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TOE framework in risk management during implementation of the Croatian national Port Community System

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ABSTRACT

The subject of this paper is use of Technological-Organisational-External (TOE) framework during implementation of the Croatian national Port Community System between 2018. and 2022. Main research hypothesis is that TOE framework is a suitable, yet generally unrecognized abstract model for project risk mitigation during development of complex maritime cargo single windows systems. Formal development requirements along with the main stakeholders and their internal systems are identified. Project risk is mapped to the framework's criteria, its execution and main milestones are identified and discussed, including risk occurrences during project execution, leading to confirmation of the work hypothesis. As a conclusion, improvements to the methodology are proposed, along with possibilities of the future research.

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1 Introduction

Port Community System (PCS) is an open and neutral electronic platform, an information system whose goal is to enable more efficient, secure and intelligent exchange of information between all public and private stakeholders in the port business process. It automates and optimizes port and logistics processes through a single, unified transmission of data and information and, thus, connects transport and logistics chains. Its purpose is increase of the competitiveness of the entire port system [1].

The main goal of the project of PCS implementation in the Port of Rijeka is connecting all port stakeholders, both government services and private companies, and the digital information systems they use, through one digital platform, to the Croatian Integrated Maritime Information System (CIMIS) [2], [3]. Main stakeholders and connectivity are shown in Figure 1.

The establishment of the Croatian port community system began in late 2017. At that time, the Port of Rijeka Authority received funding from INEA institutions in the form of a Connecting European Facility – PORT2CORE – Port Community System [5]. The funds would have been used for a number of related activities, including technical assistance contracts, development services contracts, including hardware and network components required for delivery and integration, and final audit services. The project is managed by the Port of Rijeka Authority and directed by the Croatian Ministry of Maritime, Transport and Infrastructure [6]. The main idea of the project was to align project development with other existing developments in digital technology in the maritime sector during the implementation of the project and to establish a system that could be deployed at other Croatian cargo ports after the successful completion of the initial pilot project at the port of Rijeka.

With a very ambitious project scope in which many stakeholders are involved, relatively few funds are available, under strict contractual conditions and available timetables, it immediately became apparent that many risks will affect project implementation from its start. A study was conducted to identify a risk-appropriate framework to follow up the development of such a complex system with many internal and external stakeholders and risk types. A research assumption was developed that the TOE frame-

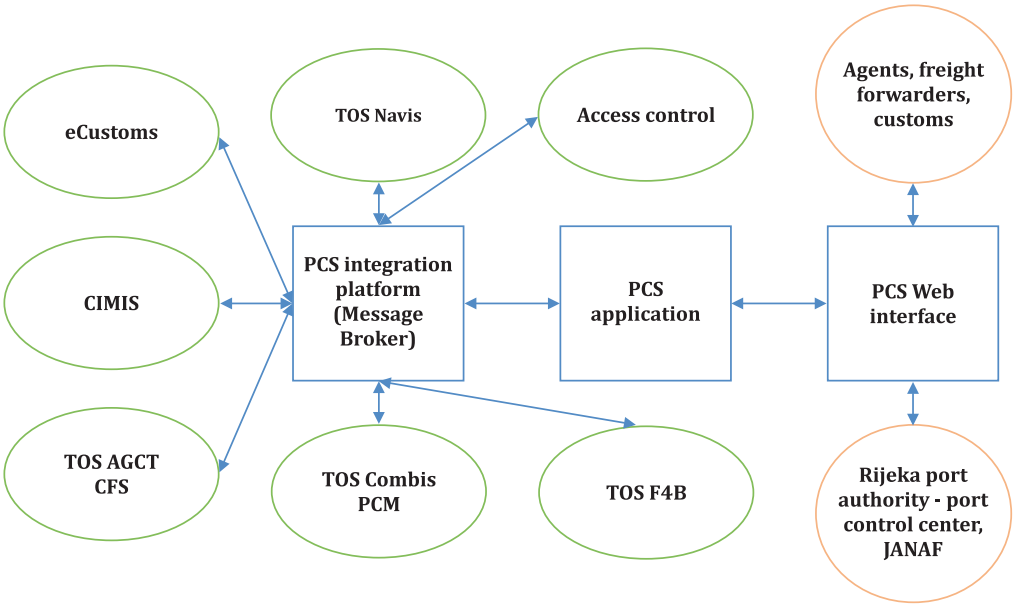

Figure 1 Architecture of Rijeka PCS and connection with other information systems

Source: Authors

Risk factors in PCS implementation – TOE ontology	**(T)echnology –** availability, feasibility, affordability, integrability
	(O)rganization – formal and informal pressures, communication, technical assistance, internal organizational structure
	(E)nvironment – quality of supplier's services, stakeholders, infrastructure, regulations, EU efforts in maritime single windows

Figure 2 TOE ontology

Source: Authors

work could be a suitable candidate, and an internal analysis led to the decision to adopt the framework and to track its performance and capacity, in contrast to the project management risk approach adopted during the four-year project implementation period until the system became operational in January 2022.

