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Automation and digitalisation on the transport workforce: How can the shock be prevented?

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Abstract

The transportation industry is experiencing a significant transformation due to the increasing adoption of automation and digitalization. As a result, professionals in the industry are increasingly concerned about how these changes will impact the workforce, and they are seeking effective strategies to address any potential challenges. This paper presents the findings of a study that sought to identify barriers and opportunities related to the impact of automation and digitalization on the transportation industry workforce. The study involved a collective intelligence and consensus-building process through structured discussions among stakeholders and partners/experts during a sequence of thematic area group convocations and focus groups, as part of the WE-TRANSFORM project. Over 70 suggestions were recorded during 25 meetings, which were then transcribed and reported through rapporteurs of thematic groups and focus groups run within thematic areas. The process included a two-round Delphi-type of survey to formulate a narrower list of the most significant actions. The study's results highlight the importance of soft skill development, such as communication, collaboration, and problem-solving, in the face of automation and digitalization in the transport industry. The findings suggest that a more significant focus on developing these skills can help address potential challenges.

Keywords: Knowledge co-creation; Delphi surveys; Actions; Policy-agenda; Automation; Digitalisation

1. Introduction

The transportation industry is currently facing a significant change due to the increasing use of automation and digitalisation. The integration of autonomous vehicles, drones, and other forms of automation in transportation is

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expected to bring many benefits such as increased efficiency, improved safety and reduced human error, however, it also has the potential to cause a "shock" to the workforce through widespread job displacement. At a first level, digitalisation has led to changes in the skills and tasks required of transport workers; the use of real-time data and digital communication systems has made it possible for transport companies to optimise their operations. On the one hand, this has led to an increased demand for workers with higher-level skills such as data analysis, programming, and automation management. On the other hand, automation is replacing manual and repetitive tasks and low-skill work tasks in general.

This new reality is now well-recognised and thus, plenty of international organisations have been issuing reports researching actions that can be taken to mitigate the negative impacts of automation and digitalisation on the transport workforce (OECD, 2019; ILO, 2021; WEFORUM, 2022). A collection and summary of actions - not necessarily focusing exclusively on the transport domain – clustered by the authors is given below:

- Upskilling and retraining: To ensure that workers are able to adapt to the changing demands of the transport industry, governments and employers have the option to invest in upskilling and retraining programs to help workers acquire the skills they need to succeed in the new digital and automated transport landscape.
- Job creation: Governments and employers can also invest in job creation programs to help offset the loss of jobs due to automation and digitalisation; this can include investing in infrastructure projects, supporting the development of new technologies, or increasing the level of direct service to vulnerable groups as parents accompanied by infants etc.
- Income support: To help workers who may be displaced by automation and digitalisation, governments can provide income support in the form of unemployment benefits or retraining allowances.
- Labor protections: Government and employers can ensure through legislation that provisions are in place to ensure that any workers displaced by automation and digitalisation are treated fairly.
- Social dialogue: Governments, employers and workers representatives should engage in social dialogue to address the challenges and opportunities of digitalisation and automation.
- Partnerships with educational institutions: Governments and employers can also partner with educational institutions to provide training and education programs that align with the skills needed for the future of transport industry.

Although the discussion mostly revolves around mitigating the negative impacts, there is also room to create opportunities for new jobs, better pay and career opportunities. In this light, this research is applying adapted Delphi survey rounds to support the formulation of a policy agenda with a view to balancing the impact of automation and digitalisation of the transport and shipping workforce through eventual measures in that direction. Despite a continuous process of automation in air transport and segments of land transport, the advent of new technological applications and the focus on limiting human error have propelled the penetration of both automation and digitalisation across transport modes (WE-TRANSFORM, 2022a) including shipping, where autonomous vessels have been constructed already with the potential of totally crewless sailings (SkillSea, 2021). Following the assessment of overall challenges these two contemporary trends create barriers and gaps including skills' gaps in terms of skills required for the transition (WE-TRANSFORM, 2022b).

The aim of this paper is the analysis of the results of a process of discovery, discussion, formulation and ranking of a list of actions to address barriers, and gaps, but also locate opportunities in relation to the impact of automation and digitalisation on the workforce. The process is the result of collective intelligence and consensus building through structured discussions among stakeholders and partners/experts followed by the transcription by the authors of over 70 suggestions recorded during about 25 meetings with the proceedings of the latter ranked through adapted two-round Delphi-surveys and clustered on the basis of importance and variability.

The rest of the paper is structured as follows: Section 2 provides offers a comprehensive survey and analysis of relevant literature. Section 3 provides a brief background description of this research, outlines the methodological steps and elaborates on the survey design, profile of participants and survey communication. Section 4 presents the results of the two rounds of the adapted Delphi survey. Finally, Section 5 concludes by providing also suggestions for future research.

2. Literature review

The impact of automation and digitalization on the transport sector has been a topic of increasing interest in recent years. Researchers have examined how these technologies are being adopted and implemented, however, their impact on workforce and the overall functioning of the industry is not yet fully explored. The profound reason is that it is a relatively recent phenomenon that is still unfolding. Thus, time is required to study and understand the complex interactions between technology, work practices, and organizational structures, especially in a sector as complex and dynamic as transport.

