

DigLogs

Analyses of the most attractive traffic automation systems already on-going and directly transferable in the ITA-CRO area

Deliverable 3.3.2

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Introduction

The purpose of this deliverable is to select and extensively analyse the most promising innovations related automation systems among the ones gathered in D3.1.3. The activity has been carried out by Elevante Srl and UniTS inquiring all the other PPs.

In this Deliverable the most attractive innovations already on-going and directly transferable in the Italy-Croatia area in the prospective three years are analyzed. To achieve overall goals, a straightforward methodological approach is developed, which is composed by two streams of activities.

First, a best practice analysis is conducted on a number of already-on-going innovations. The results are shown in the form of “cards”, reporting an in-depth analysis of each selected innovation. All PPs have been asked to collaborate and carry out at least one analysis each, in order to define the state of the art and the most recent developments regarding the innovations that can be applied in the next three years in the project area. In addition to those provided by PPs, WPL (PP2) carried out 5 analyses and PP4 UniTS 3, while the LP has provided a document that also included several analyses.

Secondly, in order to get an effective assessment about the transferability of available innovations, PPs are involved to identify priorities. The overall idea is to move from the level of disruptive innovations to pilot actions in a smooth and coherent manner. In particular, an on-line questionnaire was developed in which each PP is asked to identify tech priorities by ranking the innovations identified in the previous Deliverables on the basis of two criteria, e.g., their importance and easiness of implementation.

The questionnaire was jointly prepared by the WPL and the University of Trieste in coordination with the LP. It was submitted to PPs in July and results were collected and analysed at the end of August in order to map the importance of the innovations described in D3.1.3 and the easiness/difficulty expected in their deployment.

Overall results are presented for each trend both in aggregate – e.g., for all the ITA-CRO area – and with respect to each PP, reporting the final rank of priorities based on the above mentioned

criteria, thus, the identification of directly transferable innovations. A both descriptive and graphical representation is produced.

The results from the questionnaire have been analysed by Elevante S.r.l. and UniTS providing a global and a single partner analysis. The former offers some insights about automation processes in the Adriatic Region, while the latter provides results highlighting the priorities of each player involved in Diglogs project, some of which will be tested in subsequent pilot actions.

1. Automation systems: best Practice Analyses of already on-going innovations

In the present section the best practices concerning the some of most important innovations connected to automation systems are discussed. The best practice analysis is essential to provide a starting point for innovation implementation within the Adriatic Region, i.e. the project area. All PPs have been asked to collaborate and carry out at least one analysis each, in order to define the state of the art and the most recent developments regarding the innovations that can be applied in the next three years in the project area. In addition to those provided by PPs – among all 3 innovation trends, namely: Informatisation, Big Data/Data Analysis and Automation systems – WPL (Elevante Srl, PP2) has carried out 5 analyses , PP4 (UniTS) has done 3, while the LP has provided a document that also included several analyses. Within the Automation Systems innovation trend, a total of 3 already on-going innovations have been investigated and presented in the following paragraphs.

1.1. Unmanned ships/autonomous vessel (PP4)

An autonomous vessel is a ship requiring minimum human intervention in its conduction. This concept can be developed with different degrees of automation up to the unmanned vessel: a ship without a crew onboard, based on completely automated systems or remote-controlled. In detail, the following categories have been defined by international bodies:

- Ship with automated processes and decision support: Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated.
- Remotely controlled ship with seafarers on board: The ship is controlled and operated from another location, but seafarers are on board.
- Remotely controlled ship without seafarers on board: The ship is controlled and operated from another location. There are no seafarers on board.
- Fully autonomous ship: The operating system of the ship is able to make decisions and determine actions by itself.

For short repetitive routes and coastal navigation fully autonomous vessels are becoming reality, but it is expected a wider application in the near future, provided that some open issues will be resolved [1].

Autonomous vessels require a remarkable initial investment in research and technology (dedicated infrastructures, sensors, communication devices, cybersecurity means, etc.). However, most of the required technologies and sensors are available on the market, and several major companies opened research centres for the development of autonomous navigation. Moreover, not only technological challenges but also some legal and regulatory issues shall be solved before autonomous ships can reach the mainstream market in freight and, even more, in passenger transport. Nevertheless, IMO has already included autonomous ships in its agenda [2] and, among classification societies, DNV-GL also did a step in this direction with the publication of specific guidelines for autonomous and remote-controlled vessels [3]. Despite the still open issues, the benefits of unmanned ships, e.g. the reduction of operative costs, the increased cargo capacity and potentially more safe navigation [4], will certainly lead to a wider application of remote-controlled vessels [5] and finally to fully autonomous ones.

Nowadays, several pilot projects dealing with unmanned vessels are on the way and the development process seems to accelerate in the last years. In 2018, Rolls-Royce and Finferries demonstrate the feasibility of autonomous navigation in full-scale: the double-end car ferry Falco performed fully autonomous navigation between Parainen and Nauvo (south of Turku, Finland) and performs the round trip under remote control [6]. In the meantime, Koongsberg is working on Yara Birkeland (Fig. 1) a 79 meters long containership which will provide service on specific routes in Norwegian fjords. In detail, Yara Birkeland will transport fertilizer from the company's production plant in Porsgrunn to the container ports in Brevik and Larvik, reducing substantially the road traffic and the environmental impact (the ship has a



Figure 1 - Yara Birkeland, the first unmanned containership © Yara

fully electric propulsion system). Yara Birkeland will be initially manned but it is expected to become remote-controlled within 2019 and to perform fully autonomous navigation within 2020 [7].

If unmanned ships for coastal navigation are becoming a reality, the oceangoing vessel will be soon on the market too. In fact, the feasibility of unmanned merchant ship [8] was thoroughly demonstrated in 2015 by MUNIN project, financed by the European Union. It is expected that the first remote-controlled oceangoing vessel will be launched within 2025. This technology could be available on the mainstream market in 2030, while a fully autonomous vessel in 2035 (Fig.2).



Figure 2 - Autonomous vessels development in the mainstream market © Rolls-Royce.

1.2. Drones for Warehouse Management Systems (PP2 Elevante)

Unmanned aerial vehicles (UAVs) – drones, are often associated with outside activities, however they can also be used indoors, such as in warehouses.

Today's inventory management requires workers to scan items manually, which is a very time consuming and an error-prone process. It's impossible to keep track of all items in the warehouse manually. Drones can be successfully deployed to upgrade warehousing processes. A good example is the special aerial drones using optical sensors (cameras) which can help locate an item in a warehouse or scan the respective RFID tags at a distance of tens of meters. In larger warehouses, a drone system can be used to gauge inventory levels and transmit the data directly to the warehouse management system. This will facilitate the fast detection of individual items and prevent inventory mismatches.

- The WMS is fully integrated with the drone's software. From this, the drone can access inventory location data down to the specific aisle, rack, or bin level.
- The drone is assigned with counting the inventory amount of a certain item, which is contained in boxes that are stored on the top shelves of an aisle.
- The drone maps out the optimal travel path to the stock location. The drone has an optical system that combines with computer vision and deep learning technology – which is a sub-field of machine learning that allows it to recognize images based on a network of learning layers.
- The drone arrives at the stock location, known based on X, Y, Z coordinates.
- The drone visually inspects the labels, takes a photo of the SKU barcode, or uses RFID sensors to relay the inventory count to the central WMS.

In larger warehouses, flying drones and robots now patrol distribution warehouses regularly and are fast becoming the norm. They've become workhorses of the e-commerce era online that large retailers (such as Amazon) can't do without. Inventory audits using drones have been calculated to save more than 50% time of worker time, e-commerce click-to-ship times can be reduced by up to 75%, and inventory persquare-foot can be increased by as much as 50% since drones can navigate in tighter spaces than humans.

Two drones can do the work of 100 humans over the same time period, according to supply chain specialists. This means they can do several tours of a warehouse – even at night – compare results, identify discrepancies, and build up a much more accurate picture much more quickly:

ClarusWMS is a UK based supplier of warehouse management solutions with a wealth of industry experience in third party logistics, wholesale / retail distribution, online fulfillment and manufacturing warehousing. ClarusWMS now also provides drone scanning & computer vision solutions that can assist in taking that next step towards this latest technology. Drone makers claim scanning accuracy of close to 100%. It is driving down warehouse costs (and, incidentally, it is also putting people out of work)

Most advanced drone can use using image recognition: US-Company FlytBase's solutions overcome the need for dedicated barcode or RFID scanners, thus improving the cost-effectiveness and scalability of warehouse drone programs. Their drones can also highlight items with worn out or missing barcodes, for perfecting value inventory management activities.