The Technology–Organization–Environment framework (TOE) is first described by researchers Tornatzky and Fleischer [7]. Initially, as an organization level theory, it was envisaged to describe how the firm context influences adoption and implementation of innovations [8]. However, recently, this framework was used also to describe other qualitative characteristics of complex systems and implementations, including sources of risk. Basic layout of TOE ontology is shown in Figure 2.

Therefore, in this research, a main research hypothesis is identified during the very inception:

- TOE framework is a suitable tool to envisage and follow up risk during development of complex maritime cargo single window systems

Supporting hypotheses of the research are:

- Nature of the risks during development of complex maritime cargo single window systems are suitable candidates for domains of TOE framework, and
- TOE framework is a suitable risk management model to be applied during project execution where circumstances change unpredictably, jeopardizing favourable end results.

In order to prove research hypothesis, previous research on the topic is going to be identified in form of a brief literature review. Then, formal development requirements and project risk register is going to be identified and discussed aiming to identify gaps in the risk identification. Instead of traditional risk management approach, TOE framework is going to be adopted and risk will be identified according to that framework, striving to lessen the gaps in comparison to the traditional approach. In case that some risks are identified using ToE framework while they were not identified using traditional risk approach, research hypothesis is going to be proven and ToE framework would be more suitable for this purpose than traditional risk approach.

2 Previous research

Tracking of the project risks is typically just generally delegated towards senior management that needs to pay attention to the monitoring of the project risks and mitigation efforts, that should be in line with projected schedules [9]. Some authors, deriving on previous experience, conclude that in some cases there is a possibility that the costs of implementation may be higher than the benefits [10], rendering entire implementation projects futile. In most cases, risk assessment related to maritime cargo single windows is focused on their economic feasibility. The quantitative benefits can be evaluated in terms of classic project management methodology and financial indicators and methods, while qualitative benefits are best suited to be exploited through strategic analysis. Careful consideration is needed during the analysis, in order to avoid biased input parameters which could obscure the end result [11]. However, this approach has inherent premise that PCS system is already successfully implemented and producing certain effects, which cannot be taken for granted when approaching a project of building a new PCS. European Union uses also predominantly outcome-based global risk approach, and it is focused on better rule enforcement (risk analysis-based checks) and policy making (better statistics) [12].

According to the World Intellectual Property Organization, the main business risk factors relevant to almost all organizations and the mark assigned to them can be summarized as: financial risk – 35%, strategic risk – 25%, operational risk – 25%, legal and compliance risk – 15% [13].

By analysing these risk groups on the example of NSW implementation, there are nine most common challenges: lack of government support, complicated procedures and document requirements, budget and human resource constraints, organization and human resistance to change, inadequate coordination between customs, other regulatory institutions and the trade community, laws and legal challenges, inadequate legal framework, lack of leading agency, lack of information and communication technology (ICT), security issues (due to centralized information sharing and electronic documents) [14].

Different approach is taken by the researchers that are more technically oriented in their research, and such vision of risks during project execution is limited to aspects of the underlying technology, their digital components and cybersecurity. They recognize that until few years ago, ports were mainly concerned about physical security. However, nowadays the highest risk lies in cyber attacks [15]. However, some authors do recognize that there is a curtailed cybersecurity of maritime awareness as well as an importance of the holistic approach based on risks and maritime cyber risks valuation that are associated with authorities of maritime and indication of the crucial assets around this sector [16]. Considering that a PCS presents a portfolio of new operational functionalities implemented within the Port Community, it needs to demonstrate a good compromise between financial return on investment, success factors, impact of possible project introduction risk on current business development and infrastructure improvement [11].

Based on previous research, there seems to be a disjointed approach to risk analysis and management methodology during development of complex cargo maritime single window systems, where different stakeholders, based on their previous experience in a separate segment of the system, take a different approach towards individual risk types and mitigation measures, instead of an integral model approach. This fact has served as an initial impetus for the research of this topic. Treatment of the topic of risk management during time and finance limited complex cargo maritime single window projects is sparse and incidental and has not been thoroughly covered. Existing research is oriented towards top-level risk and there is a pronounced disregard of other risk categories. There was no identified research effectively addressing risk management during PCS implementation using TOE framework, so in this paper, it will be used to identify risk categories that were overseen using traditional project management methodology.

3 Formal development requirements of Croatian national PCS

Rijeka PCS is designed to improve and facilitate optimal flow of information between the participants in the integrated maritime and land transport using integrated components. The main requirement was therefore interoperability with the existing IT systems of individual port community members, CIMIS system and the eCustoms [17]. Also, the key requirements are simplification and optimization of business processes between members of the port community, single data entry and ensuring confidentiality, integrity and availability of data. The design of the Rijeka PCS had to be adapted to the configuration and layout of port of Rijeka and all its four separate port basins [18] – central port Rijeka-Sušak, Bakar, Raša and Omišalj [19].