Attempting to contextualize the relevant literature, two clusters of studies emerge; the ones that focus more on why and how this is happening, and those attempting to measure the impacts and how to prevent them in view of the transition to automation and digitalisation. As per the former cluster, Polydoropoulou et al. (2023) in their research tried to understand workforce-related barriers and facilitators associated with the implementation of automation. The analysis of the results indicated that the transport sector's automation has been evolving at a different pace per sector and challenges concern stakeholder categories in different ways. Specifically, challenges related to loss of jobs are bound to affect groups within the workforce which may be constrained by regulatory age limits, or vulnerable, if in part-time employment without access to retraining. Alonso Raposo et al. (2018) acknowledged that deep changes in the labour market are expected progressively making some occupations and skills less relevant, while at the same time opening up new opportunities for different businesses and requiring new and more advanced skills. In their research, they state that automation and digitalization will bring a substantial transformation in industries, and social and living systems, and they conclude by analysing the potential effects of CCAM on the workforce and the identification of skills that need to be addressed in the mobility transition. Cedefop (2017) presented the findings of a study on the future skills needs of the European Union (EU) workforce in the context of digitalization. The study highlights the rapid pace of technological change and the increasing digitalization of the economy, and the implications this has for the skills and competencies required by the workforce. The report also provides some recommendations for actions that can be taken to develop the necessary digital skills and competencies, including the need for lifelong learning and upskilling, the importance of digital literacy, and the need for collaboration and partnerships between stakeholders.

As per the latter cluster, European Commission (2021) developed a typology of different measures that can be used to support the transition to automation and digitalisation in the transport sector. This typology in combination with literature review and participatory workshops produced good practice examples and recommendations that considered the level of awareness and preparedness of transport stakeholders. Muro et al. (2019) examined automation and AI on the US workforce and economy. Specifically, their study analyzed the current state of automation and AI, and projected their impacts on jobs and regional economies in the coming years. The study concludes by recommending policy interventions such as investments in education and training, targeted assistance to workers affected by job displacement, and the creation of new social safety nets to mitigate the negative impacts of automation and AI. Vermeulen et al., (2018) explored how digitalisation affected work and employment in a small-scale company in Finland. The authors find that digitalisation has brought changes in work content, work organization, and skills requirements. While some of these changes have led to positive outcomes such as increased flexibility and autonomy, others have resulted in negative consequences, such as increased workload and the feeling of being constantly connected to work. Eurofound (2018) provides an overview of the current state of automation and digitalisation in the European Union and the implications of these developments for work and employment. The report finds that while automation and digitalisation are likely to bring productivity gains and new job opportunities, they also pose risks of job displacement, skills obsolescence, and unequal distribution of benefits. The report highlights the need for policy responses that promote a human-centred approach to automation and digitalisation, including measures to support workers' skills development, ensure social protection, and promote decent working conditions. Accenture (2017) report highlighted the need for organizations to shift their focus from traditional ways of working to more flexible and agile ways of working, and to invest in developing new digital skills and capabilities in their workforce, without focusing specifically on transport. The report discusses the role of technology in enabling new business models, while it stressed the need for accelerating reskilling people, b) redesigning work to unlock human potential, and c) strengthening the talent pipeline from its source. Moreover, similar reports that refer to challenges that automation brings e.g. job displacements and workers' replacements are WEFORUM (2022), World Bank (2020), European Commission (2020), Shift2Rail (2019).

3. Background to the research and methodology

In the chain of the Horizon 2020 WE-TRANSFORM EU project results and directions of the analysis of barriers, gaps, opportunities, success and failure factors related to automation and digitalisation in terms of their impact on the workforce, were fed as input into the project's thematic groups created at the start of the related project task aiming at knowledge co-creation of which the specific objectives are presented on the right-hand side of Figure 1 below:

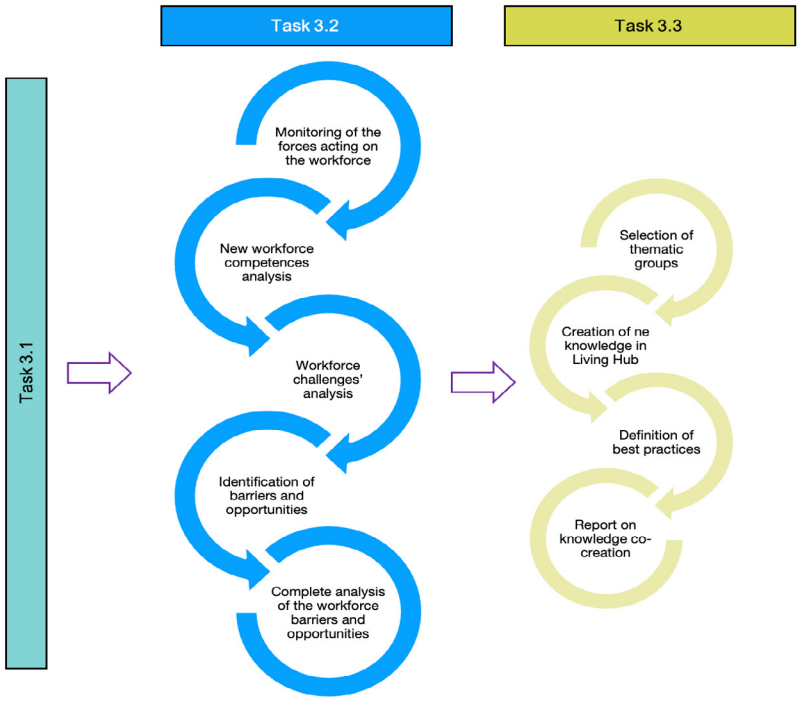

Fig. 1. WE-TRANSFORM T3.3 subtasks in the sequence of the WP3 implementation plan.

Already by the end of the previous project task, eight thematic areas (TA) were created in which stakeholder and project partners assessed and through collective intelligence formulated directions for actions in the area of mitigation of the negative impact of automation and digitalisation on the workforce and of enhancement and conversion of any opportunities into positive outcomes.