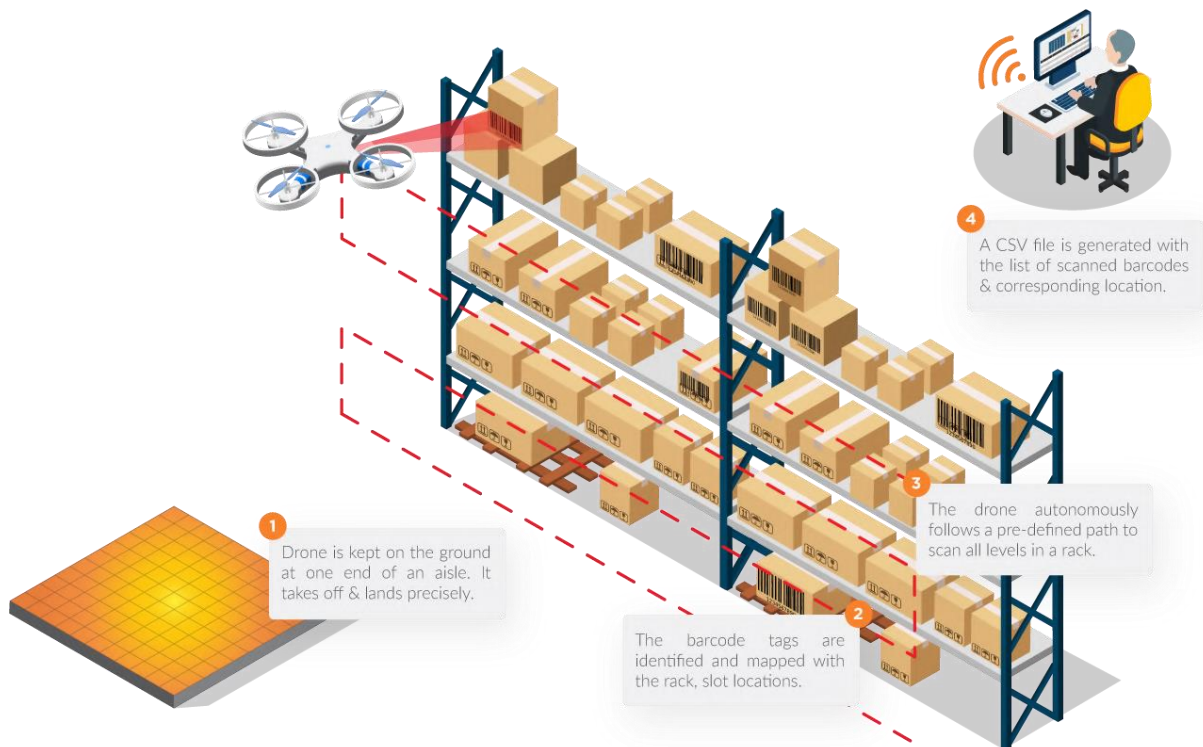


Figure 3 - FlyTBase example of drone integration in WMS

In Germany, InventAIRy offers a complete ecosystem for automated stocktaking and inventory management with drones around pallet rack areas, equipped with smart multi-sensors. When attached to other autonomous vehicles, inventAIRy® works with AGV (Automated Guided Vehicles) and forklifts. The systems offers just data and digital information but also visual impressions of the warehouse, such as images (for pattern recognition and inspection tasks) that can be then preserved as evidence.

Expensive warehouse real estate can be optimally used by drone-based detection of empty and full slots, thus improving operational metrics.

In addition to that, drones also check—up warehouse structures for cracks, leaks, rust, etc. due to environmental conditions – such periodic drone-based inspections can spot such damage early on.

Despite drones appearing to be a winning technology, outperforming other technological applications in speed and accuracy, it is important to look at the limitations: drones must overcome a number of drawbacks, such as safety, payload capacity restrictions, and political acceptance, before they will reach a high level of adoption.

1.3. Autonomous Tug Boats (PP7)

Nowadays, trends are pointing towards harbour tugs being among the first vessel classes to become autonomous. Improvements in safety and lower operating costs through less crew as the reason harbour and terminals are likely to focus on developing autonomous tugs first. This is a technical trend that we are seeing. The future is that autonomous tugs tows and manoeuvres autonomous container ships [European Dynamic Positioning Conference in London, 2017 – Mike Ford, VP, Commercial Operations, at Wärtsilä Dynamic Positioning]

There is a strong case for autonomy in operations as, according to a report published by insurance company Allianz in 2012, between 75 and 96% of marine accidents are a result of human error, often caused by fatigue. Remote controlled and autonomous ships will reduce the risk of injury and even death amongst ship crews, as well as the potential loss of, or damage to, valuable assets.



Figure 4 - Keppel Singmarine autonomous tugboat, expected in Q4 2020

Remote controlled and autonomous ships will allow vessels to be designed with a larger cargo capacity, better hydrodynamics and less wind resistance. With no crew to accommodate certain features of today's ships – for example, the deck house, the crew accommodation and elements of the ventilation heating and sewage systems – these can all be removed. This will make the ship lighter, cutting energy and fuel consumption, reducing operating and construction costs and facilitating designs with more and different space for cargo.

Four degrees of tug automation can be considered:

Degree 1: Tug with automated processes and decision support. Tug crew is on board.

Degree 2: Remotely controlled tug with crew on board.

Degree 3: Remotely controlled tug without crew on board.

Degree 4: Fully autonomous tug: The operating system of the tug is able to make decisions and determine actions by itself.

There can be added:

Degree 5: Fully autonomous tug with (limited) crew.

If tugs would operate autonomously, it would have significant advantages with respect to reduction in manning. The question should be asked: is this feasible and is this acceptable? Whether it is acceptable depends on the port or country. Low wage countries and those with a large number of unemployed people will not be interested in crew reductions.

Let us assume that a system has been developed which makes connecting of a tug to a ship possible in a safe and fast way and at rather high ship speeds and without the need of a person on board the tug to handle the connection system. Would then autonomous tugs without a crew on board the tug (degree four) be feasible? If weather and sea conditions don't present a problem and the critical aspects of section 3 (interaction effects, net tug forces, technical failures on board, etc.) can be handled or prevented, unmanned autonomous tug assistance can become a possibility, however, due to the complexity not directly expected to be realized in the near future.

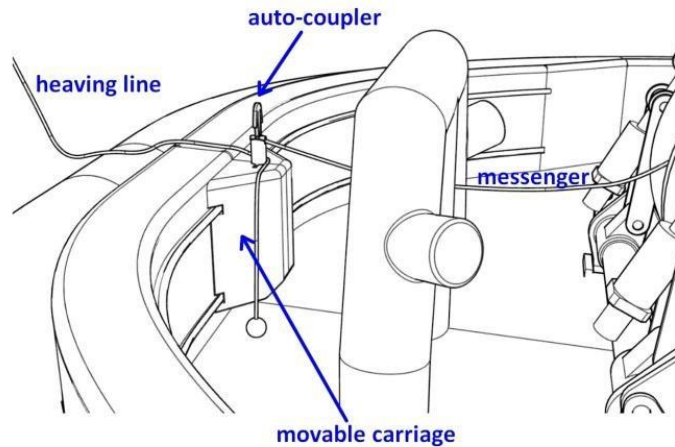


Figure 5 - Auto towline connection system (courtesy Damen Shipyards).

This brings us first to remote controlled tugs, still unmanned. Remote controlled (degree three) tugs -or autonomous tugs that can be remote controlled- still assuming that the earlier mentioned tug-ship connection system has become available, will now be considered. How the tugs will be controlled in the control stations, by duplicating a tug control station, with the use of touch screens, voice recognition, etc. is not relevant for this discussion, as long as it works in an optimum way in normal conditions and in adverse conditions of fog, rain, hail, etc.

Let us take as an example of a middle sized port with ten tugs, all capable of being remote controlled. Each tug needs one control station and each control station needs an experienced tug master, who also should have been trained carefully in remote controlling of tugs. It is true, not all company tugs are always needed at the same time, but conditions might be busy in the port or strong winds are blowing and then all the available tugs are needed.

As said, with a crewless tug a lot of money can be saved. Unmanned remote controlled tugs can also be used for fire-fighting if equipped as such, as proven by KOTUG, Rotterdam and even company tugs operating in some other (foreign) ports can be operated remote controlled. On the other hand the several control stations, including maintenance, also cost a lot of money, and a large number of tug masters/ tug controllers is needed for a 24/7 service. In addition, ICT (Information and Communication Technology) systems become much more complex and more

ICT specialists are needed. It should also be kept in mind that the tug and its engines need regular maintenance and should be regularly cleaned.

Although this costly system with several control stations can work, it is questionable if this is the optimum solution. The best would be to have a limited number of remote controlled tugs and the rest normally manned (degree one and three). Why? Because this has the advantage that less control stations are needed and practical experience in tug handling and ship assistance does not get lost and tug master can, if well trained, shift between a manned tug and the control station. Another important point to have a number of tugs manned is that harbour tugs have to carry out several other tasks, for which a full crew is needed. Furthermore, well-designed and equipped seaworthy harbor tugs have also more than once to operate at sea in case of emergencies or for offshore tasks, requiring the tugs also to be fully manned.

If a tug crew is still needed for securing, then of course even a remote controlled tug should be manned.

Summarising, it can be assumed that in the near future a modern towing company may have a small number of remote controlled tugs, which are manned as long as not yet a remote controlled tug–ship connection system is available and also depending on the work to be carried out. The other manned tugs will remain available. It will take a number of years more before autonomous tugs become reality.

A question to be answered is whether port authorities and shipping companies agree with the employment of autonomous or remote controlled tugs, manned or unmanned.

1.4. RPAS Drones (Remotely Piloted Aircraft Systems) for emissions (PP9)

The Directive (EU) 2016/802, known as the Sulphur Directive, regulates emissions from ships and places limits on the maximum sulphur content in fuels, regrettably, in areas of dense maritime traffic, ship-generated emissions can be substantial. This is mainly due to the burning of fossil fuels - sulphur oxides (SO_x), nitrogen oxides (NO_x), carbon dioxide (CO₂) and particulate matter (PM) that are released into the atmosphere. These emissions are harmful both to the local population and the environment. Ship owners must use fuels with reduced sulphur levels in order to achieve a reduction of SO_x emissions, or alternatively adopt an Emission Abatement Method such as an Exhaust Gas Cleaning (EGC) system.

Remotely Piloted Aircraft Systems, known as drones, can be used for measurement and control of environmental aspects, detection of contamination, tracking and monitoring those responsible for the environmental breaches.

Monitoring the emissions from a ship's smokestack by Remotely Piloted Aircraft Systems (RPAS) can help to enforce the Directive as the information provided can be shared among the relevant authorities.



From April of 2019 a large drone is used for checking emissions from ships in Danish waters to make sure they comply with the sulphur limit. The drone operates in an area north of The Great Belt, where many large tankers transit on their way to and from the Baltic Sea. The drone is provided by the European Maritime Safety Agency (EMSA) and is used as a means of preventing ship pollution.

The drone is fitted with a gas sensor, so-called “sniffer” capable of measuring individual ship’s sulphur emissions. Entering the ship’s exhaust gas plume, the drone can register the amount of sulphur in the fuel. These data are immediately available to Danish authorities who can follow up if a ship does not comply with the requirements of the European Emission Control Area (ECA). In that case, the data is also reported in the ESMA inspection data base - THETIS-EU , that supports the Port State Control inspection regime foreseen by Directive 2009/16/EC.

The RPAS in use is the UAS Skeldar V-200. In addition to a Fuel Sulphur Content dual sniffer system, the drone is equipped with infrared cameras capable of photographing vessels during daytime and at night, as well as an Automatic Identification System (AIS) receiver to enable the RPAS to identify and track offending ships. It is under contract with EMSA from a consortium comprising Nordic Unmanned AS, UMS Skeldar Sweden AB and NORCE Northern Research Institute AS. Authorities will be able to track the flight path of the drone in real time using EMSA’s RPAS data centre, which provides flight details, images, video and measurement data.

