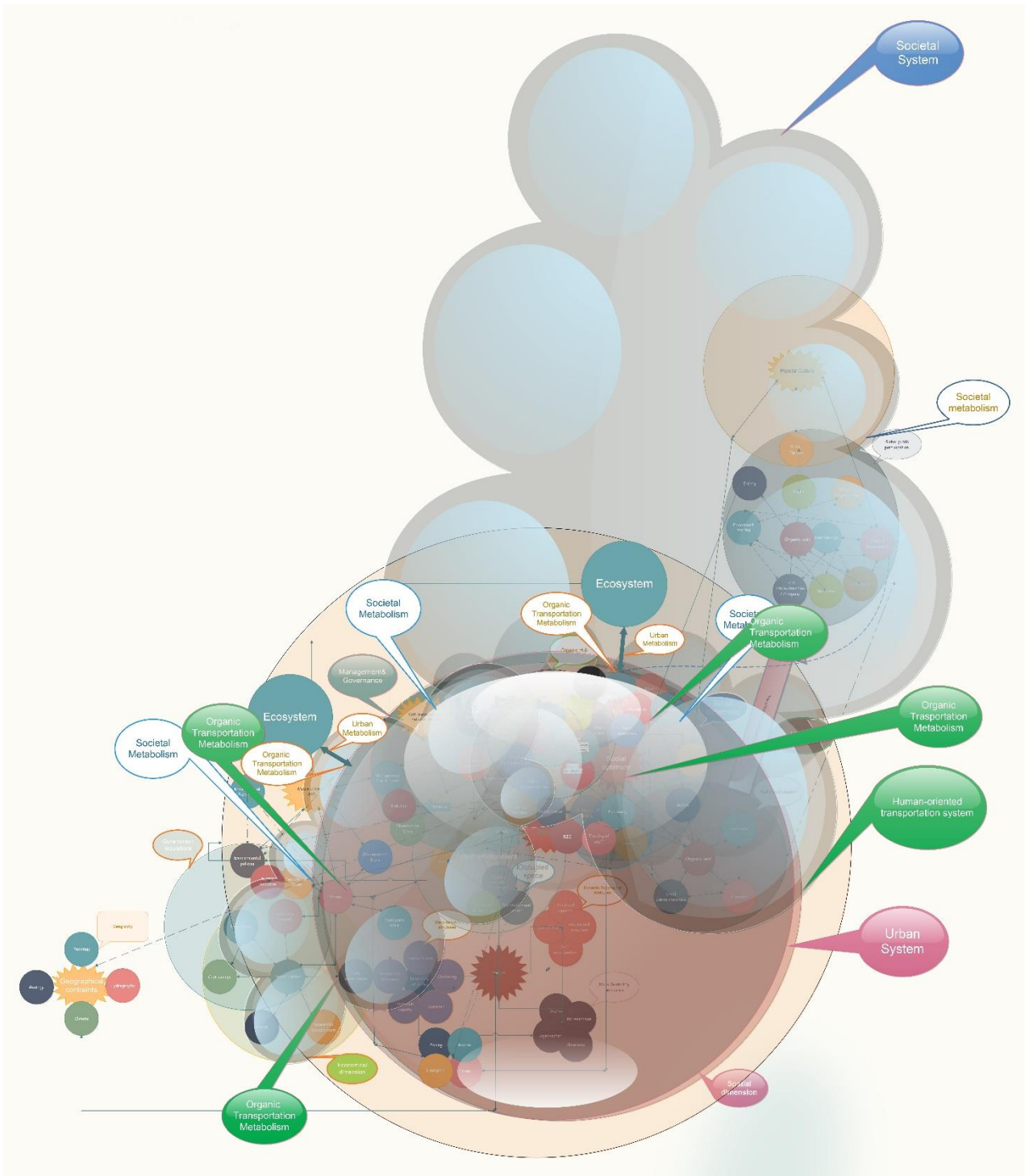


Figure 6. Human-oriented transportation system framework

#### 4. Case studies: Finland (Helsinki) and Italy (Rome)

Initially, the ontological structure that show an existing logical categories that along the cyclical pattern interrelationships (influence-and-feedback) is constructed. From the the this diagnosis or analysis it could be confirmed that city of Helsinki might enter the integrated public-soft transportation network stage by 2025 provided the both planned social and physical transformations will be archived (Helsinki City Survey Division, 2015, pp. 3-26). Social transformations (modified perception of a bicycle in accordance with affordability, equality, security) in Helsinki has been partially archived by completing the first step : social acceptance of bicycle as a mode suited for the short distances within the city (Helsinki City Survey Division, 2015, pp. 3-26). However, social acceptance of

bicycle can only be completely archived when perception of bicycle is changed from individual private equipment to the common shared public service (Galychyn & Ustundag, 2017).