The methodology included five steps – summarised in Figure 2 next – were:

A. Literature analysis for the selection of suitable methods for knowledge co-creation in the context of the thematic areas'(TA) groups;
B. Appropriate transcription and adjustment of the material obtained through the thematic area reports;
C. Design of the Delphi-round questionnaires;
D. Categorisation and ranking of results obtained in the form of a list of priority actions for potential inclusion in a Policy Agenda to address the impact of automation and digitalisation on the workforce in the transport and shipping sectors;
E. Comparison of the results obtained with the most recent ones obtained within EU-funded research;

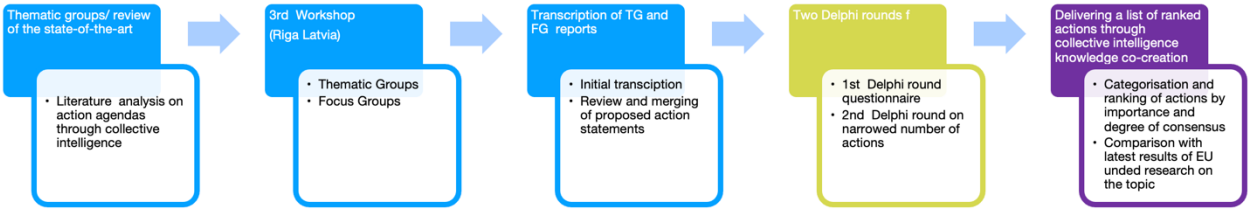

Fig. 2. Knowledge creation chain of WE-TRANSFORM and main methodology steps.

3.1. Division of thematic areas

To provide structure to the co-creation knowledge process, eight Thematic Groups (TGs) in the corresponding Thematic Areas (TAs) below were formed as follows:

1. Governance of transition;
2. Common skills to develop between same-level workers in different sectors of the transport industry;
3. Minimisation of exclusion processes in the reskilling of the workforce;
4. Platforms for gig workers: implications on jobs production;
5. The role of local and regional authorities;
6. Role of workers in Automated Public Transport Settings;
7. Regulation of transition in the view of collective bargaining
8. Automation and sustainability.

Each of these Thematic Areas was formed by a group of We-Transform (WET) partners participating in the co-creation knowledge process and was expanded through external stakeholders participating in the relevant project workshops.

3.2. Transcription and Clustering of Actions

Based on the textual analysis performed in the TG reports, 10 clusters of actions were formulated (A-J). The last cluster (J) represents the last field meant to be left open so that new actions could be contributed by the respondents of Delphi's round 1 survey. These clusters were :

A. Business Models for the Automation & Digitalisation Era
B. Skills and Competencies for the New Era
C. Training Strategies, Mentorship & Ambassadors for Automation & Digitalisation
D. Management Training in Automation & Digitalisation
E. Cooperative Automation & Digitalisation Training of Management and Workforce
F. Related risks
G. Workforce focused
H. Company related
I. High Level Regulatory Decisions and External Aid

Each cluster contained a number of actions; the full list of clusters along with the actions (72 in total) can be found in Appendix A.

3.3. Survey Design

The Delphi surveys in the English language were hosted on excel sheets to prioritise transcribed actions and suggest viable solutions to support the creation of an importance-variability map of such candidate actions to be taken at EU level. Pure, adapted/modified Delphi survey rounds have been applied for agenda-building in policy matters (Gasana et al., 2021; Karakikes and Nathanail, 2020; Beddoe et al., 2016; Hilbert et al., 2009) including in similar social-impact issues.

The survey consisted of two parts: The first part recorded respondents' organization type (ie. Road, Rail, Maritime, Air, Other). The second part aimed at measuring the importance of actions, according to stakeholders' experiences and accumulated expertise. All actions were rated based on the question "HOW IMPORTANT do you think the below ACTION is to tackle the challenges connected to the effects of automation on the transport labor force; thus the rates express the level of improvement they would bring to the workforce upon their adoption.

3.4. Profile of participants and survey communication

The survey was addressed to two groups of participants: a) participants of the WET TAs, and b) all WET partners, other than Universities and Research centers. Universities and Research centers were excluded from the survey as the effects of automation on the transportation workforce should be reported by the actual workforce (managers, workers, HR staff) with first-hand experience and knowledge of the changes within their industry with their perspectives being of high relevance for informing policy and decision-making. As per the former, the participants of the WET TAs were internal-to-WET stakeholders, i.e. state and private enterprises, municipalities, trade unions, national authorities, industry, transport operators, and external-to-WET stakeholders, i.e. transport authorities, policy makers, citizens' representatives, etc. with this diversity of participants designed to reflect stakeholder groups' contextual factors diversity.

The Delphi process usually enables a group of experts in advance by requesting their commitment to participating in all survey rounds; however, within this specific survey, it was deliberately decided to enable an open panel of participants i.e., stakeholders and not necessarily experts. In that way, the credibility of Delphi results is increased as influential individual experts cannot bias their responses favorably towards one direction, with collected knowledge reflecting thus a broader layer of the topic (Kezar and Maxey, 2014).

The participants of the survey were reached through email. As a first step, TA leaders were contacted by the survey administrators and asked to forward to their groups' members an email containing a) information about the purpose of the research, instructions on how they can contribute to the research and the time horizon of the two Delphi rounds, and b) the excel file in which the rating of the actions would take place. The remaining WET partners that were not serving any of the WET TGs were contacted directly by the survey administrator. In total, emails were sent to ca. 95 individuals. The first round opened on 10 November 2022 and remained open till 27 November 2022. The second round opened on 20 December 2022 and remained open till 11 January 2023.

4. Survey and results

4.1. Sample characteristics

The final sample size of the first round comprised 23 participants who fully completed the questionnaire, while 14 participated successfully in both rounds. The dropout rate (39%) between the two rounds is considered high according to other e-Delphi studies which range from 20 to 25%; however, it can be also deemed rather satisfactory given that no commitment was pre-requested from participants (Hall et al, 2018). The map of the participants' organisation countries can be seen in Figure 3.