This project will contribute to a more efficient enforcement of the sulphur rules, thereby reducing air pollution from ships while ensuring fair competition for shipping companies. In Denmark, the Danish Environmental Protection Agency is responsible for enforcing the sulphur rules, and the Danish Maritime Authority supports this work through ship inspections in Danish ports and now also with drone monitoring.

2. Identifying the most attractive directly transferable innovations: the Questionnaire

A questionnaire has been designed and implemented as an online tool by means of the Google Forms platform. It has been submitted to all the PPs in order to collect data devoted to rank the innovations defined in previous deliverables by importance and analyse the issues related to each innovation deployment in the project area. The questionnaire is composed of three sections:

- General information;
- Informatisation processes;
- Big-Data;
- Automation.

In the general section, some information is collected regarding the respondent which is compiling the questionnaire. This information is useful to properly qualify the subject and his/her expertise. In detail, the following data have been collected:

- Name
- Surname
- Age
- Project Partner (the affiliation of the subject)
- Position (the position of the subject within the project partner)
- Seniority (years of service in the current position)

The other three sections deal with a specific innovation trend. Each subject was required to select the innovations he/she deems more relevant to them in terms of appeal and applicability to their local needs. In detail, each innovation was ranked per importance on a five steps scale:

1. not at all relevant;
2. not very relevant;
3. no opinion;
4. relevant;
5. extremely relevant.

Moreover, efforts required to implement the innovations in the current environment were also ranked according to the following scale:

1. very difficult to implement;
2. somehow difficult to implement;
3. no opinion;
4. somehow easy to implement;
5. very easy to implement.

PPs were required to briefly explain the reasons behind their choices. They were also asked to suggest up to two additional innovations for each innovation trend.

Finally, each subject was required to rate only innovations that apply to his context and field of expertise, in order to prevent the collection of inconsistent data.

2.1. Results

In this section, the results related to the automation innovations trend are provided. First, the global analysis coming out from the outcomes of all the collected questionnaires is provided. Then the outcomes and ranking of the innovations are provided for every single partner.

2.1.1. Global Analysis

Overall, 24 responses have been collected from partners (see Figure 6).

The distribution of age and seniority of the subjects involved in the completion of the questionnaire are provided in Figures 4 and 5 respectively. Since most of the partners are engaged in research activities the concentration on 0-5 years seniority is not a surprise, given the dynamic labour market typical of such a sector. However, most of the low-seniority subjects are scholars or other specialists with strong experience. Moreover, all the other subjects involved in the questionnaire completion have a strong experience in their field since they cover the same position for a relevant time period (greater than 5 years).

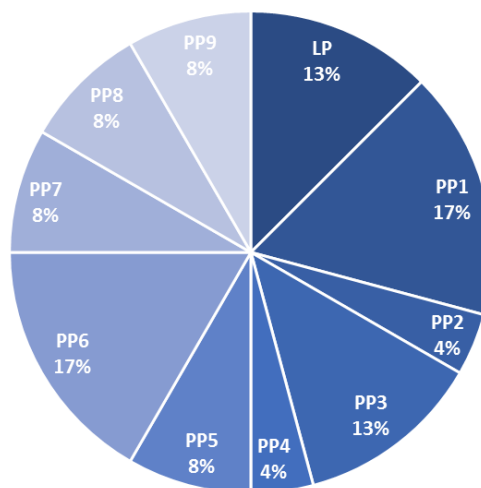


Figure 6 - Responses collected from PPs

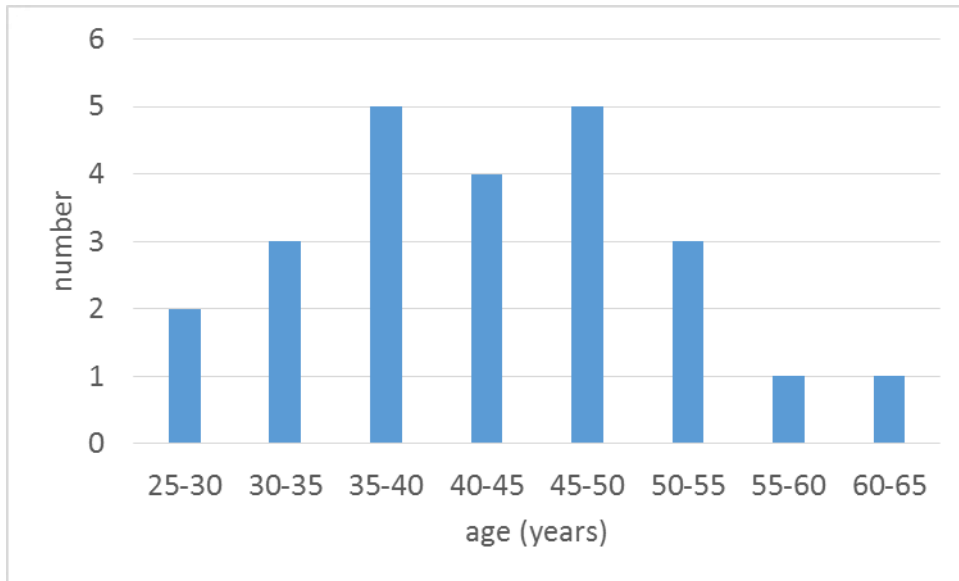


Figure 7 - Age of the subjects

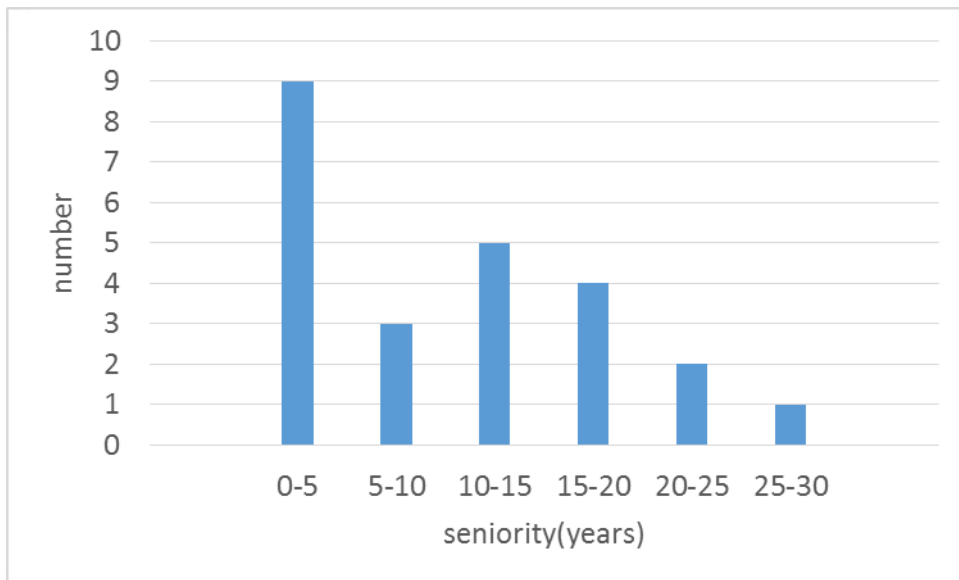


Figure 8 - Seniority (in current position) of the subjects

The innovations ranked by importance I are shown in Table 1, together with their deployment difficulty/easiness D . Moreover, the standard deviation σ are provided for both quantities:

$$\sigma_x = \% \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}$$

Figure 6 provides a graphical representation of the results on a scatter diagram. It can be noticed that all the innovations are located in a restricted area located in the upper part of the diagram. Figure 7 provides a more detailed view of such an area of the scatter diagram. Numbers showed in Figure 7 refer to innovation ranking (Tab.1). It can be concluded that no correlation exists between importance and deployment's easiness/difficulty. Moreover, the concentration in the upper part of the scatter diagram highlights how all the partners assigned a medium/high importance to all the innovations defined in D3.1.3, thus, confirming that the selection process was very effective.

Table 1 - Global Rank of innovations

Rank	Innovation	I	σ_I	D	σ_D
1	Maritime transport chain	4.35	0.65	2.70	0.95
2	ETA, Delivery of Notification	4.32	0.76	3.74	0.99
3	Automatic digital identification of passengers	4.21	0.61	2.74	0.85
4	Deliverables Planning	4.21	0.69	3.50	0.90
5	Electrified Lift Solution	4.12	0.83	2.76	0.81
6	Autonomous Trucks/Busses	4.05	0.79	2.43	0.90
7	Automatic container carriers/truck handling systems	4.00	0.69	2.76	0.94
8	Automated Lighting and air-conditioning systems	4.00	0.79	3.44	1.06
9	Smart Connected Lift Trucks	3.93	0.85	3.19	0.88

10	Fully Automated Container Terminal	3.90	0.97	1.95	1.00
11	Unmanned warehouse	3.75	1.04	2.70	0.95
12	Autonomous vessels for coastal navigation	3.68	1.13	2.37	0.81
13	ASC	3.53	0.78	2.65	0.84
14	Unmanned bulk cargo terminal	3.50	0.96	2.18	0.78
15	Unmanned ships/autonomous vessel	3.45	1.20	2.30	0.78
16	Unmanned services	3.41	1.03	2.50	1.17
17	High Bay Storage Systems (BOXBAY)	3.38	0.86	2.94	0.97
18	Autonomous vehicles in port area	3.33	0.94	2.72	0.87
19	WMS with voice integration	3.32	0.86	3.11	1.12
20	Drones for WMS	3.30	1.00	2.70	0.90
21	Remote Cranes	3.26	0.87	3.24	1.03
22	RPAS drones to check ship emissions	3.22	1.23	2.82	0.86
23	Autonomous tugboats	3.19	1.14	1.71	0.76
24	ALP	3.19	0.81	2.80	0.65
25	Automated mooring technologies	3.16	1.18	2.11	0.72
26	Event data certification	2.90	0.92	3.14	0.89

