

# Exploring the Factors that Affect the Resilience of Port Organizational Ecosystems through a Survey of Common Uncertainties

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**ABSTRACT:** Reliable port services are key to the performance of port organizational ecosystems. These ecosystems are an integral part of the transportation system and are vulnerable to disasters of anthropogenic or natural causes, including natural disasters, malicious cyber-attacks, technological factors, organizational factors, economic factors, and human mistakes, and other uncertainties. To address the challenges triggered by these uncertainties, this research is dedicated to the detailed analysis of organizational resilience, the port organizational ecosystem's resilience, and possible uncertainties which are the basic factors for modelling the resilience of the whole port organizational ecosystem. The research aim is to analyse the uncertainties influencing the port organizational ecosystem's functioning in the context of the port organizational ecosystem's resilience. Research methodology is based on theoretical modelling including analysis of port organizational parameters representing resilience level. The research results found that the port organizational ecosystem's resilience could be defined by the main organizational resilience drivers such as leadership and adaptive capacity, which are interrelated and have the functions of main business excellence drivers. Also, it was found that the external and internal port resilience factors could be classified by their nature, field, and type of organizational resilience components. All uncertainties could be categorized in a three-dimensional uncertainties model which could be used for elaborating effective managerial interventions in future investigations.

## 1 INTRODUCTION

Reliable port services are key to the performance of port organizational ecosystems which are an important part of national economies' integration into the worldwide international trade system. An emphasis on the resilience of port organizational ecosystems provides flexible and collaborative modelling of these ecosystems to address the diverse risks of disruption proactively, particularly as new hazards and threats are constantly evolving [1]. Additionally, insufficiency of resilience-related scientific literature in the maritime domain together with the vision to establish resilient maritime business

results in an urgent need to develop a modelling method using integrated theoretical approaches of organizational resilience and maritime business risk management for elaborating the structured uncertainties' system which will help organizational ecosystems to develop effective managerial decisions for the enhancement of their resilience.

There are two possible ways to reduce the negative impact of external environment on the processes in maritime business: one of them is the prevention-oriented management which includes defensive measures for reducing the probability of uncertainties or extent that an ecosystem will be affected by

unpredicted external factors, to improve its resistance and reduce the possible losses it may suffer [1]; the other is response-driven management which improves the recoverability of ecosystems after the occurrence of disruptions and restores normal conditions as soon as possible [2]. The theory of organizational ecosystem resilience enables the possibility to analyse the integral combination of these two types of management for the enhancement of organizational ecosystem's resilience.

The research aim is to analyse the uncertainties influencing the port organizational ecosystem's functioning in the context of port organizational ecosystem's resilience.

The research objectives are:

- To explain the organizational resilience enhancement model's parameters.
- To substantiate the definition the seaport organizational ecosystem's resilience.
- To identify main uncertainties by locating them in the organizational resilience model.

The research methodology is based on theoretical modelling subject to the analysis of previous research conducted on resilience models and uncertainties' management, theoretical analysis of possible uncertainties of the seaport organizational ecosystem.

## 2 THE THEORETICAL MODEL OF ORGANIZATIONAL RESILIENCE

Because resilience of the port organizational ecosystem is directly related to the field of organizational resilience research, the organizational ecosystem resilience model for port organizational resilience could be built upon by using existing organizational resilience models by extending them to the specific resilience parameters appropriate to the specificity of the maritime business sector. So, the definition of organizational resilience is required as the theoretical background which will enable the identification of the correlation between the uncertainties of the seaport organizational ecosystem and developing the resilience to respond to them.

The term resilience has several different definitions and explanations in different contexts:

- Disturbance factors in different definitions are defined as accidents and incidents [3], shocks [4], stress [5], mishaps [6], operational hazards [7], disasters [4], traumas [8] emergencies [3], uncertainties [9], contingencies [10] and volatile, uncertain, complex and ambiguous (VUCA) environment [11] including all elements into one term of VUCA conditions.
- Characteristics of influenced objects to the response are called abilities (abilities to accommodate [5], abilities to adapt [3], abilities to cope [12], abilities to maintain [4], etc), capacities (capacity to adjust [8], capacity to renew [13], etc.), properties (properties to "bounce back" [4], etc.), resistance and renewing [7].
- Speed of reaction can be fast [12] or short-term [4].