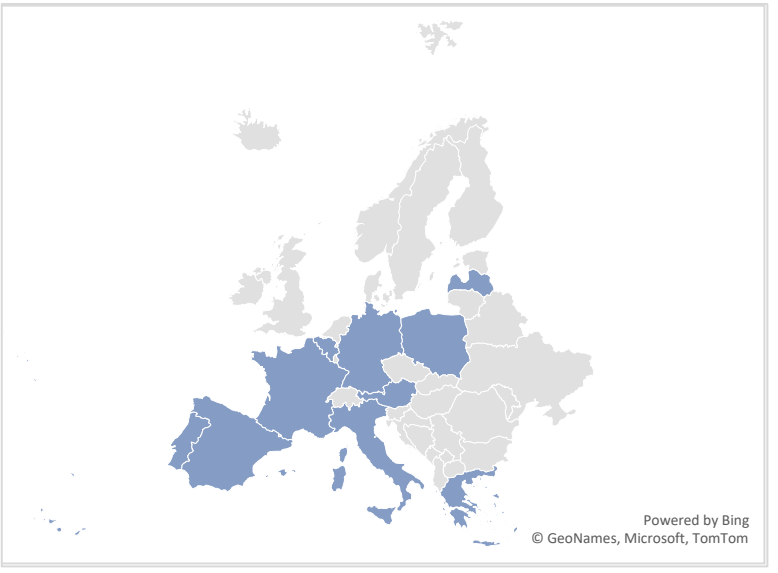

Fig. 3. Map of participants' organization country.

Figure 3 shows a good distribution of respondents' organization countries across EU, covering different levels and paces toward transport automation and digitalisation, including countries that have taken more mature steps in embracing and enacting landmark legislation. The frequency distribution per organization type and membership in a TG, for both rounds, can be seen in Figure 4.

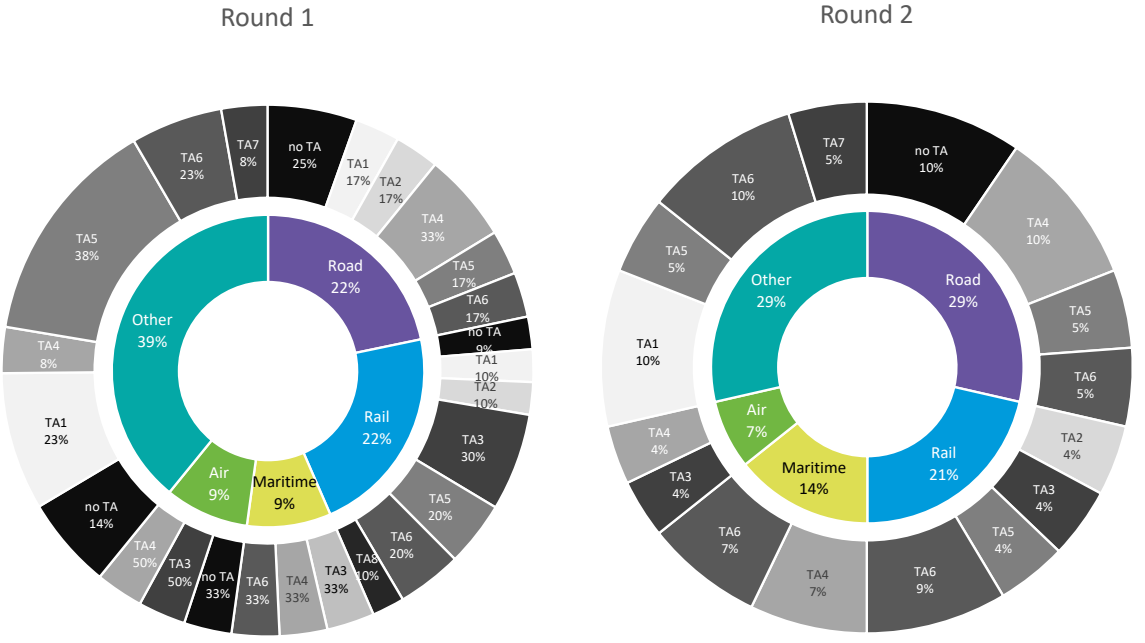

Fig. 4. Participants' distribution per organization type (Road, Rail, Maritime, Air, Other) and membership in a TA (1-8).

Figure 4 shows the distribution of respondents' transport modes, as well as their distribution in the eight WET TAs. Considering that "Other" mainly refers to stakeholders that they involved in Public Transportation – which in Europe is represented mostly by Road and Rail – the distribution seems to match the EU modal split of inland transport (Eurostat, 2022).

4.2. Delphi round 1

In Delphi round 1, all 72 actions were rated as per their importance on a 1-6 Likert scale. The average results for all 23 participants per action were estimated and can be seen in Appendix B. Other than the average scores, the standard deviation was also estimated to measure the dispersion of the data. Moreover, the last column of Appendix B shows the average value per cluster of actions.

Action C6 "Support mentorship of members of the workforce for transition in the Automation & Digitalisation era" emerged as the most important action as it was rated with 5.31 (STDEV 1.07). The action with the least importance was F4 "Expand minimum income to mitigate Automation & Digitalisation impact on workforce" with 3.8 (STDEV 1.17). On a cluster level, "H. Company related" cluster, demonstrates the highest importance, highlighting the responsibility of the companies to reach down the workforce and fill any gaps between technological innovation and frontline work current practices. Moreover, participants were given the opportunity to add any missing actions in the last part of the questionnaire, namely cluster J. The six actions that were brought up by the respondents were the following:

1. Engage with users to evaluate needs regarding Automation & Digitalisation
2. Evaluate the alternatives for those who are info-excludes
3. Address social acceptance of public transport automation by users and the workforce
4. Update traditional study programs in Universities -Introduce new cross-field educational programs to address the emerging need for combined technical & A&D skills in the workforce
5. Awareness programs, social interactions, advertisements and deploy a skillful person within the territory of Digitalisation and Automation usage so that the users which are frequent travelers are skillful enough to use such applications if they are not familiar with the technology.
6. Promotion of generational transition awareness inside companies.