Although city's bike&bike rack services have been implemented, the services haven't been successful in achieving this goal due to the absence of optimal social decision (Galychyn & Ustundag, 2017), (Helsinki City Survey Division, 2015). The socially optimum decision cannot be elaborated due to lack of safety-driven decision system in Helsinki (Galychyn & Ustundag, 2017)

for generating optimized design and pattern of bicycle (Galychyn & Ustundag, 2017), (Puget Sound Regional Council, 2014) as well as undermined endogenous and exogenous influences indicated above to limit design alternatives for this mode (Grant & Mittelsteadt, 2004). In other words, standard decision framework for planning process is utilized (Helsinki City Survey Division, 2015, pp. 3-26). During the safety-centered process the planner makes decisions by means of Kaleidoscopic method (four dimensions of diamond) with the safety parameter placed in the center (Costa Lobo & Ustundag, 2007). This approach gives a priority for a safety instead comfort (Galychyn & Ustundag, 2017). During this process different cycling route types were transformed through pedestrian-oriented design : separation of cycling and pedestrian traffic (one-way cycle path), the widened pedestrian paths (separate cycle path), reduced road width (cycle line, no parking), speed regulations (mixed traffic route, cycling on road) (Helsinki City Survey Division, 2015, pp. 3-26). An absence of most of physical data except bicycle traffic (bicycle&pedestrian paths, pedestrian traffic and bicycle parking data) as well as the pedestrian accessibility (Helsinki City Survey Division, 2015, pp. 3-26) were identified beforehand through the up-to-date report that was crucial for the building an ontological structure that builds on the foundation of the integrated public-3,4 ontology1,. The consequences of third-tier categories (mixed traffic on the road) spread to the network structure (second-tier variable) to bring the output (substitution of the third tier category contained in network structure) : increase of road width and duplicate traffic along the route from the transit station (Helsinki City Survey Division, 2015, pp. 3-26). Then , the network structure .applies an output as input to the same third-tier category (McGinnis & Ostrom, 2014). The outcome is an action situation: bicycle&pedestrian traffic along the routes decrease in width. In other words, the overall supply is a lower than a overall demand. This situation situation can be explained by preferential attachment law in the street design, where the duplicate routes are assigned to the streets with more traffic mixes (high hierarchy) and fewer routes to the streets with single traffic option (low hierarchy) (Roth, Kang, Batty & Barthelemy, 2012). This result allow for a third-tier category to bring the last outcome as an input again to generate a changes in the second-tier (transportation networks) structure. This time the other third -tier categories contained in the same scale (top-tier category) are joined together in accordance with their importance within the scale (Galychyn & Ustundag, 2017). This action is allow to observe how many instances of the top-tier connected together can produce a more lasting outcomes within a broader socio-economical settings (McGinnis & Ostrom, 2014). In case of Helsinki the following outcome were predicted: 1) In the long term soft transportation modes will be removed from the route permanently due to the excessive competition along the route (Helsinki City Survey Division, 2015, pp. 3-26). 2) Motorized transportation will take the streets back in the long-term perspective. Some of outcomes is harder to predict than the other due the absence of the logic relationship existed in particular settings. For example, an orientation and extent of network growth is unpredictable due to routes more promising in terms of demand but poorly linked to the network structure (second-tier category), built environment scale (density, diversity, design, ownership structure) (Carvero & Kockelman, 1997, pp. 199-209) and physical scale (pedestrian-oriented design) (Puget Sound Regional Council, 2014). Although bicycle system is owned&maintained among different authorities (management&governance) it causes difference in the standard of maintenance among owners (Helsinki City Survey Division, 2015, pp. 3-26). This issue contributes to the emergence of sprawl in the long term. When it matures to this critical state, the sprawl should be inserted into integrated public-soft transportation network ontology (McGinnis & Ostrom, 2014). Based on this ontology local environmental policies must be structured (Bagliani & Dansero, 2011), then optimal social decision is generated by an organic unit (Galychyn & Ustundag, 2017). Finally, this decision of organic unit (top-tier category) is linked through the feedback to a density, diversity, design, compactness and social design (second-tier categories) (Carvero & Kockelman, 1997, pp. 199-209)

to produce outcomes: access for disabled, walking&cycling space, pollution and safety control (Codoban & Kennedy, 2008). Rome, unlike Helsinki, had the late start in terms of sustainable mobility opening a way for integrated public-soft transportation network in 2010 with the approval of the Framework Plan for Cycling of the Municipality of Rome (Rome Services for the Mobility, 2010).