Based on these definitions of the main components of organizational resilience it can be assumed that

organizational resilience is the ability of an organization to be prepared to respond to unexpected regular and irregular external events in a robust and flexible manner in the shortest period of time possible. Notably, the organizational resilience theory acknowledges the sensitivity of organizations to gradual and random changes and that the main determinants of change are non-linear and not easily determined [6]. Based on these findings it can be argued that uncertainty is a prerequisite for resilience and resilience is a unique tool for organizational planning in the face of uncertainties.

Due to the complexity of the definition of organizational resilience researchers developed organizational resilience model. Organizational resilience, consistent with the research results [9], [10], [12], could be approached from two different angles assuming the following definitions of static and dynamic resilience:

- Static resilience as the ability or capacity of an organization to maintain functionality when shocked [4] which proposes that resources are used while they are available and accessible in the most effective way possible at the moment of disaster.
- Dynamic resilience as the ability to hasten the speed at which an organization recovers ('bounces back') from a severe shock to achieve a desired state [4] which suggests long-term investments for repairing and reconstructing organizational processes.

These assumptions made for the modelling of organizational resilience assume that all organizations have the capacity [13] or potential for the resilience [14]. Consequentially, resilience can be defined not only as a static characteristic of an organization, but also as a multiparametric function with dynamics in change, which incorporates the speed of reactions identified in the definition of resilience [8] and consists of several main contextual blocks including people, organizational context for change, organizational processes and external environment [15].

As figure 1 demonstrates, the organizational resilience model can be developed by extending the parametric groups from the organizational functioning point of view [16].

Thus, a research model can be constructed by developing Zahra's predictors model [17]. In this model organizational resilience is advanced by removing external environment from the influencing factors' group and by building organizational resilience based on individual and organizational components. As figure 1 demonstrates, organizational resilience (OR) is dependent on the components of resilient leadership (RL), resilient organizational culture (ROC), adaptive capacity (AAC), resilient critical infrastructure (RCI) and organizational and managerial capabilities (OMC) on the organizational level and on the components of awareness cognition (AC), organizational learning (OL) and psychological alignment (PA) on the individual level. Furthermore, all aforementioned components could be customary in their activation as a reaction to external uncertainties (fig. 1).

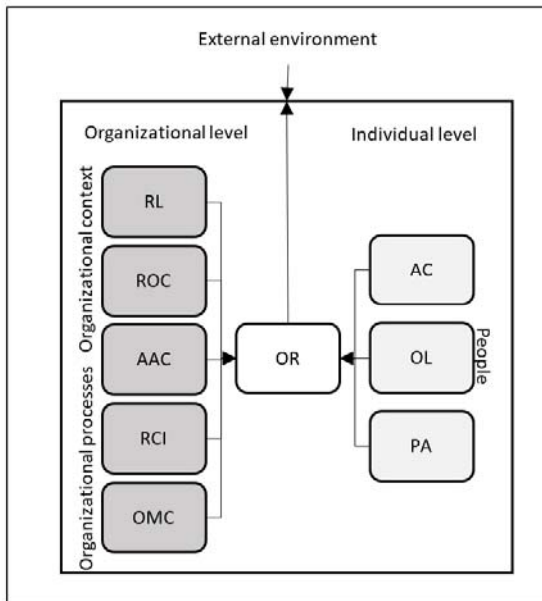


Figure 1. Components of organizational resilience [8], [16], [17]