Interestingly enough, the majority of the proposed-by-the-respondents actions, focus on addressing user needs and societal acceptance, although a more descriptive version of the actions would allow a more clear and specific interpretation.

Based on the rates of actions' importance in Round 1 as well as their standard deviation an adapted Importance Performance (IPA) map was developed (Martilla and James, 1977) shown in Figure 5. In this adapted version of an IPA map, performance is translated into variability. The lower the standard deviation (variability) scores are, the higher the convergence of opinions as per the importance of an action. The division of the IPA map into quadrants was performed by setting the threshold lines equal to the average values for importance and variability, respectively.

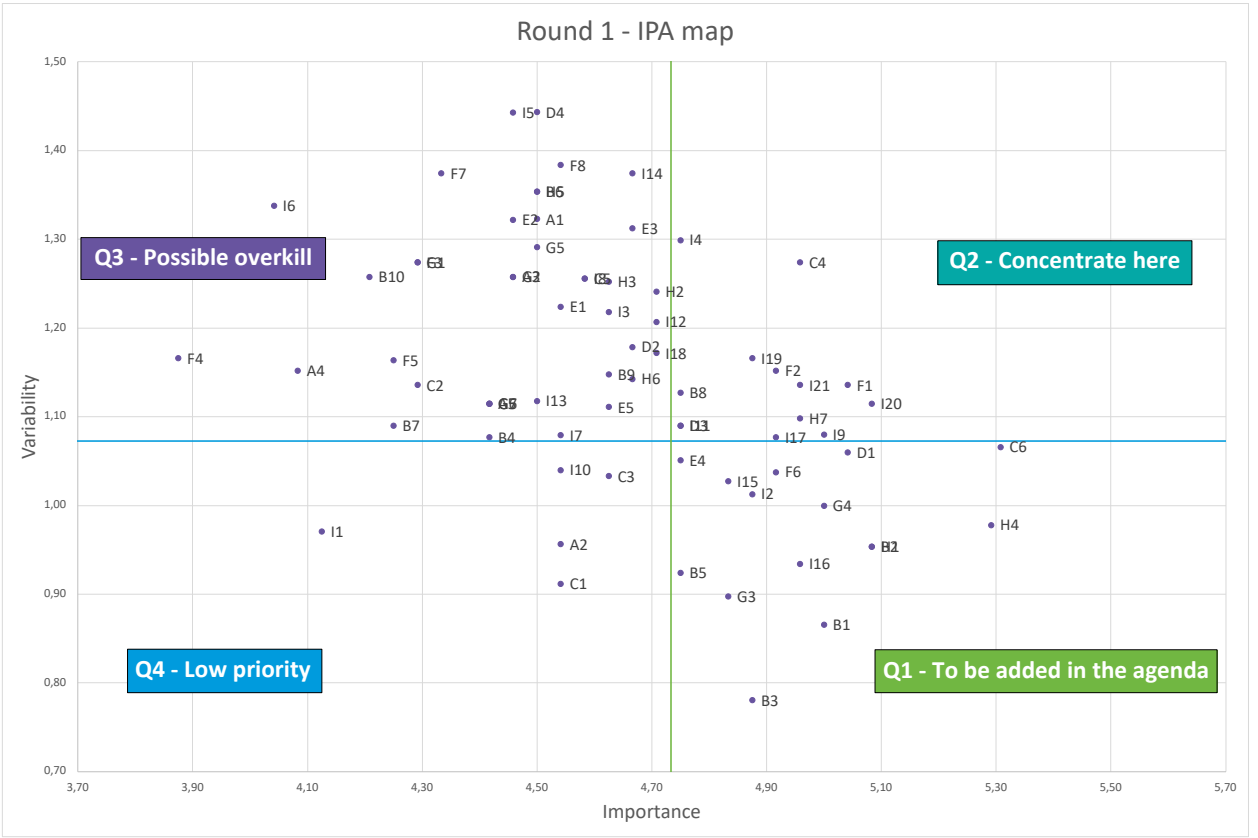

Fig. 5. R1 Importance - Variability map (as an adjusted version of the Importance Performance map).

Actions lying in Q1 are directly appropriate for inclusion in a policy agenda, as they combine high importance and lower variability, thus high convergence. Such actions are: “Encourage setting up workforce and management cooperation mechanisms for transition to Automation and Digitalisation”, “Strengthen workforce digital skills”, “Invite local authorities to cooperate to cater for Automation and Digitalisation created gaps including legal”, “Address the specific gaps and difficulties of transition for blue collar workers”, “Reskill the workforce to assist placing users at the center of the Automation and Digitalisation transition especially in terms of inclusiveness”, “Address the difficulties for public transport operators and small cities recruiting personnel skilled in Automation and Digitalisation”, “Protect life-work balance at risk through 24/7 digitalisation pressure”, “Invite research and education cooperation to cater for Automation and Digitalisation created gaps including legal”, “Encourage the development of stronger soft skills”, “Encourage cross-generational training to bridge and exchange knowledge between workforce generations”, “Address management training in management of changing skills for Automation and Digitalisation”, “Explore and define new occupational profiles arising through Automation and Digitalisation”, “Identify common competences such as basic digital skills and transport-mode specific new competences required for Automation and Digitalisation”, “H4: Introduce continuous upskilling and reskilling training programs”, “C6: Support mentorship of members of the workforce for transition in the Automation and Digitalisation era”. Q3 and Q4 area contains actions that respondents scored as least important; thus, actions in the latter areas are considered with “possible overkill” or “low priority”. Likewise, in the Q2 area lay actions in which convergence is low, and thus their inclusion in a policy agenda cannot be supported as having a strong portent of controversy as, no matter how important they are considered there is no evidence of stakeholder agreement. Such actions are: I4, B8, D3, I11, I19, F2, I17, C4, I21, H7, I9, F1, I20.

