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TERRITORIAL INTELLIGENCE AND ENTREPRENEURSHIP FOR URBAN RISK MANAGEMENT

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A B S T R A C T

Urban risk management faces significant challenges related to the complexity of urban systems, governance processes, and information management, which make it difficult to analyze, plan, and make decisions effectively and efficiently. These challenges can be addressed by territorial intelligence (TI), which aims to build the necessary knowledge for societies. This paper examines both the concept and the approach to operationalize urban risk management research. The challenges of urban risks and the difficulties they pose to current risk management practices will be discussed; subsequently, the TI framework will be proposed, and its key themes will be analyzed. In the last part, a case study will be presented as an example of the potential of TI to address urban risk challenges. By examining the complexity of urban systems, such as the interdependence of infrastructure and population density, as well as the often-fragmented governance processes, this paper highlights the current difficulties of urban risk management. IT offers a holistic and integrated approach, combining spatial data, socio-economic analysis, and information technologies to improve the resilience of cities to risks. The case study will illustrate how the application of IT can transform urban risk management by providing relevant information and facilitating collaboration between different stakeholders. Ultimately, this paper aims to demonstrate that territorial intelligence is not only an innovative solution, but also a necessity to effectively manage risks in complex urban environments.

1. INTRODUCTION

Sustainable development aims to ensure the advancement of present and future generations through the simultaneous satisfaction of social, environmental, and economic objectives. This concept underlies the General Law on Sustainable Development (LGDS) for the State of Durango, Mexico, which integrates various management approaches, including risk management. Faced with the growth, imbalance, and dynamics of local

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and urban development, risks associated with earthquakes, contaminating spills, transportation, explosions, gas leaks, floods, hurricanes, and fires have created territorial imbalances that adversely affect the human living conditions of the regions affected. These risks directly or indirectly affect the population living in hazardous areas; these areas have expanded due to the urban development of cities, towns, and municipalities in the state. The management of disaster risk reduction (DRR) is limited because it does not consider planning of the actions or possible grounding, or the identification or allocation of resources, and does not use responsible territorial intelligence to gather all the information available (Cutter, 2003).

Territorial intelligence has become an essential tool for disaster risk management, including prevention and mitigation preparation for decision-support risk management. In Spain, a software named Management and Territorial Intelligence for Disaster Risk Management (GEO-URT3D) is being developed. The Geo-URT3D is an information system that combines territorial intelligence techniques with Geographical Information Systems (GIS) and more traditional disaster risk management programs to monitor, repair, and prepare decision support for the following components: prevention, preparedness, response, and recovery. Geo-URT3D leads to more sustainable and safe risk management decisions. Geo-URT3D combines spatial geospatial data; intelligence exploration tools; technological interoperability; communication of expectations, capacity, and aptitude; prior knowledge; and specialized communication. This system collects information generated by different agencies and systems, reducing redundancy, and improving the information quality.

2. UNDERSTANDING URBAN RISKS

Risk arises from the interaction between hazards and vulnerabilities, threatening exposed assets with undesirable consequences (Turner et al., 2003). In the context of urbanization, accelerated by globalization, the expansion of large cities and other factors, there is an increasing concentration of people, buildings, vehicles, and infrastructure in confined spaces. This increased concentration in urban areas (Hallegatte et al., 2013), combined with an abundance of vulnerabilities such as poor construction, inadequate services, poverty, and limited performance of emergency response forces, creates an environment conducive to major urban crises. Cities, often overcrowded, are particularly susceptible to natural and man-made hazards that can spread rapidly, both locally and across borders. This density of population and infrastructure increases the risks of severe impact when disasters occur, as crisis management systems are often overwhelmed by the speed and scale of the spread of threats (Grimm et al., 2008). The combination of these factors makes cities particularly vulnerable to major crises, requiring more robust and integrated risk management strategies to minimize impacts and improve urban resilience (Meerow et al., 2016). Typically, public, private and individual actors are poorly prepared to manage unexpected impacts. Several have advocated for the use of different concepts, such as territories at risk, communities exposed to hazards and vulnerability to reconstruction, among others, in the semantic approach to disaster risk reduction. These concepts are particularly known and widely interpreted in the context of territorial, community, and organizational governance; multi-actor action has been suggested to address urban risks. Moreover, the concept of urban risk has a potentially dual meaning that is not limited to the analysis of disaster-related adversities. Indeed, urban areas are also laboratories for new forms of green and community-based economics, generating best practices, innovative models, new approaches, strengthening social resilience and adaptive environmental strategies that can reduce common daily adversities. For example, community initiatives that foster cooperation and solidarity can strengthen residents' capacity to respond to crises, while green and silver economies can promote sustainable and inclusive lifestyles. Thus, urban risks are not only threats to be overcome, but also opportunities to transform cities into more resilient, sustainable and equitable spaces.