Design of Rijeka PCS also had to include addition of the future stakeholders to the port community. Stakeholders of the PCS system are involved in the transport of goods and related activities, while their scope differs and depends on the profile and activities of each company. Each individual future stakeholder has to be able to protect its own data and control the data for which it is authorized.

The most important stakeholders of the Rijeka PCS are Port Authority, Harbor Master's Office, The Ministry of the Sea, Transport and Infrastructure, Ministry of the Interior (border police), Customs authorities, maritime carriers, port concessionaires – terminal operators, maritime agencies, shipping companies and transport organizers, land carriers (rail and road), sanitary inspection, phytosanitary inspection, veterinary Inspection, and other administrative services.

Given the large number of port basins, existing and future PCS users operating in them, design of PCS includes 11 different system modules, where each module is designed for a specific group of users and a specific part of the business process.

Modules of Rijeka PCS system and their interconnections are the following:

1. Module for official procedures of maritime administration – exchange of the information with the CIMIS system using CIMISNet specification (D1) [20]
2. ECS (Export Control System) and ICS (Import Control System) module – exchange of standardized messages in accordance with the current specifications for customs procedures prescribed by the Ministry of Finance (D2) [21]
3. Module for port container terminals operations – exchange of standardized messages with port container terminals; delivery and dispatch of containers by sea and land, handling of containers at the terminal, support for other processes in container traffic, warehousing (D3)
4. NCTS (New Computerized Transit System) module – exchange of standardized messages in accordance with the current specifications for transit customs procedures prescribed by the Ministry of Finance (D4) [22]
5. Customs module – exchange of messages with the eCustoms system, provision of data for local risk control and integration with user applications for communication with the eCustoms system; acceptance and dispatch of the cargo, records of goods in and outside of customs zones, verification of the data in the PCS system and eCustoms records (D5)
6. Module for port coordination and task planning – announcing tasks to terminal operators by the service users, planning of use of the resources, determining the order of; ship/railway/truck loading and unloading operations, operational planning of warehousing operations (D6)
7. Module for control of access to the port area – control of vehicles and persons in the port area under ISPS rules, announcement of arrivals of vehicles and persons in the port area, issuing permits, collection of entry fees, exchange of messages with the port terminals, connection with devices for control of vehicle entry and persons in the port area (D7)
8. Module for conventional cargo warehouse operations – exchange of the information with IT systems overseeing warehouse operations for conventional cargo; delivery and dispatch of goods by sea and land, handling of containers at the terminal and in the warehouses and other processes in container traffic (D8)
9. Module for hinterland container terminal operations – exchange of the information with hinterland container terminals; delivery and shipment of containers and goods by land, container and warehousing operations at the terminal (D9)
10. CFS (Container Freight Station) module – container manipulation orders at the container terminal, storage and warehousing (D10)
11. AGCT Rail module for rail container traffic – railway wagon operations (D11)

Orchestration of connections and message exchange between different stakeholders using interconnected systems and PCS modules is shown in Figure 3.

In order for all these modules to be successfully created and put into operation, PCS needed to be connected to the following diverse information systems used by port operations stakeholders:

1. CIMIS – developed by the Ministry of the Sea, Transport and Infrastructure (MMPI). Users are the administrative authorities involved in the departure and arrival of the ship, Customs, maritime agencies and others
2. eCustoms – the Customs Administration uses standardized messages for customs procedures, harmonized with EU regulations. ECS and ICS modules are used by maritime agencies to report cargo on arrival and departure of a ship, while NCTS is used by shipping companies during transit
3. Terminal Operating System (TOS) F4B – used by the concessionaire Luka Rijeka j.s.c. to monitor the operation of its conventional cargo warehouses
4. TOS COMBIS – company Luka Rijeka j.s.c. [24] uses TOS business information system to monitor the operation of its container warehouse at the Škrljevo hinterland terminal
5. TOS NAVIS – operated by the Adriatic Gate Container Terminal j.s.c [25] and uses the Navis [26] business information system to support its business processes on the Brajdica container terminal
6. TOS AGCT CFS – operated by the Adriatic Gate Container Terminal j.s.c , used for container operations and entry and exit of goods from the terminal warehouse