4.3. Delphi round 2

The purpose of the second Delphi round was to build further convergence for actions that scored "high importance and low variability" rates (Q1 area in Figure 5) but also "high importance and high variability" (Q2 area in Figure 5). Following this rationale, 33 high-importance scored actions were returned to the respondents, asking them to revise (if they considered it appropriate) their ratings, considering this time the results of the first round. Specifically, respondents were asked to revise their previous scores so as to converge more to the average scores of the other participants (their Round 1 scores were available to them). The revision of the scores was optional and there was no specific consensus threshold to be reached. A color indication was used in order to establish an easy detection of those actions that diverge more than one unit in the 1-6 scale, as compared to the average values.

The average results for all 14 participants per action were estimated and are shown in Table 1. The same table includes the respective values of round 1 to allow comparisons and draw conclusions.

Table 1. Mean and STDEV values of the actions qualified in the second Delphi round.

Action	Mean (R2)	STDEV (R2)	Mean (R1)	STDEV (R1)
B1	5,00	0,88	5,00	0,87
B2	5,04	0,95	5,08	0,95
B3	4,83	0,76	4,88	0,78
B5	4,74	0,94	4,75	0,92
B8	4,65	1,09	4,75	1,13
C4	4,87	1,26	4,96	1,27
C6	5,13	1,02	5,31	1,07
D1	5,00	0,98	5,04	1,06
D3	4,78	0,93	4,75	1,09
E4	4,70	0,95	4,75	1,05
F1	5,13	0,95	5,04	1,14
F2	4,91	1,02	4,92	1,15
F6	4,78	1,02	4,92	1,04
G3	4,78	0,88	4,83	0,90
G4	4,96	1,00	5,00	1,00
H1	5,00	0,93	5,08	0,95
H4	5,35	0,87	5,29	0,98
H7	4,91	1,10	4,96	1,10
I2	4,87	0,90	4,88	1,01
I4	4,83	1,13	4,75	1,30
I9	5,04	0,91	5,00	1,08
I11	4,70	1,04	4,75	1,09
I15	4,74	0,99	4,83	1,03
I16	4,91	0,93	4,96	0,93
I17	4,83	1,05	4,92	1,08
I19	4,78	1,06	4,88	1,17
I20	5,04	1,12	5,08	1,11
I21	4,91	1,14	4,96	1,14
J1	5,62	0,62	-	-
J2	5,00	0,95	-	-

J3	4,78	1,03	-	-
J4	4,89	0,99	-	-
J5	5,00	0,82	-	-

Overall and based on the results of the second round, the majority of the respondents revised their ratings by scoring lower the actions. This can be attributed either to their willingness to achieve higher convergence or to that they decided that some of these actions were not as important as they initially thought towards tackling challenges in view of the transition of the transport workforce towards an automation and digitalisation era. In both cases, higher convergence rates have been achieved in the second round as variability was lower almost for every action. The IPA map of round 2 is shown below in Figure 6.

Based on the results of the second round, most of the respondents revised their ratings downwards. This can be attributed either to their willingness to achieve higher convergence or to their personal perception shifting towards lower importance of the actions compared to their initial thought. In both cases, higher convergence rates have been achieved in the second round as variability has lowered almost for every action. Exceptions to this rule are B1 “Encourage the development of stronger soft skills”, B5 “Strengthen workforce digital skills” and I20 “Use three sides – state, industry, workers – collective bargaining for the Automation and Digitalisation transition to protect the workforce and include new rights possibilities – reskilling, etc.” where standard deviation slightly increased, and B2 “Identify common competences such as basic digital skills and transport-mode specific new competences required for Automation and Digitalisation”, H7 “Promote diverse and engaging training in Automation and Digitalisation” and I21 “Use negotiations between unions and employers to manage the Automation and Digitalisation transition” where standard deviation remained steady.

Similarly, like before, the IPA map of round 2 can be seen below in Figure 6.