2.1 Natural and Man-Made Hazards

There are two types of hazards: natural and man-made. Natural hazards have always been part of the Earth system. They have always been known to cause damage to livelihoods and national economies, disrupt systems, and ultimately lead to harm to public safety and national security. Their impacts are often widespread and vary between countries and regions, sometimes producing effects that extend beyond the affected area. A natural hazard is the threat of a natural event that will have a negative effect on human beings. This negative effect is what we call a natural disaster. Natural hazards include phenomena such as earthquakes, hurricanes, floods, volcanic eruptions, and droughts. These events can cause significant loss of life, destruction of infrastructure, economic disruption, and mass displacement of populations. The consequences of a natural disaster are often amplified by factors such as population density, vulnerability of infrastructure, and community preparedness. In addition, climate change is exacerbating the frequency and intensity of some natural hazards, increasing the risk of disasters. In the face of these threats, it is crucial to develop resilience and risk management strategies that include preparedness, rapid response and reconstruction. Public education and awareness, sustainable urban planning and early warning systems are key elements to mitigate the impacts of natural disasters and protect lives and property. Man-made hazards have been a part of the industrial society for a long time. They mainly include accidents and industrial disasters during manufacturing and transportation processes of chemical products, as well as

other types of disasters such as sabotage, gas explosions, and so on.

The rapid growth of technologies and industrial buildings has induced the ever-faster development of the environment, and a large number of different types of various disasters have appeared, threatening human life and safety (Chen et al., 2022). Some of these increasingly hazardous sites, very close indeed to places where many people live, tend to result in a greater potential for both large-scale disasters and large accidental losses. The consequences of man-made hazards are considerable and varied. Accidental deaths, injuries, illness, added stress on social safety nets, and a depletion of human, physical, and financial resources, damage to natural and man-made environments are all harmful to local populations and economies. Thus, it is important to reduce the likelihood that a disaster will occur and propose countermeasures. Almost all hazards arise from unfriendly natural conditions, and some arise when human society fails to respect or adapt to those conditions.

2.2 Vulnerability and Exposure

When the city expands, the fringes of the urban area, informal land development often becomes common, introducing a social and environmental threat to the city. Most of the time, this becomes the starting point for many environmental and social problems. The use of technology, territory planning, and citizenship integration are pointed out as important factors for monitoring and preventing this problem. Several Brazilian cities are exposed to risk, which can affect a great part of the poor population that lives in these parts of the city. This issue needs to be well distributed among city administrators, equipment managers, and society in order to establish early warnings and affect hundreds of people with minimal damages. If the use of technology in risk management and risk reduction is not immediate, it must speed up the process of observing, monitoring, and early notice (Preston et al., 2011). To address the issue of optimizing urban spaces while maintaining the physical, cultural, and social integrity of a nation, it is imperative to recognize the complexity inherent in urban risk management. The goal is to create less differentiated spaces that integrate municipalities into a global development context without compromising the essential characteristics of the country. However, this challenge is exacerbated by the complex and often unclear nature of urban risk management. The lack of clear monitoring and control processes is largely the result of the urban and social model in place, which seems to neglect humans, the main actors of vulnerability and occupants of territories at risk. Indeed, the urban expansion models often adopted are characterized by anarchic and unregulated growth, where land occupations and concessions are made without adequate planning. This approach leads to serious consequences, including an increase in risks related to critical natural phenomena. For example, the uncontrolled expansion of urban areas can lead to construction on land prone to flooding or landslides, thus aggravating the impacts of natural disasters. One of the main challenges is the difficulty in establishing effective monitoring and control processes that take into account not only the physical aspects of urbanization but also the social and cultural dimensions. To achieve this, it is crucial to adopt a more integrated and humane approach in urban planning, which includes an assessment of the vulnerabilities of populations and proactive risk management. This implies the creation of governance mechanisms that promote urban resilience while respecting the cultural and social fabric of local communities. In short, it is essential to rethink urban expansion models to ensure harmonious growth that will minimize risks and preserve the essential characteristics of the territories.