The conceptualization and comparison of the both network ontologies has allowed to conclude that the transportation system in Rome is lagging behind Helsinki. In other words, this network can be placed around the early transitional phase between motorized transportation and integrated public-soft transportation networks. This comparison has allowed to conclude that the social transformations here, unlike Helsinki, haven't been started yet; therefore, physical transformations without a social acceptance of soft transportation modes can't produce a sustainable spatial outcomes. It's important to note that the physical transformations include traffic-calming measures and physical infrastructure for cycling instead of pedestrian-oriented design. The traffic calming measures are effectuated by separating historical center with ZTL (Limited Traffic Zones) with electronic gates (Gori, Nigro & Petrelli, 2012). This measure is similar to the pacification of inner areas of superblock with only difference that speed less than 30 km/h is allowed instead of 10 km/h limit within the secondary streets of the superblock (Galychyn & Ustundag, 2017). The comparison of ontologies has allowed to grasp a situation where physical transformations have been implemented neglecting the social transformations (social design of neighborhood) (Abe-Kudo, 2007) and the social acceptance of bicycle hasn't been archived.

Thus, the social transformations (modified perception of bicycle in accordance with affordability, equality, security) in Rome unlike Helsinki has failed to attain the social recognition of bicycle as sustainable mode of transportation suited for the short distances within the city (29 bike stations with 290 bikes) (Transport and Mobility Department of Rome, 2015). The second step of social transformation (change of perception of bicycle from individual private equipment to the common shared public service) haven't been initiated. Conversely, Helsinki has embarked on the second stage in the summer 2016 year when 50 bike station with 500 bikes have been introduced (Helsinki City Survey Division, 2015, pp. 3-26). In both cases the standard decision framework for planning process is utilized here with the four dimensions of diamond and comfort placed in the center of those scales (Xie & Levinson, 2007). The influence of ownership structure (second-tier) to the network structure(second-tier) (Hansen, 1959) along the feedback paths (Roth, Kang, Batty & Barthelemy, 2012) bring the consequences of the second-tier as an outcome: volume of dispersed origins&destinations along the routes shared with private and public vehicles. This situation indicates that the time savings and safety problems (social scale) have the same effect within Rome as in any other motorized sprawled city where physical infrastructure substitutes the pedestrian-oriented design. The influence of network structure on those problems (third-tiers) can be analyzed (diagnosed) to understand how the situation where 'urban slums' within ZTL might emerge in the long-term perspective can be avoided.

## **5. Human-Oriented Renewal of Bozcaada (Tenedos) Island.**

Bozcaada is a unique case among the other studies not only because of the relative location (external geographical constraints) but also due to its size (network structure) and social organization (social scale), cultural scale (popular culture), standard decision framework, prioritized economically feasible projects (economical scale) and environmental processes (environmental scale) (South Marmara Development Agency, 2012). By diagnosis of the current situation by means of ontological structure that feedback from this problems to the network structure (second-tier) and its consequences on the multiple instances: motorized transportation network in the inner ring (minibus, bicycle and automobile routes within island) and outer ring (steamboats and sea buses, or ferries) to seize its operation in the long term perspective and cause market failure on the island (Doğan, 2011). For the long-term prediction about the market failure and network abandonment the circular pattern between the second-tier categories (network effect, path dependence and jurisdictional control) and network structure with its centrality measures is necessary (McGinnis & Ostrom, 2014).