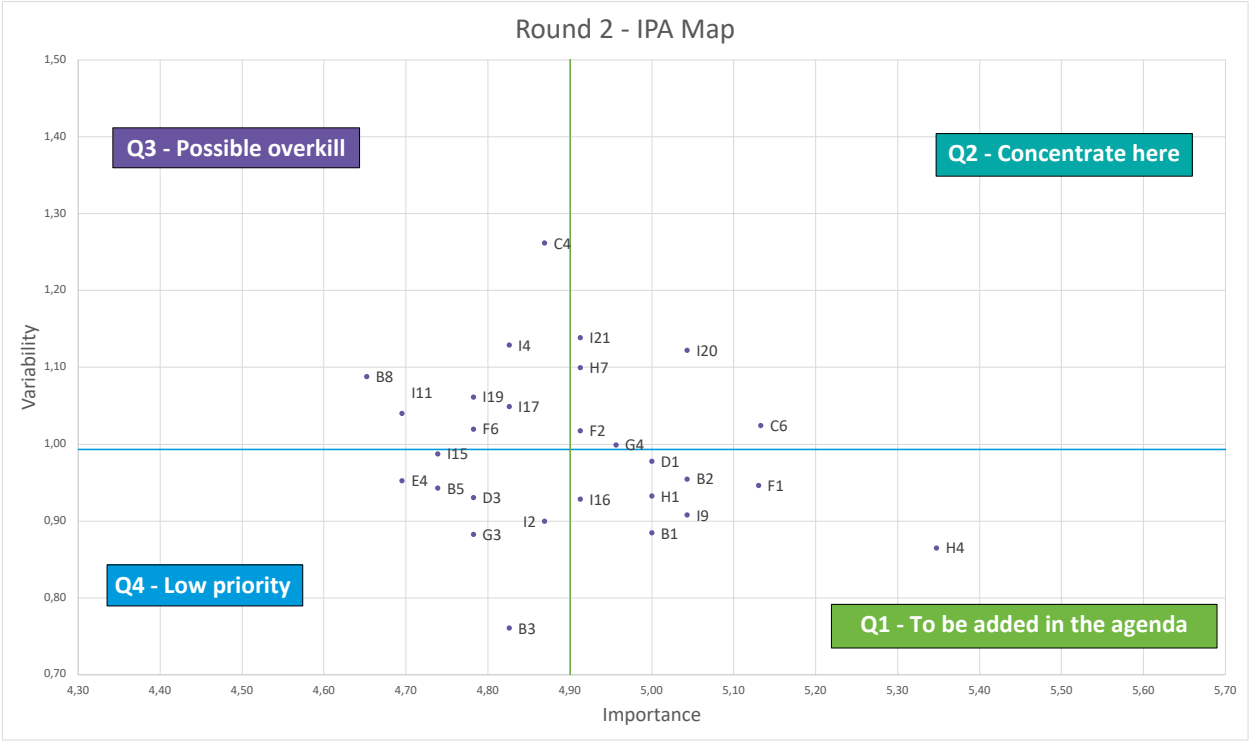

Fig. 6. R2 Importance - Variability map.

Based on the results of the second round IPA map the actions to be finally included in the agenda (actions lying in Q1) that will define the European strategy for dealing with the social impact on the transport workforce transition are the following:

Table 2. Set of agenda actions as emerged of 2nd Delphi round.

Action	Name	Type	Mean (R2)	STDEV (R2)
B. SKILLS AND COMPETENCIES FOR THE NEW ERA				
B1	Encourage the development of stronger soft skills	All types	5.00	0.88
		Road	4.20	0.98
		Rail	5.40	0.80
		Maritime	5.00	0.95
		Air	5.00	0.00
		Other	5.22	0.63
B2	Identify common competences such as basic digital skills and transport-mode specific new competences required for Automation and Digitalisation	All types	5.04	0.95
		Road	5.00	0.89
		Rail	5.20	1.17
		Maritime	4.91	1.08
		Air	4.50	0.50
		Other	5.00	0.94
D. MANAGEMENT TRAINING IN AUTOMATION AND DIGITALISATION				
D1	Address management training in management of change skills for Automation and Digitalisation	All types	5.00	0.98
		Road	5.20	0.40
		Rail	4.80	1.47
		Maritime	4.82	1.27
		Air	5.50	0.50
		Other	4.67	0.82
F. RISKS				
F1	Address cybersecurity risks created by transport Automation and Digitalisation	All types	5.13	0.95
		Road	4.20	0.40
		Rail	5.20	0.75
		Maritime	5.09	0.79
		Air	5.50	0.50
		Other	5.33	1.05
H. COMPANY RELATED				
H1	Explore and define new occupational profiles arising through Automation and Digitalisation	All types	5.00	0.93
		Road	5.20	0.75
		Rail	5.40	0.80
		Maritime	4.64	1.07
		Air	4.00	1.00
		Other	5.00	0.94
H4	Introduce continuous upskilling and reskilling training programs	All types	5.35	0.87
		Road	5.40	0.49
		Rail	5.80	0.40
		Maritime	5.27	0.86

Action Name		Type	Mean (R2)	STDEV (R2)
		Air	4.50	0.50
		Other	5.33	1.05
I. HIGH LEVEL REGULATORY DECISIONS AND EXTERNAL AID				
		All types	5.04	0.91
		Road	5.20	0.75
		Rail	5.40	1.20
I9	Explore the funding of the cost of reskilling the workforce	Maritime	5.00	1.04
		Air	4.00	1.00
		Other	5.00	0.67
		All types	4.91	0.93
		Road	5.00	1.10
		Rail	5.00	0.63
I16	Invite research and education cooperation to cater for Automation and Digitalisation created gaps including legal	Maritime	4.82	1.03
		Air	4.50	0.50
		Other	4.89	0.99

4.4. Elaboration on actions to be included in the agenda

Action 1: Encourage the development of stronger soft skills

The development of soft skills, such as communication, collaboration, and problem-solving, has become increasingly important in the face of automation and digitalisation in the transport industry. Automated systems and technology can handle many routine tasks, but they still require human input to operate effectively and efficiently. As such, workers who possess strong soft skills are better equipped to adapt to changing roles and new technologies and are more likely to remain employable in an increasingly automated and digitalised work environment.

To encourage the development of stronger soft skills among the transport workforce, policy makers can take several sub-actions such as to:

- promote the importance of soft skills training and development in existing educational and training programs;
- create initiatives that provide workers with opportunities to develop their soft skills, such as mentorship programs, workshops, and online courses;
- work with employers to incorporate soft skills into recruitment and selection processes, and to provide opportunities for employees to continually develop these skills on the job.

Action 1 is crucial for ensuring that the transport workforce remains adaptable and employable in the face of automation and digitalisation and able to take full advantage of opportunities created by the technological advancements. In particular, the evidence is mounting that measurable and coachable social-emotional skills have a significant impact on the performance of individuals and organizations. Emotional Quotient (EQ) can be a key differentiator for organizations and leaders around the world, who to date are competing in an increasingly complex and challenging marketplace. Emotional Intelligence (EI) is the ability to use emotions effectively. Since the publication of the first research on the subject in 1990, innovative organizations have begun experimenting with how to integrate EI into training and selection processes to gain competitive advantage. It has become increasingly clear that these skills form the foundation of top-performing organizations (Freedman, 2018).

Action 2: Identify common competences such as basic digital skills and transport-mode specific new competences required for Automation and Digitalisation

To effectively mitigate the impact of automation and digitalization on the transport workforce, it is important to identify common competencies required for the new technological landscape; this includes both basic digital skills and transport-mode specific competencies needed to effectively operate and maintain new systems and technologies.