3. CONCEPTS AND PRINCIPLES OF TERRITORIAL INTELLIGENCE

The concept of intelligence, in common language, corresponds in Latin and Italian languages to the insight faculty (scientia) transforming everyday knowledge into a deep understanding or innovative knowledge. The intelligence activity, in different fields, has been the object of original studies of human relations, learning processes, and strategic choices in areas like management, defense, and urban planning, considered for a long time to be individual skills of actors. In the new era of "Second Modernity," the relational vision overlaps the Cartesian one, and knowledge becomes a shared good and the basis for innovation processes. Regarding the word intelligence, two main definitions traditionally originated. The first is the military one and identifies intelligence with information processing, useful to take political-military decisions in risky and complex. This form of intelligence is conceptualized as the sequence of processes from the acquisition of information to the dissemination of political decisions. According to the Preussian school of thought and, later, German geopolitical studies, this concept translates into the capacity of an individual or a community to understand the meaning of the transformations that occur in certain sectors of national life. This form of intelligence is not limited to simply collecting data or processing it; it also involves a deep interpretation of the dynamics in progress and the formulation of appropriate. In the framework of the theories developed by the Preussian school, the emphasis is placed on the capacity to analyze and react to political, economic, or social changes. This political intelligence, or "territorial intelligence," encompasses the understanding of the complex issues that shape the national landscape and the way in which these issues interact with local and global interests. In other words, it is essential to navigate in a dynamic environment where transformations can have significant impacts on the stability and development of communities. German geopolitics studies have enriched this concept by highlighting the need to consider not only the tangible aspects of transformations, but also the more subtle

dimensions, such as the perceptions and attitudes of different stakeholders (Adger, 2006). This approach allows us to grasp not only the nature of changes, but also the underlying forces that drive them. Therefore, such intelligence implies a deep understanding of the mechanisms of change and the potential impacts on political and social strategies. By integrating these elements into the decision-making process, individuals and communities can better anticipate future developments and develop more effective strategies to respond to the challenges posed by ongoing transformations (Peduzzi et al., 2009).

4. APPLICATIONS OF TERRITORIAL INTELLIGENCE IN URBAN RISK MANAGEMENT

The purpose of developing proposals for improving conditions is a sociocultural component and depends on the people involved. This is where a strong set of tools comes into play, among which soft systems-based methodologies have occupied for some time for researchers seeking to add focus to attempts to create an evaluation of local conditions and to propose improved conditions for the locality residents. Our aim is to draw a neighborhood map based on the holocorporal individual introspection of the inhabitants of the sector (Chambers, 1994), and to understand the different types of action (criteria for defining identity) of each sector based on the life logs of the people and the means designed by the community to carry out such actions. This paper deals with territorial logical support for decision-makers, based on building the operational concept of Territorial Intelligence, constantly considering the actions performed by individuals daily as well as the aforementioned observation.

In the previous section of this paper, we presented some ideas about the essential elements of human activities and some essential elements of social territorial institutions to which the actions are targeted as shown in Table 1. As such, we leave the choice of this new translation to the place involved and the people who live/act in it, as the occupants assume a more active role in creating the place, following the different stages that make up the stages of human spatial formation. We propose to study the questions of human development, for a neighborhood or micro-territorial level residence where residential practices result in the strengthening of individual identities, relaxation of social integration (at the citizenship and solidarity level) and the emergence of a territory or sector spatial organization.