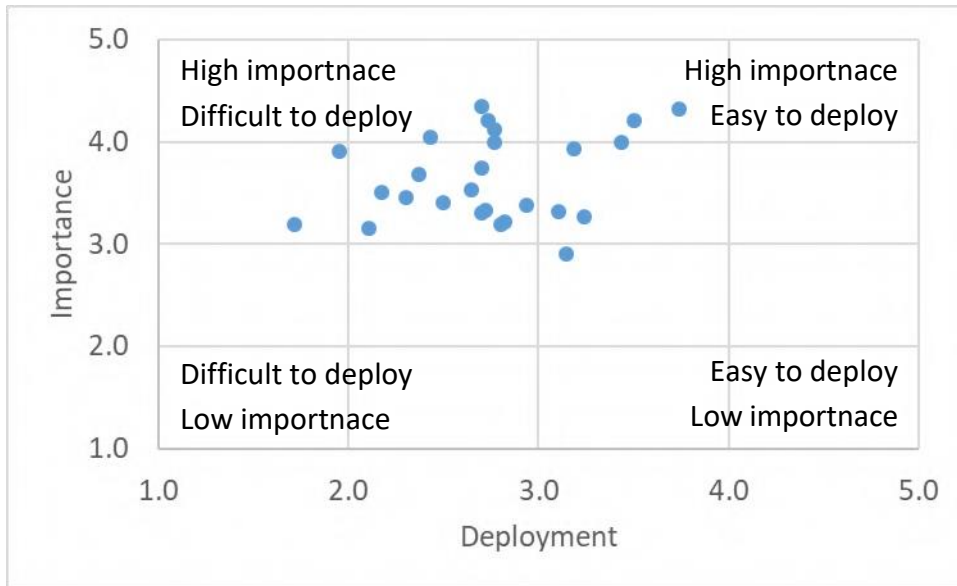


Figure 9 - Importance vs Deployment Easiness/Difficulty

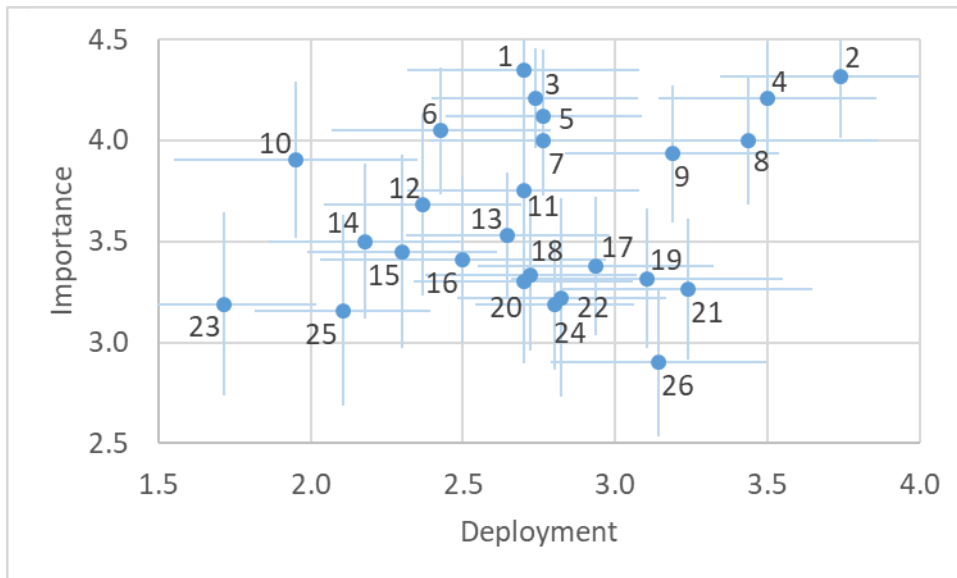


Figure 10 - Detail of Importance vs Deployment Easiness/Difficulty;
 numbers refer to ranking (Tab. 1);
 bars refer to 95% confidence interval

However, the quite high value of standard deviations related to innovations' importance reduces the significance of the ranking. Nevertheless, a group of more interesting innovation can be defined, including *Maritime transport chain*, *ETA*, *Delivery of Notification*, *Automatic digital identification of passengers* and *Deliverables Planning*. All these innovations deal with the automation of the logistics chain in both freight and passenger sectors. Thus, in general, it can be concluded that PPs are strongly interested in this topic, rather than autonomous vehicles or other automated devices (cranes, lifts, drones, etc.). In fact, the least innovations by importance are: *RPAS drones to check ship emissions*, *Autonomous tugboats*, *ALP*, *Automated mooring technologies* and, with a quite large gap, *Event data certification*, whose impact was considered very limited.

A wider spectrum/picture was obtained on the difficulty in innovations' implementation in the Adriatic Region. An almost equal level of standard deviations was spotted in this case, leading to lower uncertainty about PPs overall preferences. The innovation of the easiest implementation is *ETA*, *Delivery of Notification*, which largely outdistances the second and the third: *Deliverables Planning* and *Automated Lighting and air-conditioning systems* respectively. It can be concluded that *ETA*, *Delivery of Notification* and *Deliverables Planning* are the most interesting innovations considered in the present study, since both show high importance and very easy deployment, according to PPs. On the other hand, the most difficult to deploy innovation are *Fully Automated Container Terminal* and *Autonomous tugboats*. Generally speaking, it can be concluded that the infrastructure/vehicle automation in port facilities is not considered an easy task in the project area and, according to the ranking by importance, neither a priority.

2.1.2. Individual partner results

The following charts show the ranking of innovations deemed by each partner as the most interesting.

In the first chart the length of the horizontal bar represent the easiness of implementation for each innovation: the longer the bar, the easiest the implementation.

In the second chart, the lower part (in *blue*) of the istogram represents the importance of each innovation, while the upper part (in *orange*) shows the feasibility (easiness) of its implementation.

In our methodology, the importance and easiness ranking are not meant to be summed to obtain a total value: therefore, this is simply a graphical representation to help us understand how those values “move” for each innovation and for each surveyed partner.

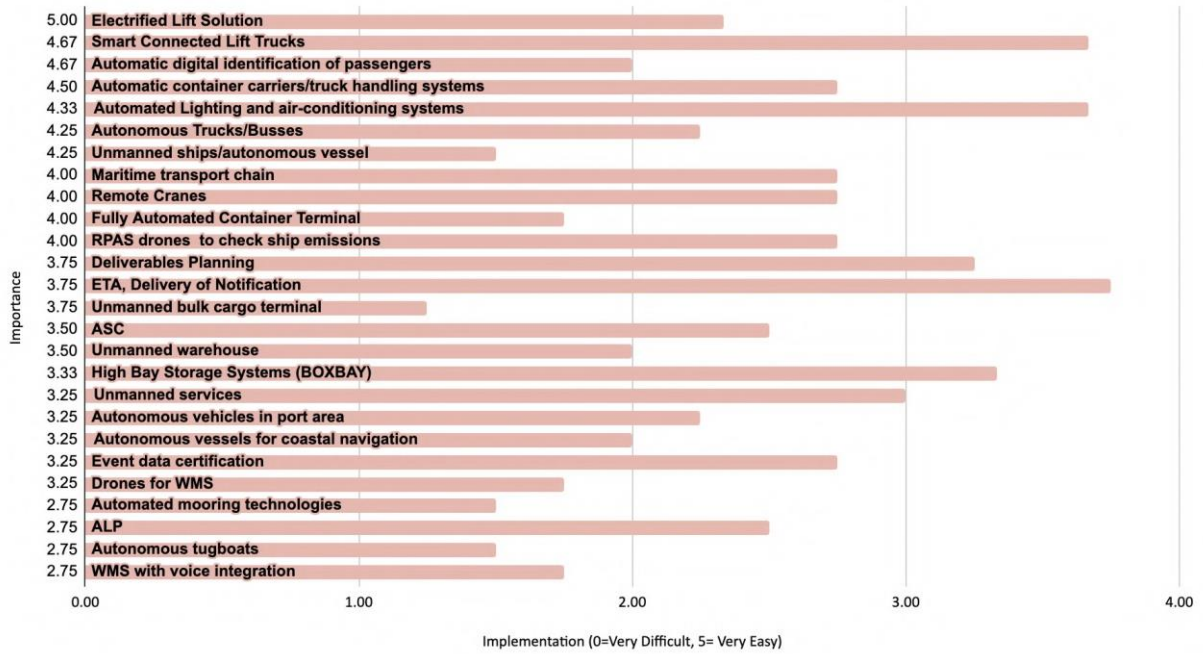
PPs interested in adopting an innovation were expected to be already somehow knowledgeable about the innovation itself and about what its implementation entails.

Please also note the these judgements, are as perceived by partner participants – and they do not refer to an objective evaluation/scoring.

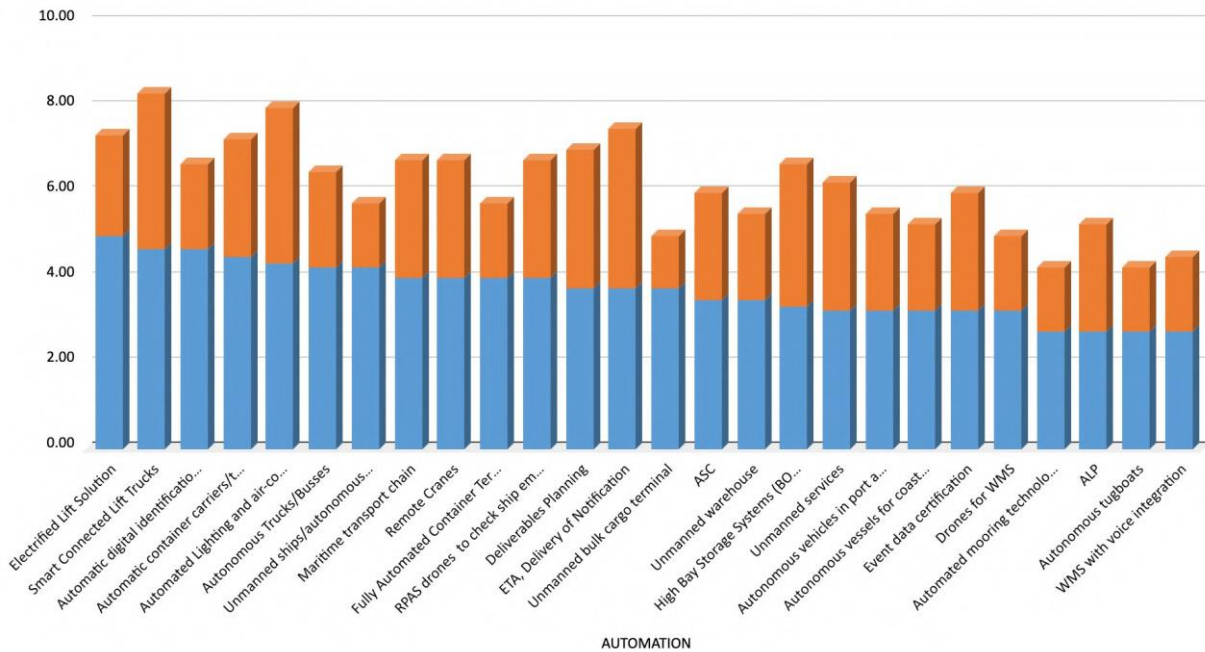
From those innovations considered important by the partner, we can see that a few were also seen as the directly transferable (as perceived to be somewhat easy to implement). However, from the chart it is clear that many innovations we ranked as having mid to high importance and also to be feasible for implementation.