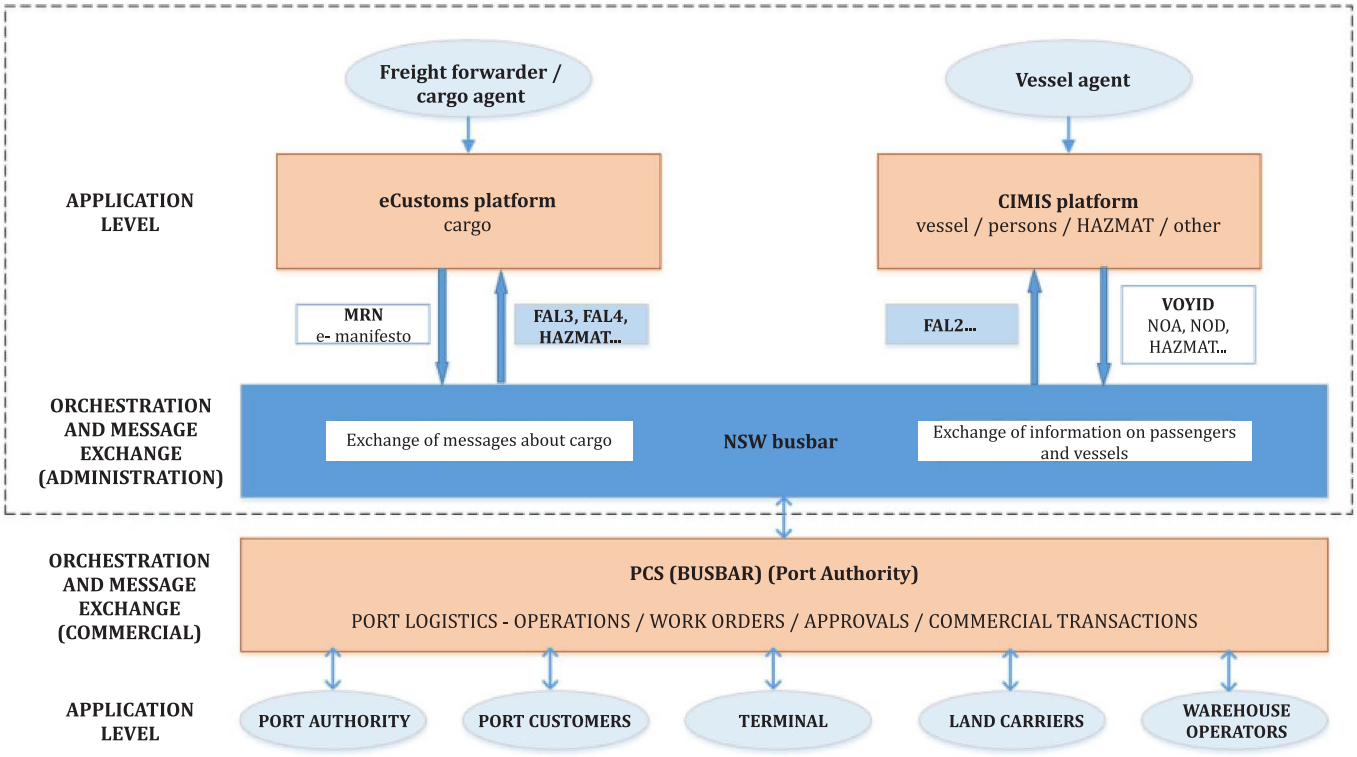

Figure 3 Connections and message exchange between different stakeholders

Source: [23]

7. PORTUNUS – IT system used by concessionaires in the Port of Rijeka to control access to the port area [27]

Diverse PCS modules, stakeholders and numerous integrations with external systems that are also changing during project execution proved to be the main sources of risk.

4 Project execution and critical milestones

Project execution can be divided to several phases, where each phase was marked by occurrence of a number of risks that resulted in annexes to the original contract, extension of scope and change of dynamics of the project development. After starting the project development and integration formally in May 2019., the first major milestone was creation of a functional specification of entire PCS system and development of D1 module in the supplier's test environment. This activity should have been executed in parallel with delivery and installation of the hardware in two separate physical environments, where production environment would be set up and D1 module transported into production. Part of this activity was also setting up administrator's workplace and education centre.

Due to difficulties in initial project kick off and supplier's team organization, slight latency in delivery of hardware and integration services, changes in focus of different stakeholders, and the fact that national CIMIS system was not ready for bidirectional communication, it was apparent that a change of the project plan will be needed. As a consequence, the supplier could not deliver an integral functional specification for the system. In May 2020., the first annex [28] to the original contract was stipulated, formalizing the required changes. According to this annex, functional specifications for individual modules will be delivered along with their acceptance In the summer of 2020., the hardware was delivered and installed in the physical locations.

Development during 2020 was significantly impacted by the onset of covid-19 pandemic, and work shifted predominantly to remote mode and virtual meetings between all parties involved in development. While partial module development was completed, many others were in early testing stages. Mid-2020 there was still no bidirectional communication with national CIMIS system, which was a staple for further integration. Some concessionaires have started internal analysis to ensure alignment with the PCS, while others were lagging behind. The supplier has started providing maintenance and helpdesk services for the integrated modules. There was an open opportunity to extend the project for one more year, and late in 2020, second annex [29] to the original contract was stipulated and financial value was increased for 17 % because of the operational cost of the system for one more year of development and identified need to develop three additional modules (D10, D11 and D12).