4.1 Early Warning Systems

Early warning is the recognition of a hazard and its significance, triggering an impact on human welfare or economic loss. It includes four interrelated processes: risk assessment, prediction and forecast of hazards, monitoring, and communication and information management (Basher, 2006). These processes are used to define a lead-time or prediction horizon for an effective response decision. The concept applies to a large spectrum of forms and scales of disasters and includes events due to natural and man-made hazards (Di Baldassarre et al., 2013). It is composed of four structural elements of early warning systems to reduce the risks from natural and man-made demand events: risk assessment, monitoring and warning service, development of the response mechanism, and communication used in a device increment, the territorial structure approach. Effective early warning systems rely on several key elements that must work in harmony to ensure their success. First, an accurate and well-informed risk assessment is essential. This assessment, based on rigorous scientific data, must be transmitted in a timely manner to responsible decision-makers. Once risk information is obtained, it is crucial to have appropriate response capacities in place to mitigate the effects of the transmission of warnings. Effective communication channels also play a vital role in this process, ensuring that information reaches populations at risk in a clear and understandable manner. A major challenge is ensuring that vulnerable communities receive and understand the warnings issued. It is crucial that these populations know how to respond appropriately to minimize threats to their well-being or economic prospects. This involves not only effective dissemination of warnings but also ongoing education on response procedures and preventive measures. However, in developing countries, these requirements are often complicated by a range of exacerbating factors. The increasing probability of catastrophic events, combined with their increasing frequency and severity in recent decades, makes risk management even more complex. These countries often face structural challenges such as limited infrastructure, insufficient financial resources, and less developed communication systems, which can compromise the effective implementation of early warning systems. In addition, awareness and education of local communities may be insufficient, limiting their ability to respond effectively to warnings and take preventive measures. To overcome these challenges, it is crucial to strengthen local capacities, improve infrastructure, and promote international partnerships to strengthen early warning systems and improve community resilience to disasters.

4.2 Risk Assessment and Mapping

This issue around the cartography of territorial intelligence is not put aside when we explore the theme of the prediction and mapping of natural hazards (Merz et al., 2009). A literal analogy can be established between the process of predicting an event – in a risk assessment purpose – and the same process in surveillance work for police force. Both must produce concrete results in the priorities of a real "here and now." Research has proposed models termed "natural hazards" or "disasters" (epistemic) traps, for relieving the resilience or the tolerance characteristics analysis, opposition to the risky

or fragile territories zoning, inherent to the management of crisis. Some operational examples describe the mobilization of collective know-how to cope with a flood in Progressives Seniors Group of the Urban Community of Bordeaux. The classic concept of "protection works" has devoted to urban hydrographic charters that were drawing, size by size, the floodplain administrative prohibition areas (Stevens et al., 2015).

To manage risk effectively, it is necessary to know the physical character of the possible threats. This is, the phenomena breeding they are, under which situations of conflict, and their mechanisms. In situations of human dependency to nature and under bipolar debates, the first "step" of the dialogue and operational exchange between stakeholders will be to explain and to understand the risks themselves on a non-technical or one's own ground. In the specific case of certain natural hazards (drought, low flow, sinking ground, etc), an inventory is less easy to establish, because the knowledge of the involved warning criteria is sometimes recent, and the consensual definition of the future phenomenon is less clear. It is often the case of the territory and any preventive action with the human being, locally present (or revealed partially) potentials. In the case of urban risk, urban preventive zoning is a good example of an administrative application of this concept.

5. TECHNOLOGICAL TOOLS FOR TERRITORIAL INTELLIGENCE

Several tools and methodologies have been developed to apply territorial intelligence, each contributing to urban risk management through its ability to improve communication between different actors and foster networking. These tools cover a wide range, from information and communication technologies (ICT) to social research. Their use varies considerably, offering different approaches to the management and analysis of territorial information. Among the technological tools, Geographic Information Systems (GIS) stand out for their ability to manage and analyze complex spatial data. GIS allow the visualization and integration of geographic data, facilitating a deeper understanding of urban risks and the planning of appropriate responses. Specific technologies such as SIGTV exemplify this approach (Goodchild & Li, 2012). SIGTV is designed to manage information and promote spatial analysis by respecting the principle of maximum diversity. This means that it can integrate a wide variety of data from different sources while encouraging creativity and innovation in risk analysis. In addition to GIS, other modern technologies such as Semantic Web, Web 2.0, and real-time GIS bring a new dimension to urban risk management (Batty et al., 2012). These technologies facilitate the access and sharing of information through collaborative platforms based on web communities such as wikis, weblogs, or web portals. These tools not only allow more efficient information management but also better coordination between the different actors involved in risk management. By using these collaborative platforms, information can be updated in real time, and response strategies can be adjusted quickly according to new available data. The integration of these tools and methodologies in urban risk management constitutes a significant advance, offering increased capacities for the analysis, communication, and management of territorial information. By facilitating collaboration between stakeholders and optimizing the use of data, these tools play a crucial role in reducing risks and improving urban resilience. Social techniques for territorial intelligence, which assess decision-making mechanisms and innovation in territories, are based on the comparison and distribution of knowledge between different actors. They refer to the conditions that allow the interlocutors to organize and participate in the public debate in an informed and equitable way, combining listening, mediation, and negotiation. From the numerous methodologies available, we point out two, SWOT and Focus Groups, and exemplify their use in the Communist Party district in Milan. These three public actors embody, within the territory, some of the major roles that play in the context of Urban Risk Management, roles that help in their relationship with each other and therefore endow them with a particular politological charisma.