Based on the literature analysis, it is evident that organizational resilience could be enhanced by increasing organizational adaptive capacity on the basis of strengthening resilient leadership (fig. 2) where resilient leadership (L) is a consequence for increasing in adaptive capacity (AAC) [16], which explains the propensity of organizations to adjust their characteristics or organizational behaviour to cope with external stresses and shocks [18]. As one of the organizational resilience characteristics, the adaptive capacity (A... in figure 1) enables organizations to learn and to retain knowledge and experiences to increase their functional resilience to hazards [19] and by the nature of its definition can explain the resilience of organizational ecosystems as well as organizations [20]. Resilient leadership (L) is an important influencing factor for adaptive capacity [21]. Furthermore, based on the organizational resilience modelling results, resilience could be explained in accordance with a theoretical model constructed on the resilience predictors model [17], which was modified for the purposes of this research study and is presented in figure 2.

As identified in the organizational resilience (OR) model (fig. 2), all components can be arranged into separate groups based on the organization's general definition as follows:

- Organizational culture components (ROC) include parameters of commitment, involvement, networking, cultural and traditional relationships, intercultural communication.
- Individual level components (ILP) include parameters of individual resilience (fig.1), comfortable workplace and work regime, psychological climate, partnership and cooperation culture, loyalty, and motivation to the awareness of cognition, organizational learning, and psychological alignment.
- Critical infrastructure components (CI) include all technical resources' preparedness for the uncertainties in the external environment and including CI development and management options.

- Organizational and managerial capacities (OMC) include all governance and management principles and tools and best practices of managerial interventions.
- Leadership (L)
- Organizational adaptive capacities (AAC).

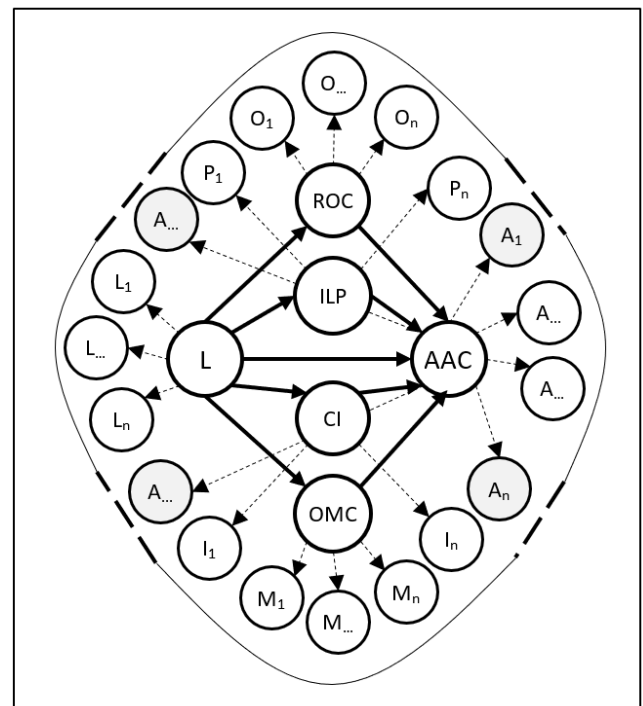


Figure 2. The theoretical model of organizational resilience [16], [17], [21], [20]

Thus, the analysis of organizational resilience definitions could, arguably, be considered to be one of the main drivers of organizational resilience and defined as interconnected components of leadership and adaptive capacities connected through the components of organizational culture, individual resilience, critical infrastructure, and managerial capacities. Crucially, each component of organizational resilience provides a set of managerial interventions. Therefore, as figure 2 exhibits, organizational resilience could be enhanced by improving all components. Nevertheless, from the perspective of enhancing organizational resilience, one of the most significant components is the adaptive capacity component (AAC), which is the component of managing uncertainties through managerial interventions dedicated to the development of resilience in its weakest areas (A...).