Please not that results for LP and PP3 are not presented here, since those two partners will not be involved in pilot actions and therefore do not need to identify specific innovations within the context of the Diglogs project.

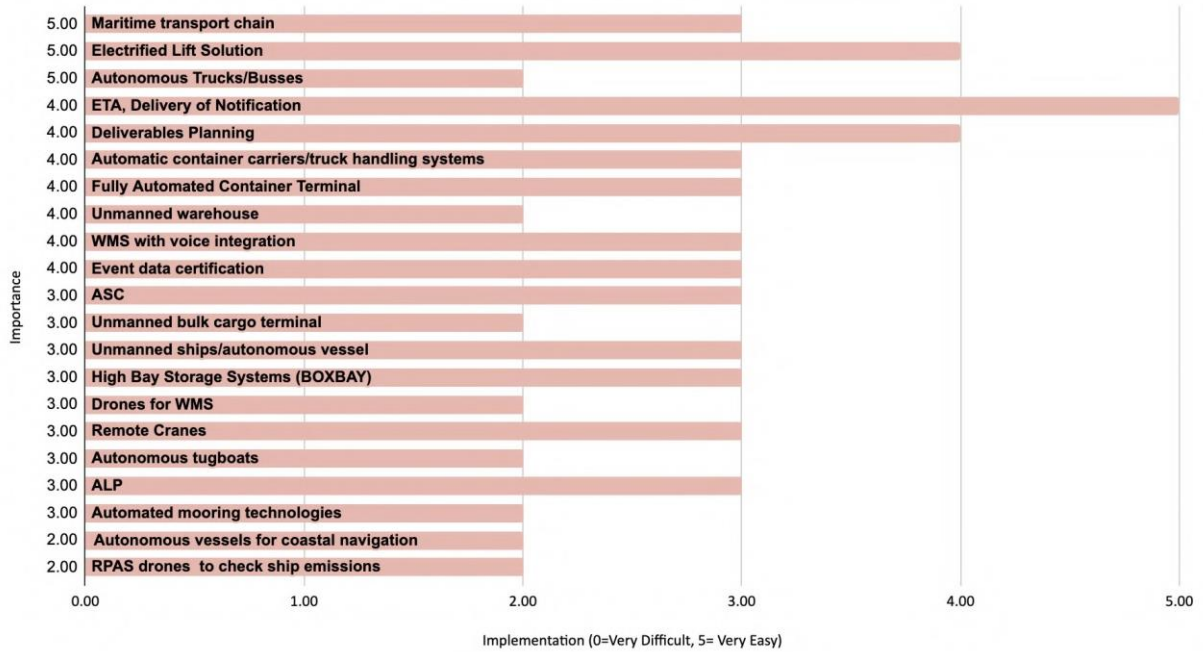
PP1 - Innovations in Automation Systems



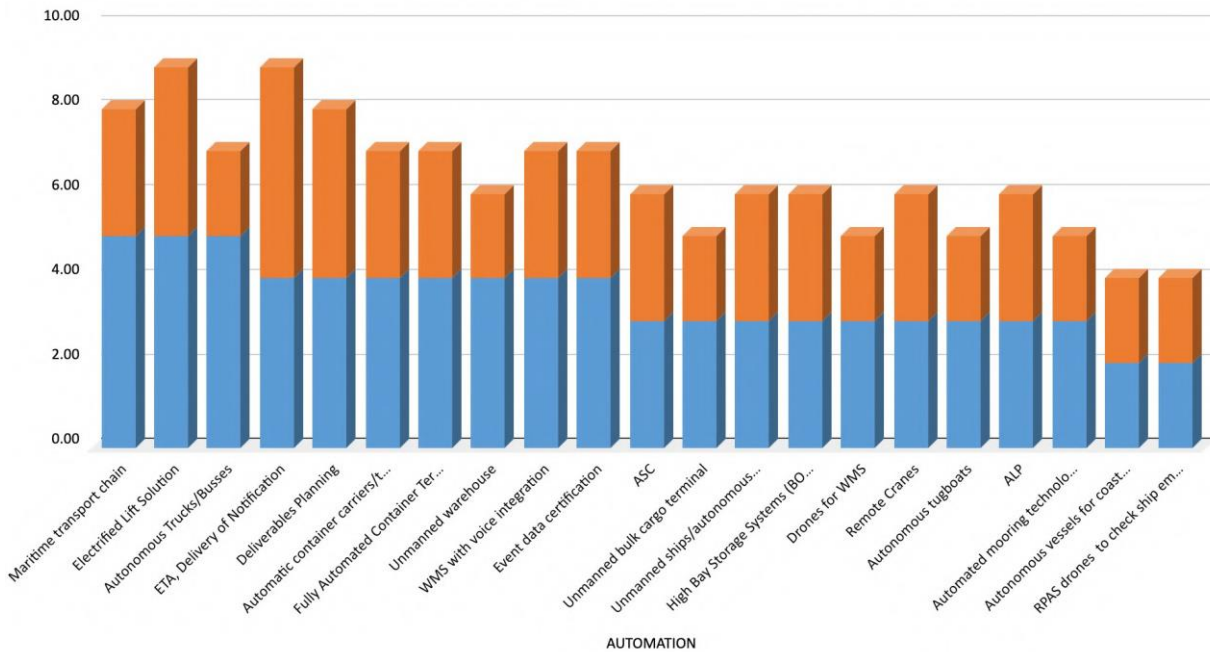
PP1 – combination of perceived Importance [blue] and implementation easiness/difficulty [orange]