6. CASE STUDIES AND BEST PRACTICES

In this section, we review several examples of best practices and previous applications of territorial intelligence concepts and tools, often in interaction with fuzzy modeling tools, for sustainable urban construction and territorial security. These examples illustrate how these tools have been used to navigate the complexities associated with urban sustainability and risk management (Figures 1, 2, 3). A first imperative is the management of uncertainty on the one hand, and the rapid use of information to support the multi-objective nature of sustainable activities on the other hand, in order to improve the final outcome. Urban sustainability involves juggling various objectives, such as environmental protection, economic development, and social well-being. This multidimensionality requires managing the trade-offs and conflicts that may arise between these objectives. For example, the decision to develop a green space may conflict with the need to develop residential or commercial infrastructure. Effective management of these trade-offs is essential to achieve balanced and sustainable solutions. On the other hand, it is crucial to feed the decision-making process effectively by identifying the information considered fundamental. Territorial intelligence tools and fuzzy models allow to process and integrate uncertain or imprecise data, thus providing a solid basis for decisions. Fuzzy models, in particular, are useful to represent the aspects of uncertainty and imprecision in territorial data, allowing a more nuanced assessment of risks and opportunities. For example, in the context of sustainable urban planning, these tools can help to assess the environmental, social, and economic impacts of different development

scenarios by considering the uncertainty inherent in forecasts and stakeholder preferences. By integrating these approaches into practice, decision-makers can improve the accuracy and relevance of the information used, while effectively navigating through the complexities and uncertainties associated with sustainable urban construction. Past experiences show that the combined use of territorial intelligence and fuzzy modeling tools allows the development of more robust and adaptive strategies to meet the challenges of sustainability and territorial security. The following figures present a projection on the case of the city of Casablanca.

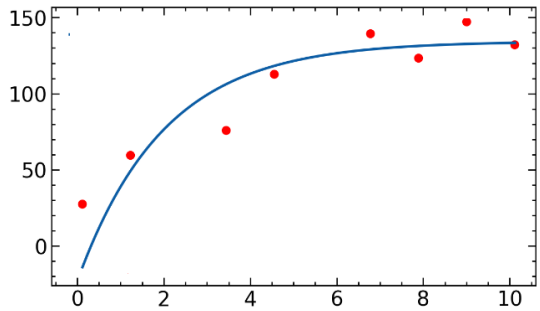

Figure 1. Urban risk management and territorial intelligence in the Casablanca area

The blue parabolic figure, accompanied by red dotted lines, illustrates how the integration of territorial intelligence and fuzzy modeling tools allows the development of robust and adaptive strategies to address sustainability and territorial security challenges, taking the example of the city of Casablanca. The blue parabolic curve represents a non-linear relationship between variables related to urban management, showing an upward phase where the benefits of the strategies increase, a maximization point where efficiency is optimal, and a downward phase indicating the limits of the strategies. The red dotted lines are used to visualize areas of uncertainty and possible variations in the results, providing perspectives on alternative scenarios and the sensitivity of forecasts. Together, these elements allow for a better understanding and adjustment of urban policies according to the specific challenges of Casablanca, optimizing approaches to maximize benefits while minimizing risks associated with sustainability and urban security.