### 3 THE DEFINITION OF THE RESILIENCE OF PORT ORGANIZATIONAL ECOSYSTEM

As the global business environment changes, no company operates in isolation [22]. Rapid changes in global international trade, development of new technologies and integration into the business processes, and uncertainties in the environment create special emergency conditions for each organization and their business processes, including public and private capital organizations [23]. Such changes shaped the need for a flexible business models'

platform that would be capable of creating changes in business processes and performing flexible transitions in added value creation pursuant to unpredicted changes in organizational environment [24]. Platform-based business models focus more on the social and economic relationship between added value actions creation for the stakeholders and providing critical infrastructure [25]. This point of view considers the existence of organizational ecosystems with their own platform-based business processes. Initially, the definition of an organizational business ecosystem originated from ecology sciences and was later adopted for use in management sciences, especially in the field of business studies [26]. An ecosystem is explained as a group of interconnected players that act together with the common goals to create value and gain benefit under the conditions of balanced functioning together or incorporated with the external ecosystems [23].

Seaports are good examples of organizational ecosystems where there are many players and a lot of interactions between them while working together for the creation of added value for stakeholders and for the ecosystem's business processes excellence. This ecosystem serves as a profit source for a variety of businesses, including shippers, shipping agents, energy companies, importers, and exporters, port authorities, municipalities, and hinterland business organizations [27]. The first known definitions of ports as ecosystems can be found in research on port governance effectiveness [28], [29], which focused mainly on effective management related problem resolution. All managerial functional segments of the interface presented in figure 3 consist of different organizations, which consist of both public and private capital funded organizations, operate on national and international organizational levels, and have different interests in general, but share connecting interests of profit and benefit as well as effective functioning of port organizational structure for added value creation. Further, in the context of specialized functional triads operating in the global market, the maritime transport sector in the region was split into three categories including port authority, port, and maritime network. These findings had an impact on later research hypothesis that effectively managed seaports can have an impact on the whole maritime transport sector attractiveness in the region [30]. Thus, the management of the seaport organizational ecosystem which is dynamic and constantly evolving due to organizations interacting and adopting their environments based on co-evolution processes of the whole ecosystem can be considered highly complex[31]. Further, these findings create preconditions to analyse not only the effectiveness of the governance but also delve deeper into possible managerial practices that could serve to increase the responsiveness to the negative impact of external factors within these ecosystems.

The organizational ecosystem of the modern port serves as a profit finding centre for a variety of business and it consists of three levels(fig. 3): the infrastructure and the superstructure operational levels, and the added value creation levels which consists of extended stakeholders including societies and national economy [3]. Due to high organizational involvement and elaborate effective managerial

algorithms, this ecosystem creates the conditions for competitive cooperation development, which is one of preconditions for the adaptive capacity formation in ecosystems [19]. However, in this setting competition among port organisations is not only competition between the core competencies of the port, port industry chain or the port supply chain, but also competition between the whole port organizational ecosystem operating in line with the principles of the business ecosystems[22]. Thus, the phenomenon of competition influenced by added value increases cooperation in organizational ecosystems (fig. 3), and cooperation within seaport organizational ecosystems could be split into vertical cooperation, horizontal cooperation and the cooperation between organizations and the environment [32].

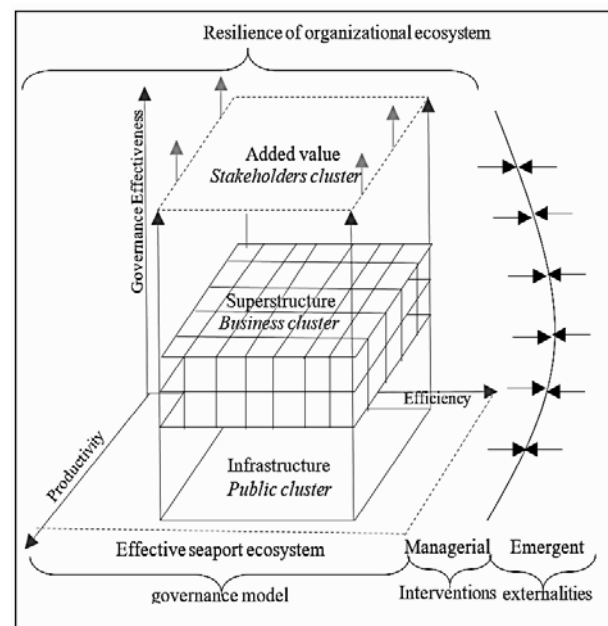


Figure 3. Illustration of the seaport organizational ecosystem [30], [33], [34]