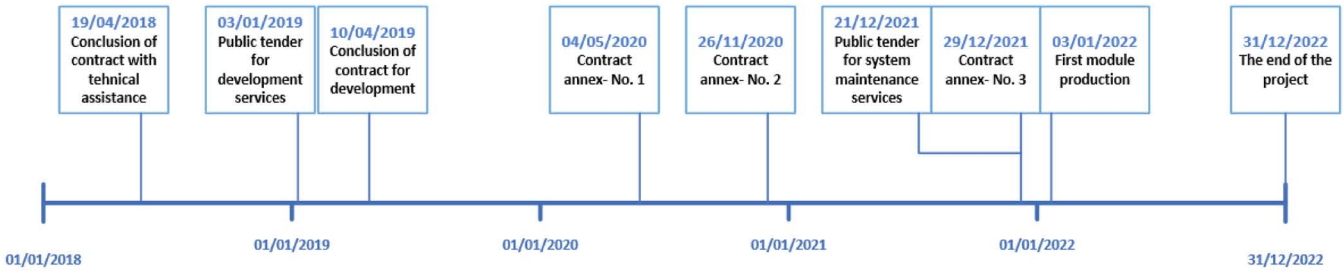

Figure 4 Implementation of Rijeka PCS – project timeline

Source: Authors

Development throughout 2021 was very intense, and several modules were completed in that period, including access control module (D7). After mid-2021, supplier of the development services for the Ministry has delivered to production the new version of national CIMIS system, with bidirectional communication capabilities, so module D1 was fully delivered. Modules dedicated to customs operations (NCTS, ECS/ICS) were also rolled out, along with planning and control part of the D6 module for Luka Rijeka j.s.c concessionaire. Testing of D3 module for Adriatic Gate j.s.c. was partially completed and initial meetings, process mapping and message exchange were tested for modules supporting processes of the Luka Rijeka j.s.c for their terminal and hinterland operation modules. However, late development of interconnected systems of other stakeholders, and unavailability of concessionaires for testing and development has resulted in further delays. To regulate this situation, at the very end of 2021, the third annex [30] to the original contract was stipulated, and with approval of INEA agency, the project execution is extended for one more year, until end of 2022, and itemized prices were negotiated with the supplier in order to ensure development services coverage in that period.At the beginning of January of 2022, the PCS system is put to production, with Port Control Center (LKC) [31] being the first user of the system, and plans to immediately roll out module D6 and D7 for planning and coordination for concessionaire Luka Rijeka j.s.c. Furthermore, technical assistance has completed a set of documents for public procurement for the future maintenance services that was issued on the public procurement portal of the Republic of Croatia [32]. This has marked formal start of the production work of the national PCS that has started its operations in the Port of Rijeka, and despite extension of the original contract for two years, there are sufficient arguments to claim it might end successfully until end of 2022 provided that concessionaires and other stakeholders remain committed to integration of their systems and processes with the PCS.

As it is clearly evident from the brief narrative of the project execution during the past four years, it has suffered from materialization of envisaged, but also unforeseen risks, and the risks have been managed competently, ensuring that the project is near its final goal. Initial project duration was extended almost twice, from one year and seven months to three years and seven months at the end of the third stipulated annex, but with strict control of the budget. Project timeline is shown in Figure 4.

Critical milestones according to the initial project plan were (1) creation of the module D1 in the supplier's environment, (2) installation of hardware and network components and (3) creation of overall functional specification. First and second milestone were reached, the third milestone was not, but it proved not to be critical for further project execution. It is interesting that the project plans according to original contract annexes do not anticipate milestones that would be on the critical path for the execution, instead, the project execution was atomized, as it was important to use available funding and deploy as many modules and functionalities as possible, deviating from the initial plan. However, this seems to have been a logical consequence of varying levels of involvement of various stakeholders and especially concessionaires in the project.

5 Methodology

Initially, only a handful of risks were envisaged, and it was proposed that the supplier should propose and explain the model of management of possible adverse effects on the project that it plans to apply during the implementation of the project, and the acceptance of which will be considered by the client. By managing potential adverse effects during project implementation, the supplier should have ensured timely detection and effective management of potential critical external or internal impacts and events, and preventively propose effective ways to eliminate, transfer or reduce the level of impact of adverse effects on the project. The method of managing possible adverse effects on individual components of the project includes the method of communication with the client, harmonization of diagnostics, degrees of danger and the harmonization when planning the treatment of adverse effects.