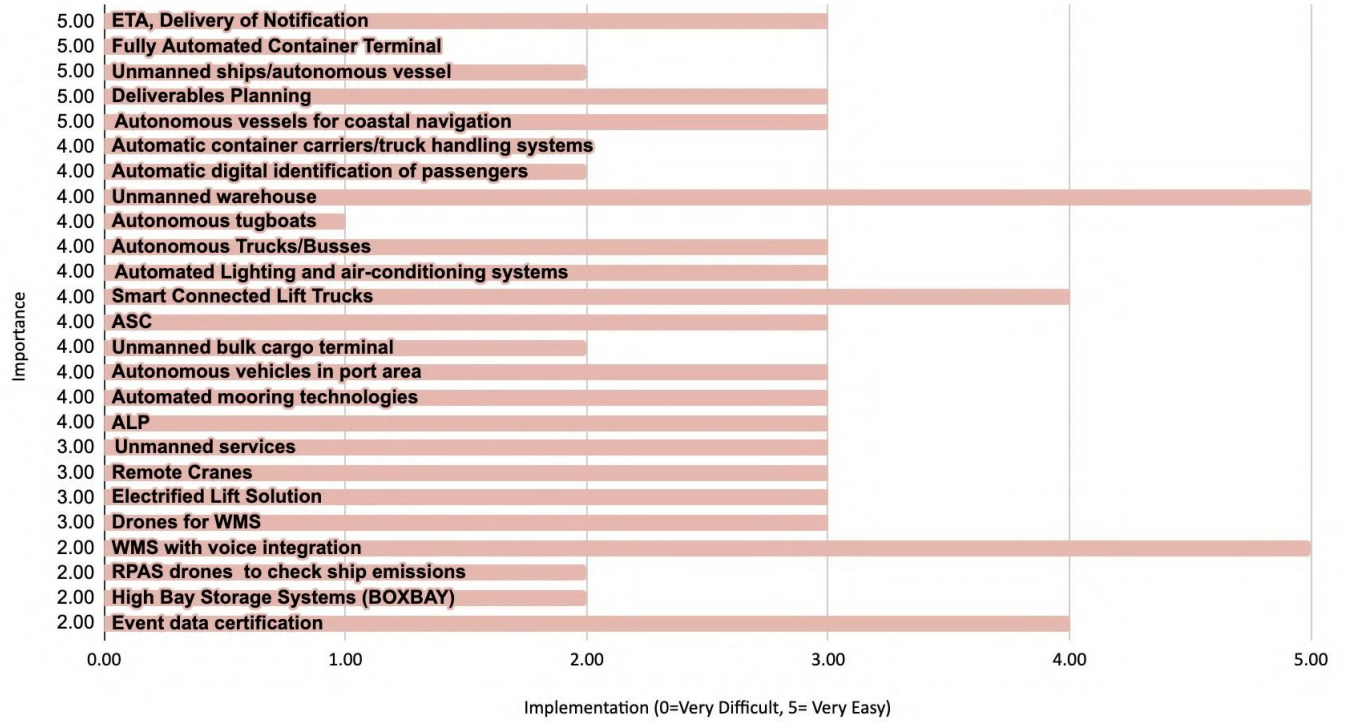
PP2 - Innovations in Automation Systems



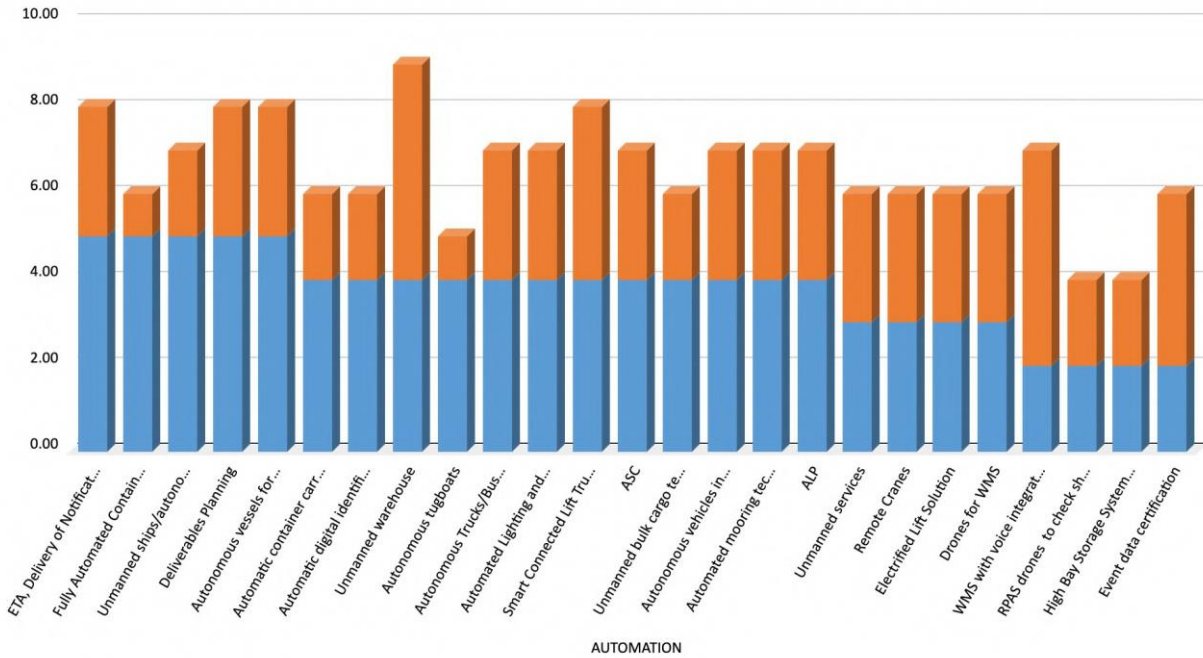
PP2 – combination of perceived Importance [blue] and implementation easiness/difficulty [orange]



PP4 - Innovations in Automation Systems

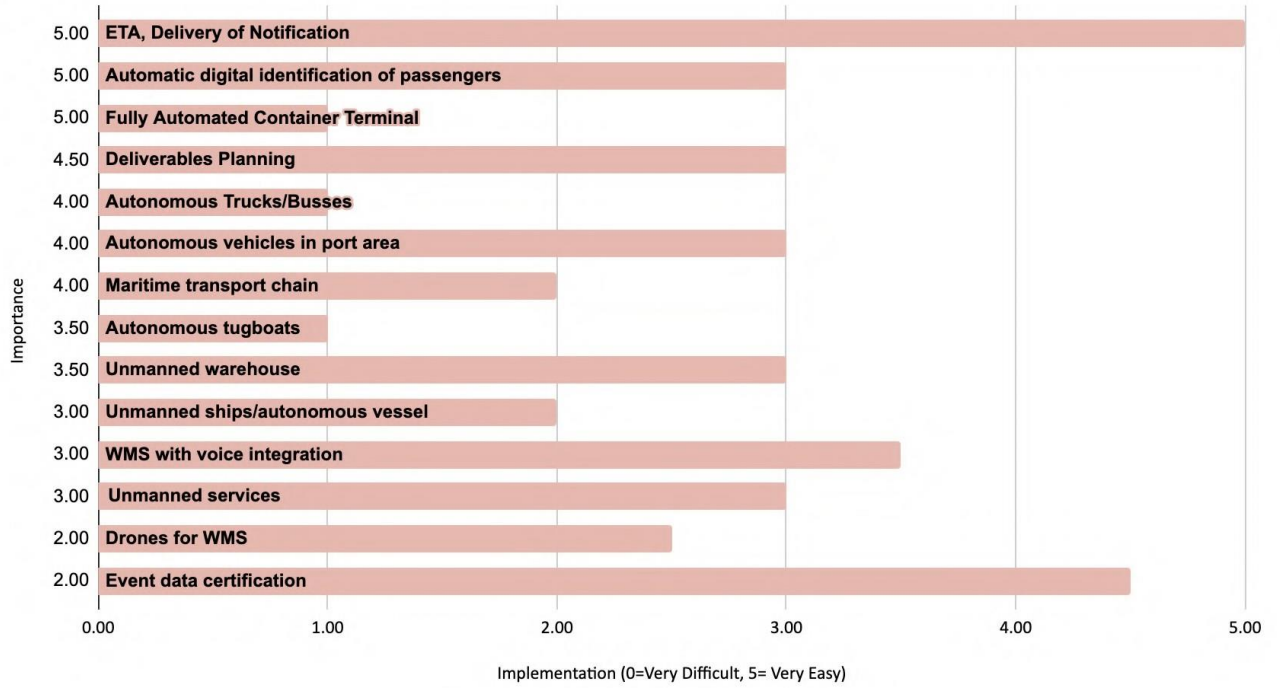


PP4 – combination of perceived Importance [blue] and implementation easiness/difficulty [orange]