Based on these findings, it can be argued that the organizational ecosystem does not exist in isolation but rather develops in tandem with different organizations helping to influence and replicate one another by competing and cooperating. The aforementioned attributes enable the definition of the port organizational ecosystem as the port business ecosystem, which centres around two additional factors:

- System level organizational goals usually focusing on performance and efficiency [35],
- Whether these goals can be accomplished depends on the organizational interdependence in the ecosystem based on interdependent workflows, often spanning conventional organizational and industrial boundaries [36].

Further, the seaport organizational ecosystem has been identified as the main workflow element uniting all port organizations to work on the global supply chain together for the added value purposes for themselves and for the whole ecosystem conforming to the main principles defined by modern management theories including principles of complex adaptive systems [33]. Consequentially, it can be

argued that the seaport organizational ecosystem as a business ecosystem is an added value driven system, with a demand for effective governance patterns, leadership, and is managerial interventions and practices oriented for the enhancing of ecosystems in their adaptive capacities [34]. These arguments enable the classification of an interlinked component between organizational ecosystems and entrepreneurial ecosystems in the context of port organizational ecosystem's resilience enhancement. As research analysis demonstrates, the definition of the entrepreneurial ecosystems is definitively related to the adaptive capacity component. This connection aids in the identification of the relationship between entrepreneurial ecosystem and the theoretical model of organizational resilience based on the definitions of adaptive capacity of entrepreneurial ecosystems as:

- Behaviour to modify or change characteristics fast according to existing or emerging stresses [18].
- Capacities to learn and to store knowledge on the organizational, ecosystem levels of structures, capabilities, and networks [19].
- Flexibility in application of knowledge to improve in adoption to artificial and natural hazards [20].
- Ability to make decisions on effective process information management with the purpose to strengthen resilience initiatives through qualitative and scientific methodology reliability [19], [37].

In addition to the definition of the port organizational ecosystems' resilience, it can be argued that the leadership and adaptive capacity components for increasing the resilience of the ecosystem are significant in the definition of business ecosystems as well as in the entrepreneurial ecosystems. A summary of the definition of port organizational ecosystems' resilience based on these findings could therefore be that the port organizational ecosystem has unique characteristics determined by its specific field of activities in the global supply chain and its critical role as crucial land-water interface, and also shares the characteristics of business ecosystems due to its added value oriented goals, and the characteristics of entrepreneurial ecosystems due to its need to develop in adaptive capacity. As such, the seaport organizational ecosystem's resilience could be explained by the model of organizational resilience and by adding the characteristic of adaptive capacity identified in the research on the resilience of business and entrepreneurial ecosystems. Consequentially, seaport organizational ecosystem's resilience could be enhanced by modelling the leadership phenomenon and its influence on adaptive capacity based on resilient critical infrastructures, resilient organizational ecosystem's culture, resilient human resources with organizational knowledge and experience, and effectively utilizing managerial interventions for managing uncertainties.

#### 4 THE DEFINITION OF UNCERTAINTIES INFLUENCING THE PORT ORGANIZATIONAL ECOSYSTEM

Based on findings presented earlier, the complexity of the seaport ecosystem's operational environment

emphasises that the functioning of the port ecosystem cannot be defined only by aggregation factors, but should be considered as an emerging phenomenon encompassing the components of an ecosystem's vulnerability and adaptive capacity [38]. Vulnerability within the seaport organizational ecosystem may be defined as one of the properties of this ecosystem, its premises, facilities, required infrastructure and equipment, inter- and intra- organizational constructions, including contracts, incentives, human resources, human organization and all its software, hardware and network, that may weaken or limit the ecosystem's ability to fight the threats and survive disruptions that originate both within and outside of the boundaries of the logistic supply chain ecosystem [3], [39], [40].