The following Table 1 defines main initially identified possible adverse effects on the progress and final success of the project, the probability of occurrence, impact on the project, and measures to eliminate, transfer or reduce the level and severity of the impact with adverse effects on the

Table 1 Main initially identified possible adverse effects on the project

Group	Name of risk	Risk description	Probability of occurrence	Impact on the project	Preventive measures / risk response
STRATEGIC	Changing the way key concessionaires operate	Changing the way key concessionaires operate may have a significant impact on changes in the logistics chain. Changes caused by changes in the environment can cause significant changes in system planning and design.	Small	Medium	At the time of implementation of each module, the rules that are valid at the time apply and based on them, the module functional specification will be created and the module in question is implemented. If the change occurs after that, there is no guarantee the change will be invorporated into the application within the scopeof the project, and has to agre with the client on how to resolve the situation. It is possible that the implemented PCS system will need to be upgraded in accordance with these changes relatively soon after delivery.
	The arrival of new key concessionaires	It is possible that a new concessionaire could start operations on the Zagreb Deep Sea container terminal – under construction.	Small	Medium	New users will be able to integrate into the PCS system if their IT systems comply with the specification. For users who do not meet the harmonized integration requirements, it will be possible to access the PCS system via a web application.
	Supplier Business	Difficulties in the Supplier's business, which may affect the quality and implementation of the project implementation plan.	Small	Low	The supplier is a stable company with many years of experience and successful results in the implementation of similar projects. The deadlines of individual phases can be moved with careful monitoring so as not to jeopardize the deadline for the project's implementation.
	Personnel changes of the supplier	The leader or key member of the team leaves the project (company). In that case, the supplier is obliged to provide adequate replacement according to the contract, but it is still possible that such changes will cause delays of the phases according to the project plan.	Medium	Medium	The supplier has other resources at its disposal that can replace existing ones.
OPERATIONAL	Inability to reconcile key concessionaires	Key concessionaires in the logistics chain do not fulfill the obligation to adapt their IT systems according to the harmonized specifications on which the implementation of the PCS ICT system is based.	Medium	Medium	An interface to which they can be linked in the future will be defined, provided that they meet predefined specifications. For users whose IT systems will not be able to use messaging, it will be possible to access the PCS system via a web application. Also, partial use of existing applications and partial PCS integration is possible.
	Endangering the project implementation deadline	Strictly limited deadline – until end of.2020. (cannot be extended due to EU project restrictions)	Medium	High	Regular monitoring of deadlines according to plan and control over possible overshoot of the project deadline due to the initial lack of clarity of requirements. Robust change management.
	Change management – variability of user requirements	Multiple changes to already identified user requirements due to insufficient initial understanding or insufficient involvement of key stakeholders.	High	High	It is necessary to precisely identify requirements with key stakeholders in the process, establish a common understanding and seek confirmation from the client.

Group	Name of risk	Risk description	Probability of occurrence	Impact on the project	Preventive measures / risk response
OPERATIONAL	Change management – exceeding the scope of the project due to imprecise requirements	A wide and open scope of requests, which are not precisely defined, but the task is to determine them precisely in the analysis phase. It could lead to exceeding the scope of the project and consequently jeopardizing the strictly limited deadline for project completion.	High	High	It is necessary to limit the requirements and direct them towards simplification, in order to ensure that the system works within the limited time available and scope of the project. It will be necessary to assess which of the possible requirements are not the subject of the project. They can be included in the candidates and/or recommendations for future upgrades.
	Insufficient stakeholder participation in the analysis	Non-participation of key stakeholders in the process or the unavailability of stakeholder staff with appropriate knowledge in the analysis and definition of requirements can lead to poor functional specification and shortcomings of the final system.	Medium	High	It is necessary to plan well the workshops and participants in them, to establish effective communication with the stakeholders and to ensure the availability of staff with key knowledge. It is necessary to raise awareness of the need to participate and immediately resolve any problems in close cooperation with the client.
	Modules with limited functionality in production	Since some processes take place through several modules, due to modular delivery into production, some of the functionalities of each process will be available only with the delivery of later modules, so previously delivered modules will have limited functionality that will be fully functional only in later deliveries. This may seem like a problem to the end user and the client may get the impression that the module is not working properly.	High	Medium	Early and clear communication is of primary importance. Each delivery will include parts of the process that are not visible in that module due to the connection with the modules that will be delivered according to the project plan later.
	Team coordination	Deficiencies in the coordination of the Client, technical assistance and supplier teams	Medium	Medium	Well-defined project roles and communication plan. Regular coordination meetings and/ or reporting, communication via email and elephone, constructive cooperation and good information of the responsible members of the project team are required.
TECHNOLOGICAL	Technology change	Possible change of the chosen technology, cessation of support for one of the key components of the system, or changes in the licensing policy of some of the key components of the system with an impact on the project	Small	Medium	The supplier selects modern and widely accepted technologies for implementation, for which the risk of cessation of support or significant changes in the way of licensing is reduced to a minimum. The architecture of the application software is based on modern standards, which allow relatively easy upgrade or replacement of system components, with available documentation.
REGULATORY	Change of legislation	Changes in legislation with possible impact on business processes in the maritime and land logistics chain. Given that a project is underway that will bring about changes in customs systems, it is possible that these changes will occur during the implementation of the PCS project or shortly thereafter.	Medium	Medium	At the time of implementation of each module, the rules that are then current and in function in existing external systems apply, and on the basis of which the module specification has just been prepared and therefore the module in question is implemented. If the change occurs after that, the supplier cannot guarantee that it will incorporate the change into the application within this project, and agrees with the client on how to resolve the situation. It is possible that the implemented PCS system will need to be upgraded in accordance with these changes relatively soon after delivery.