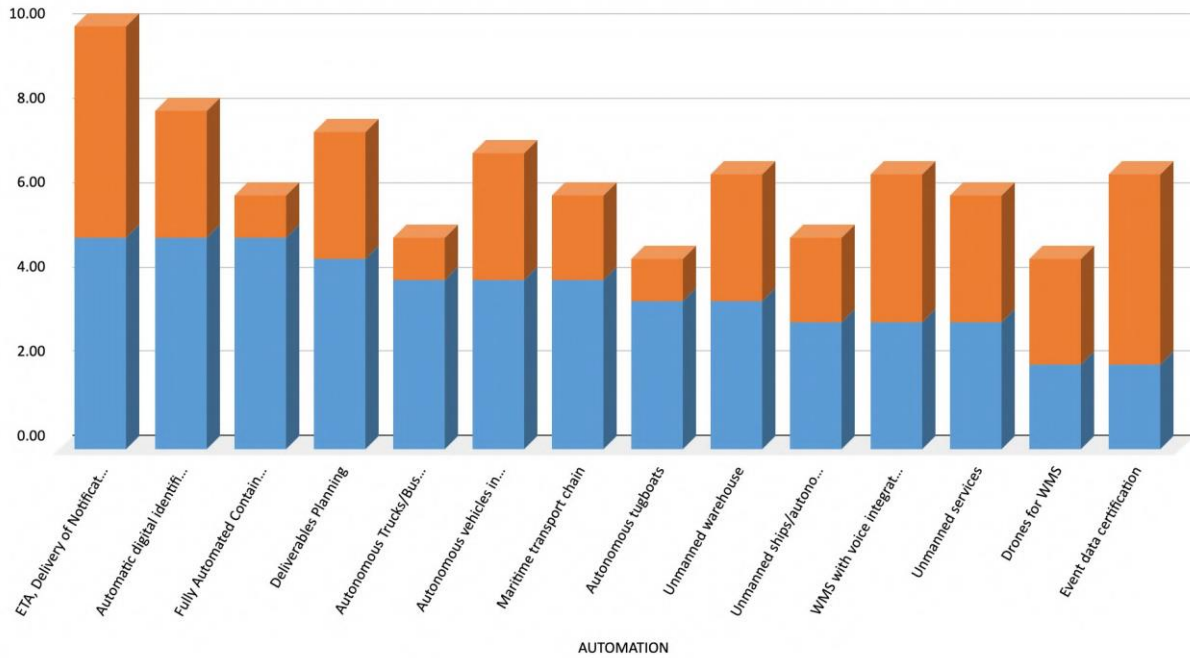


AUTOMATION

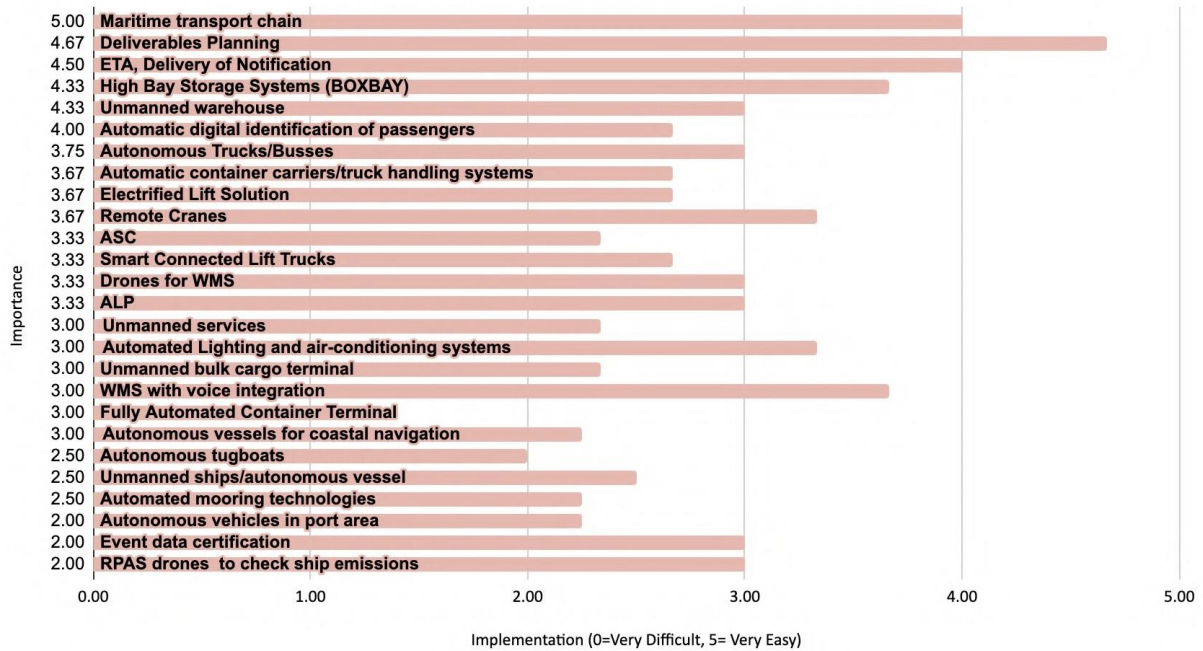
PP5 - Innovations in Automation Systems



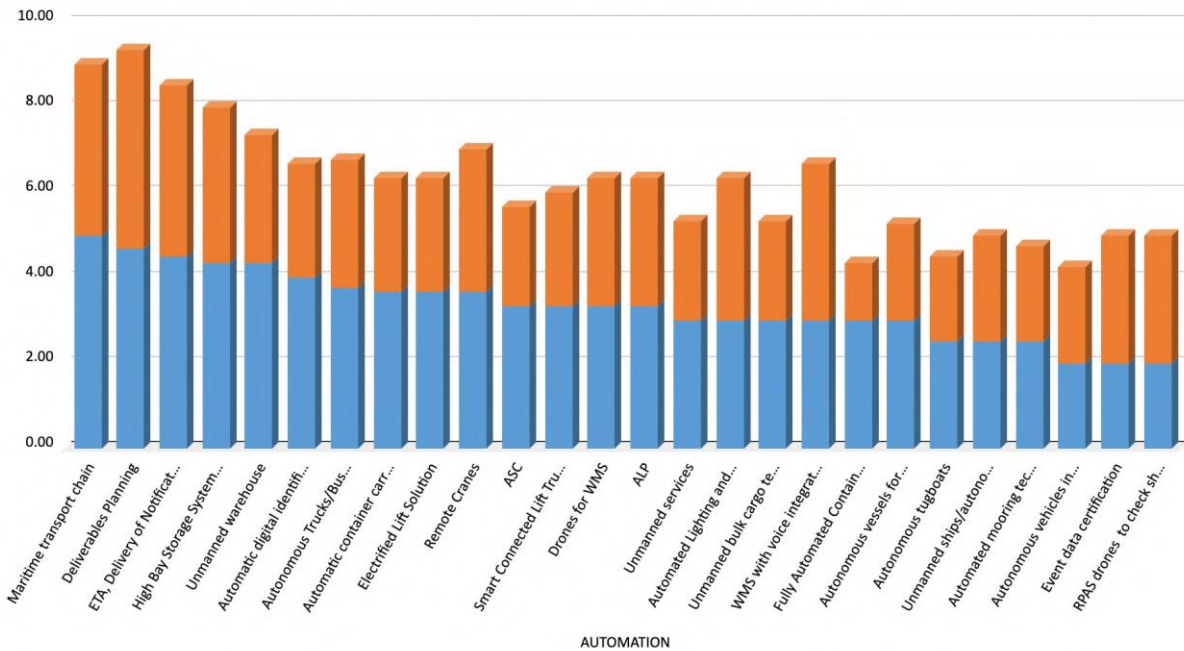
PP5 – combination of perceived Importance [blue] and implementation easiness/difficulty [orange]



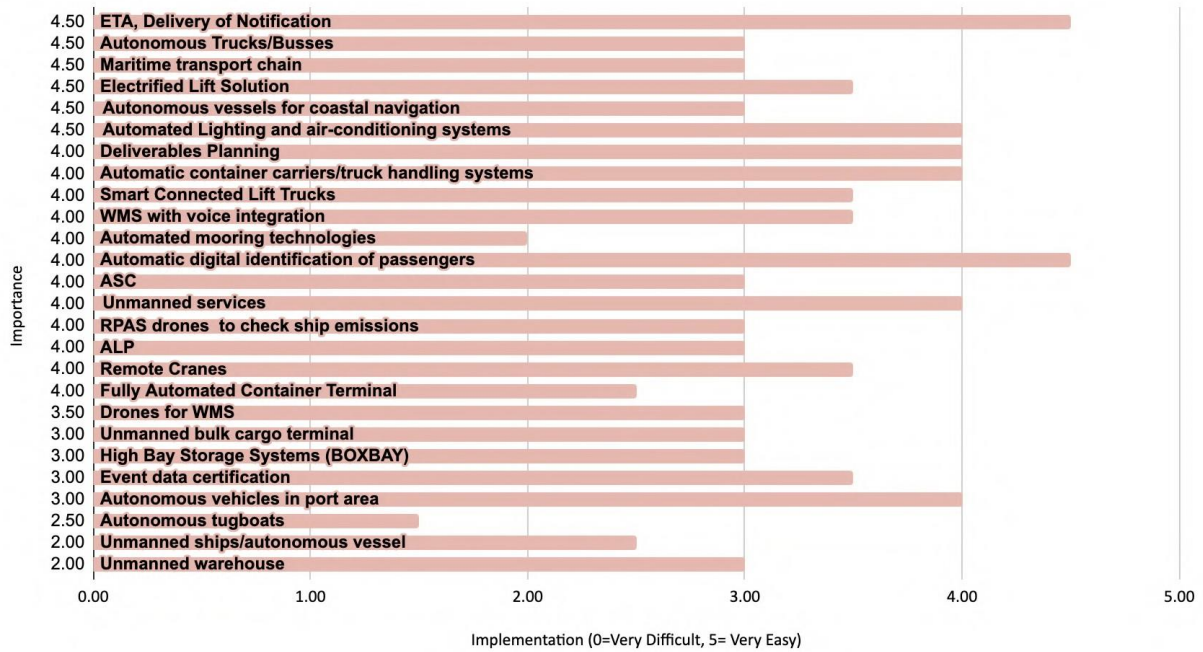
PP6 - Innovations in Automation Systems



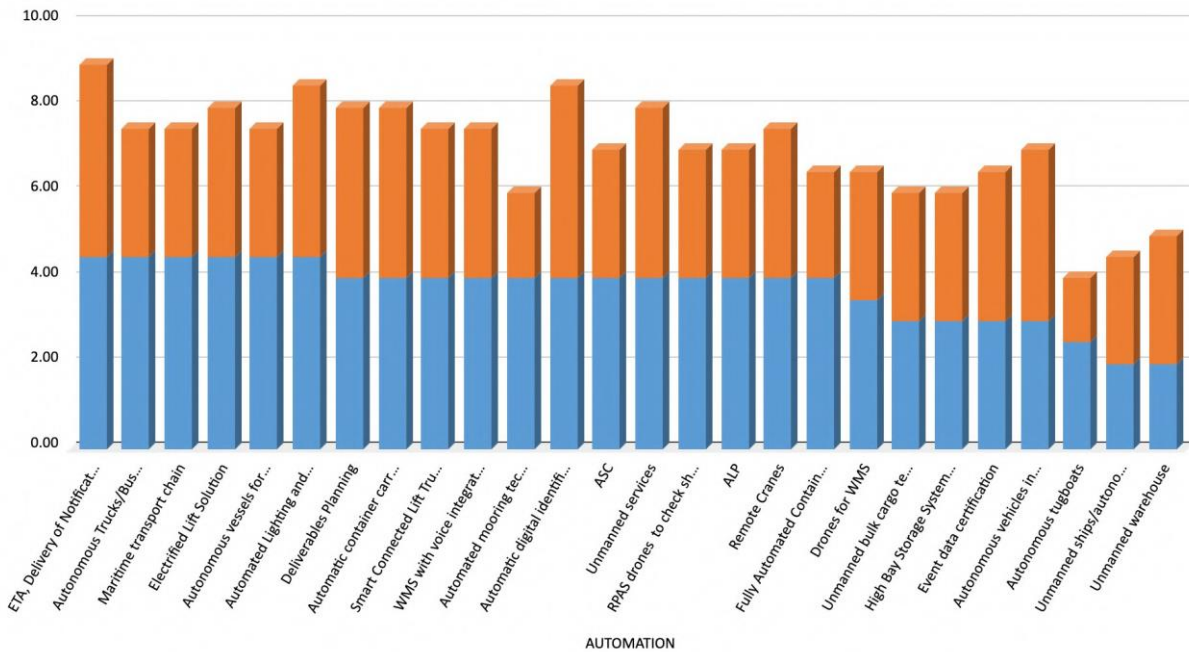
PP6 – combination of perceived Importance [blue] and implementation easiness/difficulty [orange]