The definition of organizational ecosystem's adaptivity aids in logically connecting it to the theoretical model of organizational resilience, whereby the resulting driver of organizational resilience is defined as the component of adaptive capacity (fig. 3) and is broadly analysed upon adaptive management theory's principles where the resilience assessment process is identified [6]. The resilience assessment process is inclusive of risk assessment and has emerged in response to its pitfalls by providing a framework that considers the inevitability of unforeseen periods of gradual and rapid disruptions and leaving in flexibility to account for emerging information that may facilitate future adaptations of organizational ecosystems [41]. Therefore, it can be assumed that for the implementation of resilience assessment of the port organizational ecosystem it is required to have a complex model of the port organizational ecosystem's disruption factors.

The latest research on the seaport ecosystem's resilience [34], [42] found that some critical points of interconnections of maritime business with the environment cannot be minimized by simply adapting the governance models and patterns. As a result, additional managerial interventions must be identified and applied for the creation of organizational and inter-networking resistance to these factors dependant on their nature. As demonstrated in the theoretical framework of organizational resilience, all external factors should be considered before making resilience-based decisions in organizations within the organizational ecosystem. From this point of view, in the context of organizational ecosystem response, a single organization should not respond to externalities individually, but in line with the managerial and organizational capacities of the organizational ecosystem [42]. Another specificity of organizational ecosystem's resilience is based on the assumption that the maritime business' resilience could be evaluated through key performance parameters and organizational ecosystem's resilience could be enhanced not only in relationship to the contingency of the external environment, but also by including important internal emergent parameters, namely, external threats that are political, economic, social, technological, environmental and legislator-related factors that are divided into sub-groups of internal treats that are human, organizations, and networking and access factors which are further divided into the

sub-groups. All these disruptions can stem from a variety of factors: some are foreseeable, many are accidental, and others are unanticipated [34]. Therefore, it can be argued that for the enhancement of port organizational ecosystem's resilience these uncertain factors should be analysed and stored in a system which should be updated periodically because each one of the uncertain factors or their combination could influence significant vulnerabilities of the port organizational ecosystem.

Many vulnerabilities have been identified in the field of maritime research. Some authors [4], [10] recognize uncertain factors as the reasons for the port ecosystem's vulnerability: ship re-routing, export diversion, material resources usage, conservation, unused capacities, input substitutions, import substitution, production recapture, rescheduling of timetables. Other authors [38], [40] classify uncertainties into operational, security technical, organizational, natural, and managerial groups and identify these unpredicted factors' sources:

- Operational: equipment failures, vessel accidents, cargo spillage, human errors.
- Security and safety: sabotage, terrorism attacks, surveillance system failures, arson.
- Technical: lack of equipment maintenance, of navigational systems, IT infrastructure, dredging maintenance.
- Organizational: labour unrest, dispute with regulatory bodies, interorganizational conflicts, congestions.
- Natural: hydrologic, atmospheric, geologic, seismic uncertainties (fig. 4).

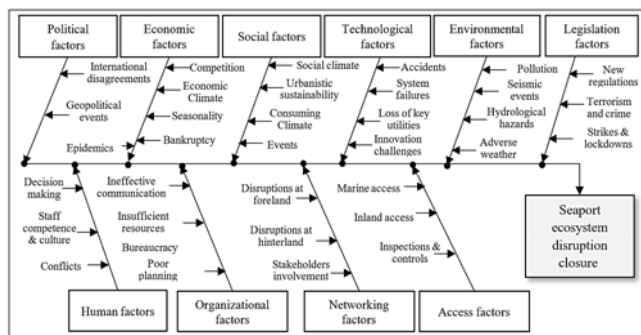


Figure 4. Seaport organizational ecosystem's uncertainties [43], [44].

Different types of uncertainties could trigger the vulnerabilities of the port organizational ecosystem (fig. 4), in different levels of environment (fig. 5).