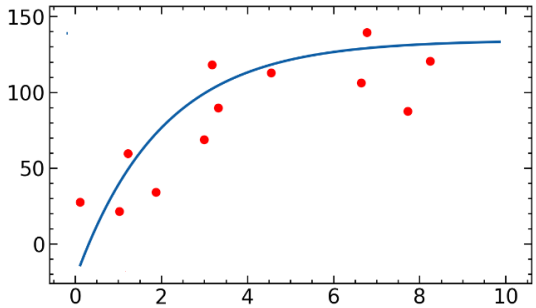

Figure 2. Using AI tools for urban risk management level detection

The blue parabolic figure, with its red dotted lines, demonstrates how the introduction of territorial intelligence has led to a significant improvement in the performance of stakeholders in urban management, particularly in the city of Casablanca (Batty, 2008). The blue parabola symbolizes the evolution of the results obtained through the integration of territorial intelligence and fuzzy modeling tools. At the beginning, the upward curve shows that the adoption of these tools begins to improve the performance of strategies by providing a better understanding of territorial dynamics and optimizing responses to urban challenges. The peak of the parabola indicates the point where strategies reach their full effectiveness, illustrating how detailed information and precise analyses contribute to more informed decisions adapted to local needs. In contrast, the downward phase highlights potential limits or decreasing effects when resources are saturated, or conditions change. The red dotted lines add a dimension of uncertainty and variability, showing how performance can fluctuate depending on alternative scenarios and necessary adjustments. The figure highlights that the introduction of territorial intelligence has not only improved stakeholder performance by enabling more precise and responsive management of urban challenges but has also helped refine strategies to better meet Casablanca's evolving needs (Zadeh, 1965).

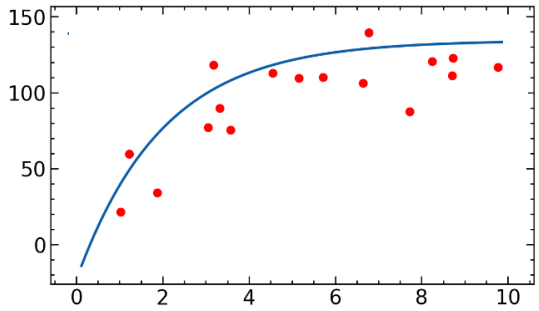

Figure 3. Improving the performance of all stakeholders following good risk management by adapting territorial intelligence

Following the analysis of the figure, it is evident that the use of technological tools, such as artificial intelligence (AI), represents a powerful asset for improving the performance of all stakeholders. The blue parabola shows how the integration of AI and territorial intelligence tools gradually improves the results of urban management strategies. The initial ascent of the curve illustrates the significant gains made thanks to a better understanding and analysis of territorial data, allowing stakeholders to make more informed and effective decisions. The peak of the parabola, where the benefits are maximized, demonstrates the optimal impact of these technologies on overall performance. The red dotted lines, representing uncertainties and possible variations, highlight that although AI offers considerable benefits, it is crucial to adapt strategies according to changing conditions to maintain effectiveness. In conclusion, the figure confirms

that AI, as an advanced technological tool, plays a crucial role in improving stakeholder performance by optimizing decision-making processes and facilitating more precise and responsive management of urban challenges.

7. CONCLUSION

While we are confident that territorial intelligence for urban risk management is a very promising approach, we also would like to highlight some unsolved issues related to the implementation and the day-to-day administration of this strategic management process. Both urban structure and social life are increasingly heterogeneous, thus accurate descriptions for each of them require a great number of indicators and metrics. The use of this information becomes complex and difficult for non-specialists involved in the different tasks of the territorial risk management, particularly in large settlements. Even in small communities, governance tools running territorial intelligence techniques for risk manage (Preston et al, 2011) ment have to allow broad involvement of different social actors and facilitate and encourage collaborative spaces (e.g. rooms of knowledge to share information), continuous and effective communication, transparency, equity, and leadership sharing. Although territorial intelligence is understood as a participatory approach, methods to encourage the creation of informative spaces require intensive support considering local needs and politics. Moreover, for large urban settlements, governance structures need to connect top-down and bottom-up approaches, i.e., hierarchical decision-making and local initiatives should be connected. However, implementation of dialogue processes between administrative management and territorial organizations seems poorly structured in terms of general functioning, ambition, resources allocation, and efficacy.

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