The ontological structure builds on the data of the report (Doğan, 2011). In accordance with the structure Bozcaada can be placed around early motorized network stage due to feedback from the instances of third-tiers: low settled population, underdeveloped inland infrastructure and absence of activity poles (South Marmara Development

Agency, 2012). It could be argued that the nationalization policy lead to the closure of Greek schools (1964) and construction of open prison and airport on public land (1965) coupled with low compensation rates from authorities were the primary factors that affected out-migration of almost entire Greek (25 people remained) and a portion of Turkish population up until 2000 year (South Marmara Development Agency, 2012). The ontology confirms that the damaged champagne industries along with the high taxes on producers (until 2001) caused a market failure, and the socio-economic disparities (top-tier category) between island the rest of the Çanakkale province (South Marmara Development Agency, 2012), (Doğan, 2011). The ontology also confirms that the both physical and social transformations haven't been initiated yet (McGinnis & Ostrom, 2014). In other words, the integrated public-soft transportation network cannot be developed on the island where both physical and social transformation haven't been occurred till today (Galychyn & Ustundag, 2017). The physical arrangement of space is out of question on the island where abandoned since 1964 physical infrastructure (network structure) influence the social and environmental scales with the following outcomes (McGinnis & Ostrom, 2014): waste storage and lack minibuses within island to maintain optimal frequency of service are present (Doğan, 2011), absence of direct service between Gökçeada and Bozcaada (South Marmara Development Agency, 2012) and waste of steamboat and garbage from sea buses coupled with irregular low frequency of service (South Marmara Development Agency, 2012), and excessive automobile traffic during spring/ autumn months (beginning/end of tourist season) coupled with smaller number of tourists (South Marmara Development Agency, 2012), (Doğan, 2011). The other issue at hand is lack of housing for public sector employers and dorms for students (third tiers) due to tourist-oriented specialization of island (second tier that contained in the social and spatial scales) (McGinnis & Ostrom, 2014). The government regulations (top-tier) (McGinnis & Ostrom, 2014) has influenced the social fear and separation (third-tier) and physical isolation (third-tier) (Grant & Mittelsteadt, 2004), (Abe-Kudo, 2007). Consequently, feedback of these third-tiers to government and how they affect each other haven't been fully grasped by both the government and citizens (education and training scale) (McGinnis & Ostrom, 2014), (South Marmara Development Agency, 2012). Therefore, according to the report all issues are remained untouched despite different strategies published in 2012 (South Marmara Development Agency, 2012). Each of those strategies grasp a single isolated scale (top-tier) only and don't incorporate any sustainable practices (Galychyn & Ustundag, 2017). The best rated strategy is aimed to solve social&physical isolation issues by performing sociological research (including roots, language and religion) (South Marmara Development Agency, 2012). The comparison among the ontologies shows the output (situation) in Bozcaada is similar to Rome because it employs standard decision framework for planning process with the four dimensions of diamond and comfort placed in the center (Galychyn & Ustundag, 2017). The same negative effects as in Rome hasn't been produced due to low population (third-tier) and its contribution to the early stage of motorized transportation network employed across the island (network structure) (South Marmara Development Agency, 2012). The deference is that, unlike the other cases above, the both physical structure for tourists and pedestrian-oriented design aren't given any priority (South Marmara Development Agency, 2012).

Steamship for car transport (third-tier) not only generate wastes (instance) but also transport cars for tourist and owners of rental property to the island (instance) (South Marmara Development Agency, 2012). This action (instances) diminish passenger capacity of ships (filling rate of rolling stock), feedback these consequences to the network structure (second-tier category) to cause to the negative instance: pollution& limited accessibility during the summer season (South Marmara Development Agency, 2012), (Doğan, 2011). This action (instances) is also fueling privatization process by feedback to the jurisdictional control (second-tier) (McGinnis & Ostrom, 2014). Therefore, steamships should be removed from service and substituted with more sea buses not only in direction Geyikli-Bozcaada but also along the route between Gökçeada and Bozcaada. Then, by inserting these services into the appropriate space (third-tier category contained with the network structure) (McGinnis & Ostrom, 2014). However, the distinct issues would be a low population and tourism-oriented specialization due to governmental regulations (including difficult procedures to get permission for reconstruction within protection areas), and a limited of space within the island for the network growth (South Marmara Development Agency, 2012). Including these categories need an clear understanding on how to logically connect them by their instance (can be done by the organic unit) (Galychyn & Ustundag, 2017). It was mentioned before that the physical transformation of surface space requires not only artificial landscape corridors but also fragmented patch areas of different sizes. The lowest available patch in the