Source: Authors

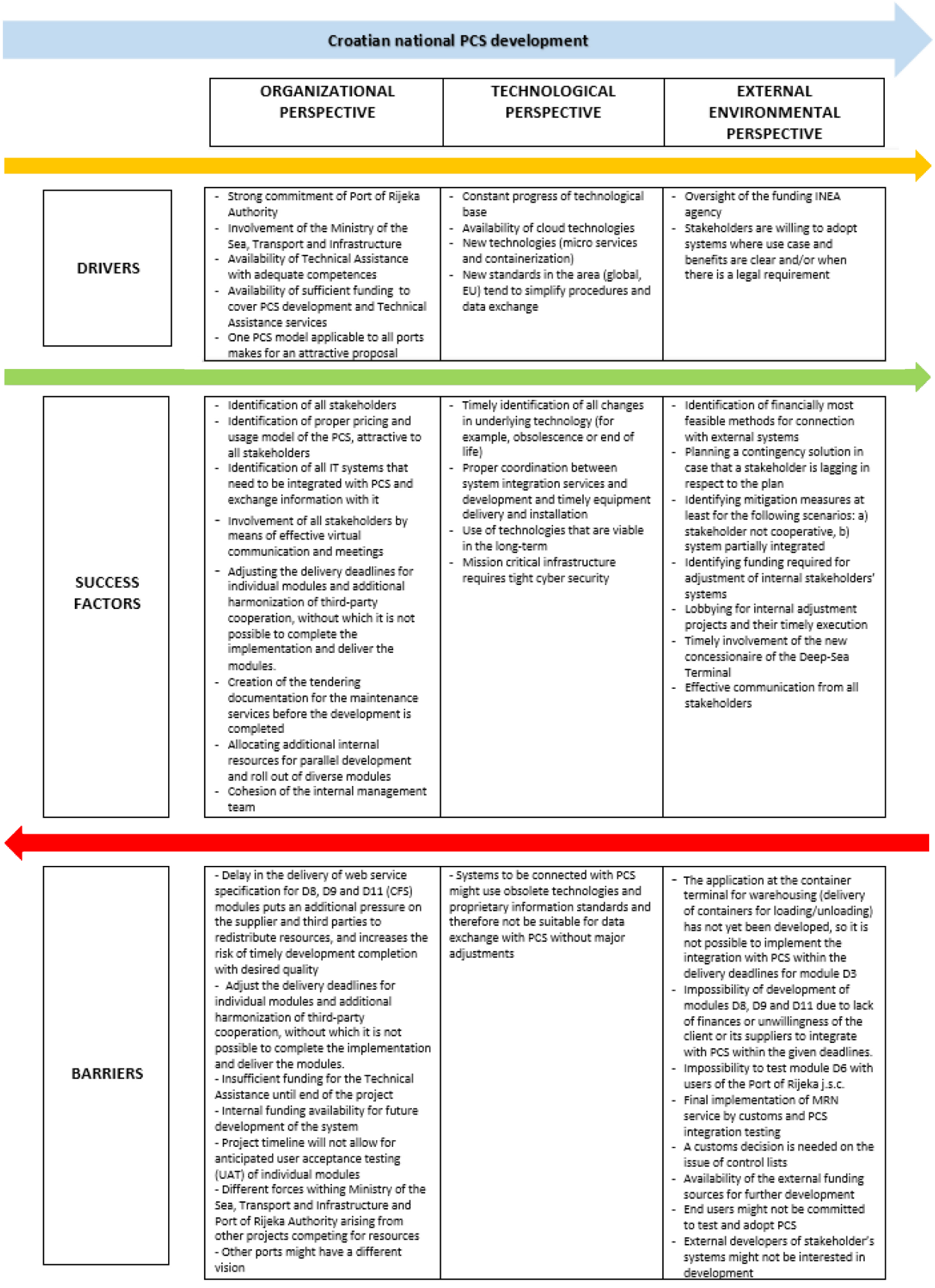

Figure 5 TOE framework of drivers, success factors and barriers of Rijeka PCS development

Source: Authors

project. The risks were coarsely divided into strategic, operational, technological and regulatory categories. This internal risk registry was later used as a source of information to be mapped onto TOE framework for risk management.