Notably, the port organizational ecosystem is not only complex in itself, but also has a complex environment split into different levels: the microeconomic level which is created by organizations and their interrelationships; the mezzo economic level – which is created on the level of organizational ecosystem; the macro level which is created on the level of national economy, the mega level which exists in the regional context and seaport organizational ecosystem's the giga- level connecting externalities on the level of global international economy and trade [30]. Based on the PESTEL methodology, all external uncertainties placed on the macro, mega, and giga economic levels are split into functional groups by their nature. So, they are

uncertain factors in the fields of policies, economic, social, technologic, ecologic and law [34]. Factors of the micro and mezzo economic environment of the port organizational ecosystem are not external, but internal uncertain factors, which can also have a negative impact on the decreasing of an ecosystem's resilience if they are not controlled and managed [10].

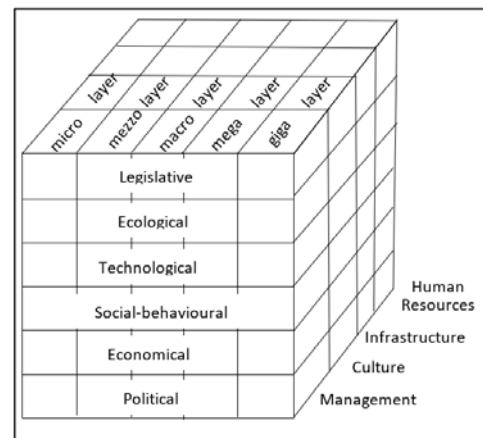


Figure 5. Theoretical three-dimensional model for the port organizational ecosystems' uncertainties

These findings allow the assumption that the general classification of uncertainties is a two-dimensional model but, according to the organizational resilience theoretical framework, they also are divided into functional groups pursuant to possible managerial intervention types. So, the assignment of uncertainties' parametrization transforms into a three-dimensional model and increases in its complexity. By defining possible uncertain factors and possible alternative reactions by applying different managerial interventions it is possible to improve the seaport organizational ecosystem' ability to handle expected and unexpected situations to continue functioning in a systematic resilient manner.

## 5 CONCLUSIONS

The definition of organizational resilience suggests that theoretically organizational resilience could be presented as the parametrized model of nonlinear function, consisting of six components split between the main resilience drivers (leadership and adaptive capacity) and components – arguments (critical infrastructure, organizational culture, individual resilience, organizational and managerial capacities).

Theoretical analysis of scientific sources on the organizational ecosystems, business ecosystems and entrepreneurial ecosystems aid in determining that the enhancement in resilience is related to increasing adaptive capacity and this increase should be implemented by developing the leadership phenomenon in organizations which also results in an increase in business excellence. Because the seaport functions as the port entrepreneurial ecosystem, their added value is business excellence of the whole ecosystem as well as business excellence of organizations which are operating in this ecosystem. The leadership component is the driver for

accelerating managerial interventions in combatting vulnerabilities which results in the enhancing of the adaptive capacity that is the determinant of the organizational ecosystem's resilience. Modelling port organizational ecosystem resilience could be implemented by combining the adaptive capacity function with the leadership argument where leadership is a function of the four main resilience components: critical infrastructure, human resources, organizational culture, and the organizational and managerial capacities. The outcome of resilience enhancement is increasing the business excellence of the port organizational ecosystem.

In line with the complexity of port organizational ecosystem, the external and internal uncertainties also have high levels of complexity and could be presented in at least a three-dimensional uncertainties' model: the first dimension is the nature of uncertainties according to PESTEL methodology, the second – the level of localization in the context of appearance, and the third one is the uncertainties classification pursuant to the main components of resilience such as individual staff resilience, organizational and managerial capabilities, organizational culture and critical infrastructure. The construction of a theoretical model of seaport organizational ecosystems' uncertainties creates possibilities to elaborate and develop effective managerial interventions for the increasing responsiveness and resistance of all ecosystem's unpredicted vulnerabilities.

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