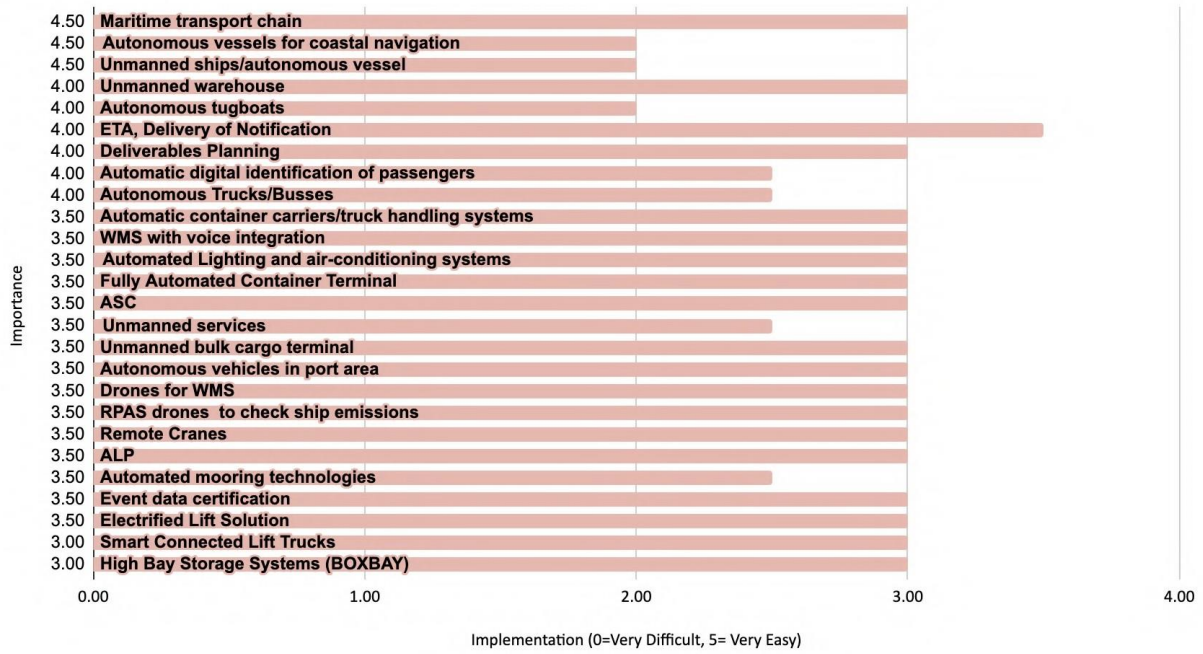
PP7 - Innovations in Automation Systems



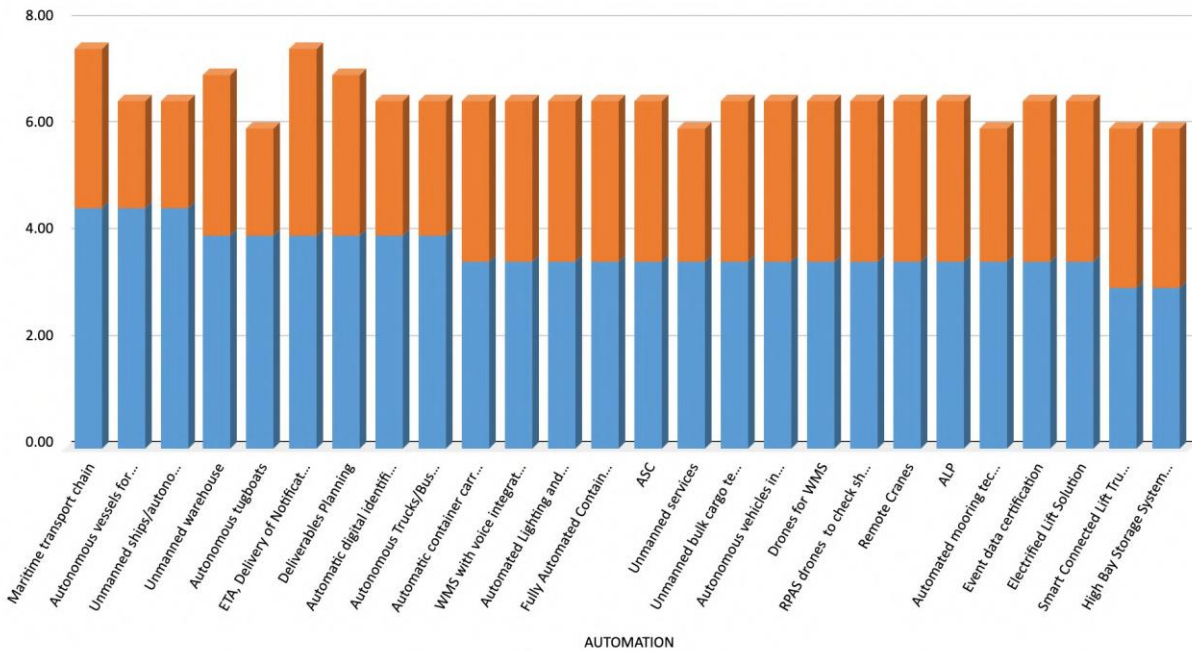
PP7 – combination of perceived Importance [blue] and implementation easiness/difficulty [orange]



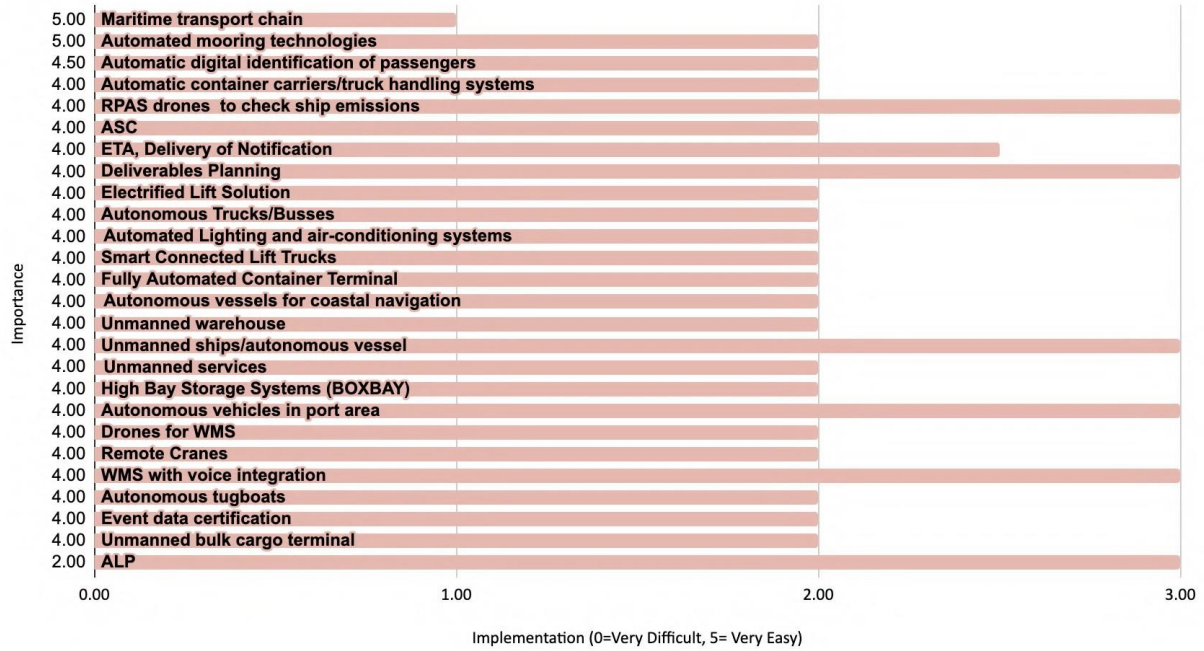
PP8 - Innovations in Automation Systems



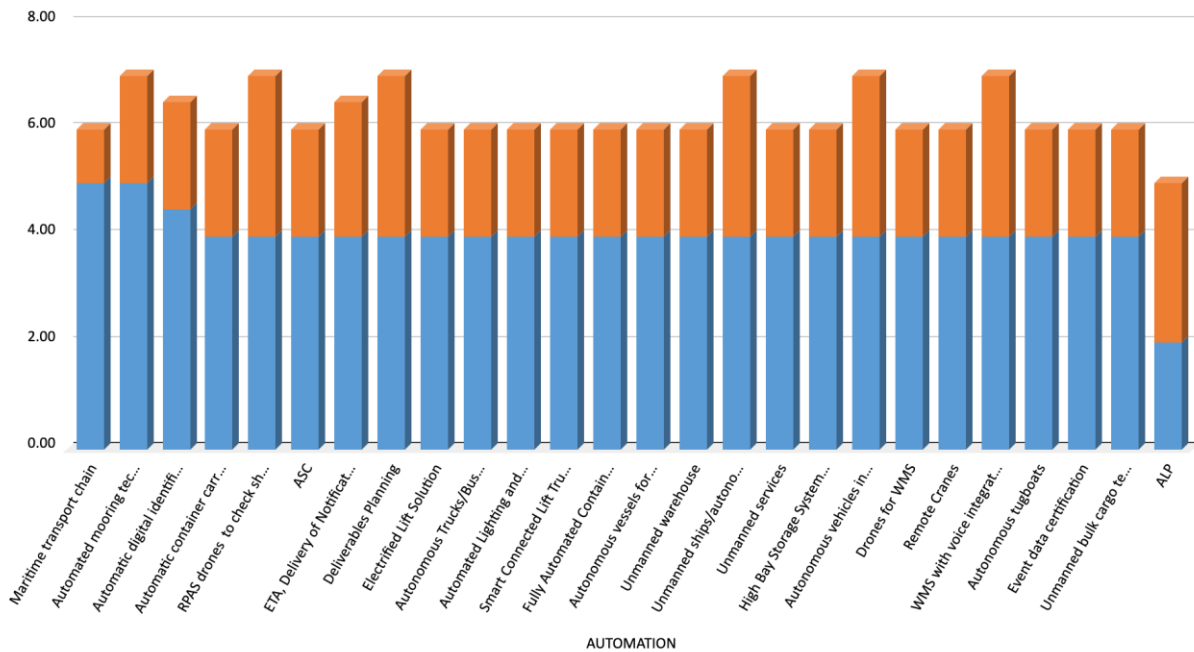
PP8 – combination of perceived Importance [blue] and implementation easiness/difficulty [orange]



PP9 - Innovations in Automation Systems



PP9 – combination of perceived Importance [blue] and implementation easiness/difficulty [orange]



Conclusions

Some conclusions can be drawn from overall results. In the field of automation systems, it can be noticed that all the innovations are located in a restricted area located in the upper part of the previously presented scatter diagrams. In general, it can be concluded that no correlation exists between importance and deployment's easiness/difficulty. Moreover, it was evident that all the partners assigned a medium/high importance to all the innovations defined in D3.1.3, confirming that the selection process carried out by WPL and PP4 in the previous deliverable was indeed effective.

However, the quite high value of standard deviations related to innovations' importance reduces the significance of the ranking. Nevertheless, a group of more interesting innovations can be defined, including *Maritime transport chain*, *ETA*, *Delivery of Notification*, *Automatic digital identification of passengers* and *Deliverables Planning*. All these innovations deal with the automation of the logistics chain in both freight and passenger sectors. Thus, in general, it can be concluded that PPs are strongly interested in this topic, rather than autonomous vehicles or other automated devices (cranes, lifts, drones, etc.). In fact, the innovations by regarded to be of least importance were: *RPAS drones to check ship emissions*, *Autonomous tugboats*, *ALP*, *Automated mooring technologies* and, with a quite large gap, *Event data certification*, whose impact was considered very limited.

A wider picture was obtained on the difficulty in innovations' implementation in the Italy-Croatia program area. An almost equal level of standard deviations was found in this case, leading to lower uncertainty about precise PPs preferences. Specific terminal automation innovations, as well as automation innovations supporting the overall digitalization and integration of logistics processes seem to represent the most important issues in the area.

On the other hand, the most difficult to deploy innovation are *Fully Automated Container Terminal* and *Autonomous tugboats*. Generally speaking, it can be concluded that the infrastructure/vehicle automation in port facilities is not considered an easy task in the project area and, according to the ranking by importance, neither a priority.

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