transportation network is the neighborhood area (Galychyn & Ustundag, 2017). The neighborhood can be considered as a margin area between TOD (more dense and more populated than the area of TODs) (McGinnis & Ostrom, 2014) and also to have a distinct properties (size, shape, structure, boundary, mix of the classes and ages, etc.) (Lehmann, 2015), (Kujala, 2016) build the integrated public-soft transportation network the social transformation must be archived (Ustundag, 2012). In accordance with the organic transportation approach a social transformation should incorporate the social design of neighborhood (Galychyn & Ustundag, 2017). This neighborhood is contained within the socio-ecological system, and the individual or collective actions of actors inhabiting the neighborhood influence/and been influenced by socio-ecological system (Bagliani & Dansero, 2011). This neighborhood should utilize waste-to-energy strategies (almost infinite source considering inland environmental issues) (Peart, 2016). Those issues (third tiers) can be inserted into integrated public-soft transportation network ontology to generate local environmental policies to be applied later to the socio-ecological system to understand their effect (Bagliani & Dansero, 2011). All this measures discussed before will not work unless the population, density as well as major attraction poles are enough for transformation into integrated public soft transportation network. However, the population of island community cannot be increased due to service sector only, namely tourism business not only because of seasonal variation of population but also due to uncontrolled privatization coupled with protection areas designed by local government and socio-economic disparities between Bozcaada and continental part of Turkey (South Marmara Development Agency, 2012), (Doğan, 2011). Those disparities are evident in labour-intensive small and medium-size noncompetitive industries like wine&champagne production as well as lodging& hotel facilities (tourism sectors) spatially unbalanced with loose technological base, and the high degree of spatial concentration of private sector R&D as well as population and economic activities in the continental part (South Marmara Development Agency, 2012), (Doğan, 2011). Those factors contribute to the government deficit (linear pattern) (McGinnis & Ostrom, 2014); therefore, local government cannot even solve basic infrastructure problem within island. Other problem is related to low education level of graduates that add to the unqualified lodging service employers that instead of upgrading physical arrangement of space including tourist-oriented facilities pursue the profit by increasing rent prices (South Marmara Development Agency, 2012).

To solve those problems Techopolis program should be enacted with emphasize knowledge-intensive industries (e.g. semiconductors, electronics, biotech as the key industries) (Araki, 2000) as well as priority of capital intensive industries (wind energy, waste-to-energy, rail transportation) (South Marmara Development Agency, 2012), (Codoban & Kennedy, 2008). This should be done simultaneously with interactive model, a continuous interaction among local government, hotel industries and lodging service industry workers, and to balance the innovation process networks by locating tourism-oriented companies together with universities to transmit their knowledge to continental regions (South Marmara Development Agency, 2012), (Araki, 2000). The same procedure should be applied also to the knowledge-intensive and capital-intensive industries. Knowledge and training of students and lodging service employers initially generated by connecting standard of living, community (exogenous influences) (McGinnis & Ostrom, 2014) to the training of staff and fundraising (education&training) performed by non-profit organizations that also involved mediation process during environmental conflict within island (Galychyn & Ustundag, 2017).

However, it shouldn't be forgotten that transport network and preexisting social agglomeration within island should be developed before industrial development and encouragement of R&D within the island (Araki, 2000). This will guaranty success of the program by attracting high-tech firms from Istanbul, Ankara and redirect a concentration of private sector R&D, population and economic activities to the island. Lastly, to increase population and facilitate technological and cultural exchange is important to include in this program not only Gökçeada but also bigger Greek islands (Rodos, Crete, Lesbos) that have already the mix of uses should encourage walking& cycling activity and to foster a walkable and vibrant environment within island. Provided those strategies are implemented deficit of space can be finally taken into account starting from evaluation of opportunities in regard to the complex utilization of space and infill sites (Popov & Siganchin, 2019). Those ordered measures will allow to redirect a growth of transportation network within Bozcaada towards a late stages of motorized public-soft transportation network to be simplified to the level of ontology and analyzed in terms of the effective process and outcomes in these settings (McGinnis & Ostrom, 2014).