The goal of mapping identified risks to TOE ontology is to align the risk management methodology of the PCS implementation project with desirable goals of enterprise risk management (ERM) by accentuating positive events and avoiding or managing negative ones [33]. The initial risk management matrix did not follow TOE framework, instead, it used a custom enterprise project management risk registry. All risks arising from the project execution until production work of the first module (D1) that were identified and managed along with measures are processed according to TOE framework and the end result is shown in the following table. Therefore, in the next step, project risks are ex-post mapped onto TOE framework.

6 Discussion

Initially adopted approach to the project risk management has followed traditional enterprise risk management methodology according to the PMBoK (Project Management Body of Knowledge) [34], and also attempted to identify not only risks, but also opportunities during the project execution. While ToE framework's approach clearly delineates the difference between internal and external forces affecting the project risk, traditional project management approach groups risk sources according to different criteria with focus on the risks' inherent qualities (regulatory, technological) and levels on which they show their effect (strategic, operational). As the PCS is a system that is connected with many other systems, this approach is clearly inadequate as it does not sufficiently represent risks that may occur with other stakeholders and their systems. These risks occurring in the environment of the project are often obscured, but they have a large impact on the process execution. Drivers, success factors and barriers of Rijeka PCS development mapped onto TOE framework are shown in Figure 5.

Using described TOE framework, at the beginning of the production work, the following residual risks were identified that will have impact on the project until the completion:

1. Harmonization of data flow and message exchange between PCS and MNSW CIMIS needs to be ensured in production system, as CIMIS does not allow for up-to-date test work environment,
2. There is a risk of inability to deliver modules D8 and D9 until the end of the project as the functional specification and development is in initial stages. At the moment, this risk was treated by additional contract extension until end of 2022,
3. There is a number of parallel project activities and development of different modules, putting a pressure on the capabilities of the supplier and jeopardizing module completion and integration, and their final quality. The extension of the project also reduces this inherent risk.
4. Given that the comprehensive transition of module D3 to production requires additional comprehensive testing, taking into account the availability of the concessionaire and other stakeholders, the deadline for the transition of this module to production can be more easily adjusted to the new framework of the final contract extension.
5. Risk of development of module D10 has been carried over to the beginning of the production work. Extension of the project opens the possibility of implementation of D10 module. Agreement will need to be reached whether the concessionaire will allow production work of D3 module without CFS, or it will insist on simultaneous production of both modules. The deadline for continuing cooperation on the integration of the CFS module with PCS, as well as the likely date for its transition to production is still unknown, so the implementation of the D10-CFS module is not possible before the end of the Q3 2022.
6. The customs decision on the abolition or retention of control lists in the customs system has not yet been made, and the PCS continues to operate according to the current rules, which means that the control lists previously generated in the customs IT system will be entered manually into the PCS system. These functionalities have been successfully tested as part of the comprehensive internal UAT testing of module D3.
7. Services for NCTS and HRAIS are still not developed on the customs side. PCS can function without these services, but MRN services are not integrated. They will be integrated with new versions of NCTS5 [35] and HRAIS2 [36].

7 Conclusion and future research

An endeavour was started mid-2017. under umbrella of CEF EU funding in Croatia to start development of a national model of Port Community System that is first implemented in Port of Rijeka and started its production work early in 2022. This Port Community System, a digital platform for exchange of messages and data on cargo between different involved stakeholders of the port cluster, should be subsequently implemented in other Croatian cargo ports. The process included different internal and external stakeholders, from the Ministry, Port Authority, supplier of integration and development services and technical assistance team, to external stakeholders that include different concessionaires, customs, police, port captain, ship and cargo agents, port control center, and diverse digital systems that will exchange data with the new PCS.

Project risk management was proposed by the supplier and managed in a traditional manner of enterprise risk management. The project risk was divided into several categories, and included strategic, operational, technologi-

cal and regulatory perspective with identification of risk probability, impact and mitigation measures. This type of approach is appropriate for projects and environments where there is a high level of categorical risk (for example, related to complexity of the used hardware, network and system support), but it lacks in refinement in situations with diverse stakeholders operating their own information systems that need to be integrated and exchange messages with the PCS. These environments are typically external in comparison to the PCS and carry undisclosed disk categories that are difficult to plan in advance, as those planning and managing the project typically have very low visibility of these complex external systems and even less possibility to implement mitigation measures.

Execution of the project was heavily under influence of the identified and residual risk. While the classical approach proved to be sufficient to manage and treat identified risk, it was not adequate enough to lower the residual risk to a minimum practicable level. This is evident by the fact that mapping primary risk to TOE framework demonstrated a more comprehensive risk registry, including perspectives, but also drivers, success factors and barriers, enabling more efficient risk management.

The possibility of a future research lies in the application of the explained process in analysing and reengineering other processes (mainly commercial processes, not administrative ones) related to the introduction of integral business information systems best suited for seaport clusters. As the system has entered production work as of January 2022, and the development services contract will expire at the end of 2022, future research might also include a final iteration of risk registry being run through TOE ontology to identify final state of the project risk.

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