## 6. Conclusion

In this paper by analyzing five streams related to the transportation network growth: geography of transportation networks (1962-1969), optimization and design of networks (1970-1987), statistical analysis of the network growth (1975-present), to the economics of network growth (1996-present), network science (2002-present) have been found that infrastructural and engineering projects were mostly have been evaluated based on the cost savings (economical scale) and physical regulations (physical scale) while environmental and social scale were never assessed to conceptualize a transportation networks. The single exception was a social data, or human behavior and needs, to generate demand forecasting models during optimization stream (McGinnis & Ostrom, 2014). In addition, was confirmed that sustainability, human-oriented transportation and socio-ecological system concepts have never been incorporated in the studies despite the impact of the exogenous influences (climate, topography, hydrography and geology), economic feasibility analysis and structural properties (network science) on the network structure has been assessed in the geography of transportation network and network science streams, (Barthélemy, 2011). The four groups of the topological attributes summarized during those streams: network properties, space occupied by transportation networks, built environment and geographical constraints with 22 attributes generalized to be included into the scales to finalize ontologies. Those attributes have been linked to the physical transformations (pedestrian-oriented design) (Galychyn & Ustundag, 2017), (Galychyn, 2011) and social transformation (modified perception of a bicycle in accordance with affordability, equality, security (Galychyn & Ustundag, 2017) and social design of neighborhood (Galychyn & Ustundag, 2017)) across the their respective scales (top-tiers) to finalize an integrated public-soft transportation network ontology (Galychyn & Ustundag, 2017). The rule of social optimum were introduced and case studies from Helsinki and Rome helped to confirm that rule regarding socially optimal decision about safety essential for archiving the social transformations for integration of public and soft transportation networks (Galychyn & Ustundag, 2017), (Bagliani & Dansero, 2011). By adding the concept of healthy neighborhood (Carvero & Kockelman, 1997, pp. 199-209), socio-ecological system (Thorne-Lyman, Wood & Zimbabwe, 2011, pp. 54-57), and underground (Popov & Siganchin, 2019), education & training (Tokyo Metropolitan Government, 2007), global participation (Galychyn & Ustundag, 2017) and cultural scales (Agnese & Rondinone, 2011), (Tuathail, Routledge & Dalby, 2006) to public-soft transportation network a human-oriented transportation system concept was developed.

Firstly, a concept of a physical transformation of the human-oriented transportation system's area was formulated by combining TOD and metropolimeter concepts (McGinnis & Ostrom, 2014), (Galychyn & Ustundag, 2017). Secondly, the cultural scale were constructed by combining in accordance with the feedback loop between the popular culture and public opinion, operationally defined as interpretation of public opinion against social optimum (Bagliani & Dansero, 2011). Thirdly, local participation model were transformed in accordance with the multitrack diplomacy into global public participation model consisting from tracks: organic unit (Galychyn & Ustundag, 2017), community, local administration/company, cost-benefit driven collaboration, education & training, mediator (non-profit organization), religious organizations (Bagliani & Dansero, 2011), safety-driven collaboration (Galychyn & Ustundag, 2017), free media (Agnese & Rondinone, 2011), (Tuathail, Routledge & Dalby, 2006). The case studies of Helsinki were helpful in understanding that integration of public and soft transportation networks cannot be successfully completed without safety driven decision system (Galychyn & Ustundag, 2017), simultaneously implemented with the optimization of design and pattern of bicycle & pedestrian paths (Galychyn & Ustundag, 2017). The case study of Rome has showed that jurisdictional organization issue (Rome Services for the Mobility, 2010) has caused motorized sprawled pattern of urban transportation network. The last case study identified limitations of the human-oriented transportation system framework due to low population, tourism-oriented industry and absolute barrier for development (sea) (South Marmara Development Agency, 2012), (Doğan, 2011). Therefore, in this case by adding the technopolis concept together with an interactive knowledge networks the transportation network can be suitable for building an ontological structure to analyze the processes and process an outcomes to bring forth the human-oriented transportation. However, this concept can still be used as ontological framework to develop the properties of the specific transportation networks within the socio-ecological systems (McGinnis & Ostrom, 2014).

Therefore, any ecologist, policymaker and analyst, and the citizen that interested in develop the similar ontological organization for knowledge to diagnose the complex systems such as cities (Galychyn & Ustundag, 2017). This framework can also help to pose a flexible questions and investigate many aspects of a given situation (McGinnis & Ostrom, 2014). Consequently, the network represents a mind map to generate new narrow or comprehensive ideas about term in question to reorganize the local parts without alterations in the overall equilibrium (McGinnis & Ostrom, 2014). Simple example can be that TOD and metropolcenter by merging with each other create physical transformation of space , an element that in feedback relationship with the design and pattern of transportation network and management&governance and underground scales. The challenge related to developing of the shared base that facilitate the diagnoses of the properties of numerous complex systems such as ecosystems and landscapes to adapt the logical linkages to these specific system as well as to make it also applicable to the numerous of theories to increase the the range of specific situations for building the appropriate models and to avoid the confusion in the further applications of the ontology will remain open in the upcoming decades.

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