To carry out this action, policy makers can:

- work with industry experts, employers, and workers to assess the current state of competencies in the sector, and to identify the specific competencies that are required to support automation and digitalization;
- develop training and education programs that target these competencies, and work with employers to encourage the uptake of these programs by their workers;
- engage with educational institutions to ensure that the necessary competencies are included in their curricula, and work with existing training and development providers to align their offerings with the changing needs of the sector.

By identifying and developing the necessary competencies, Action 2 can contribute to ensure that workers are equipped with the skills and knowledge they need to thrive in the new technological landscape, and that the transport workforce is able to adapt and respond to the challenges posed by automation and digitalisation.

Action 3: Address management training in management of changing skills for Automation and Digitalisation

The rapid pace of automation and digitalisation in the transport sector will require significant changes in the way work is organised and managed. To effectively mitigate the impact of these changes on the workforce, it is important to address the need for management training in change management skills. This will enable managers to effectively lead their teams through the transition, and to support workers as they adapt to new technologies and processes.

To carry out this action, policy makers can:

- work with industry associations, employers, and educational institutions to develop training programs that target management skills for change management. These programs can cover topics such as communication, conflict resolution, team building, and change leadership;
- include practical exercises and case studies to assist managers develop the necessary skills and knowledge;
- engage with employers to encourage the uptake of these programs by their managers, and to create opportunities for managers to continually develop their change management skills; this could include workshops, online courses, and coaching sessions.
- encourage attendance-specific emotional intelligence programs to support teams in managing even emotional change. Replacing old habits with new habits requires important efforts and energy for everyone. Identifying this challenge and generating the energy is the first step that every individual, organisation, and government should make before embarking.

By addressing the need for management training in change management, Action 3 can ensure that managers are equipped with the skills they need to effectively lead their teams through the transition, and that the workforce is able to adapt to the changing technological landscape in an adequately supported manner.

Action 4: Address cybersecurity risks created by transport Automation and Digitalisation

The increasing reliance on automation and digitalisation in the transport sector creates new cybersecurity risks, which need to be addressed to ensure the safe and secure operation of these systems. This includes risks related to data breaches, cyber-attacks, and unauthorized access to sensitive information.

To carry out this action, policy makers can:

- enable a collaboration among industry experts, employers, and workers to overcome the insufficient education available for the work force in general to cope with the rapidly growing cybersecurity risks posed by automation and digitalisation in the transport sector. There is a lack of professional trainers/specialists, who can properly educate the workers/the management (see specific challenges related to AI and self-learning machines). Specific education needs for all part of the mobility system as well as for the interfaces with other sectors need to be identified;
- develop guidelines and best practices for addressing these risks;
- provide training and education to workers and managers on how to prevent and respond to cyber incidents- This task should be addressed by specialized agencies/specialized departments of industry. Joint framework on European level may be necessary as due to the geopolitical situation a single enterprise may no longer be able to cope with the high risks on their own;
- enable a work with employers to ensure that cybersecurity measures are integrated into the design and operation of new systems and technologies, and that regular security audits are carried out to identify and address system vulnerabilities;

- encourage the development of new technologies and solutions that enhance cybersecurity in the sector.

By addressing cybersecurity risks created by automation and digitalisation, Action 4 can contribute to the safe and secure operation of these systems and help protect sensitive information and critical infrastructure from cyberattacks and other security incidents if funding/setting up specific innovation schemes/programs (industry, national government, European Commission) is provided, together with establishing specific agencies (that can also help industry in case of a cyber threat).

Action 5: Explore and define new occupational profiles arising through Automation and Digitalisation

Automation and digitalisation are rapidly changing the nature of work in the transport sector, and it is thus important to explore and define the new occupational profiles which are emerging as a result; this includes identifying skills and competencies required for these new roles and ensuring that workers are equipped with the necessary training and education to perform these new jobs effectively.

To carry out this action, policy makers can:

- enable the collaboration among industry experts, employers, workers, trade unions and societal groups to assess the current state of the workforce, and to identify the new occupational profiles that are emerging as a result of automation and digitalization. Need driven approach is required. Needs must be defined by stakeholders, industry, society, universities, work force. Involvement of society is important, especially related to issues relevant for certain groups (including disabled, poor, blind, gender, access to work and education (much self-learning is required in low densely populated areas). Also demographic change aspects need to be taken into account;
- define, at the next stage, the key competencies required for these roles, and develop training and education programs that target these competencies. Education ministers need to define how universities should be reshaped and evolve in an interdisciplinary way and how postgraduate inter sector education can create additional assets;
- enable a collaboration with employers to encourage the uptake of these programs by their workers, and to create opportunities for workers to continually develop their skills and competencies;
- engage educational institutions to ensure that the necessary competencies are included in their curricula, and work with existing training and development providers to align their offerings with the changing needs of the sector.

By exploring and defining new occupational profiles, Action 5 will enhance career clarity and attractiveness and ensure that skills and knowledge are provided to allow them to adapt and respond to the new needs.

Action 6: Introduce continuous upskilling and reskilling training programs

The rapid pace of automation and digitalisation in the transport sector requires the members of the workforce to continually upskill and reskill to keep pace with the changing technological landscape and shifting occupational profiles. This relates to previously mentioned actions among the proposed ones as a result of Task 3.3 as it involves both acquiring new technical skills and knowledge, as well as developing soft skills and competencies that are required for success in an increasingly automated and digital world of production of transport services.

To foster this action, policy makers can:

- enable the collaboration among industry experts, employers, workers and trade unions to assess the current state of the workforce, and to identify the skills and competencies required by the current workforce for success in the new technological landscape;
- develop training and education programs that target these skills and competencies, and encourage the uptake of these programs by both employers and employees to create opportunities for workers to continually upskill and reskill, including on-the-job training, online courses, and other forms of development, structuring a long life learning process;
- encourage the development of flexible and accessible training programs tailored to the needs of employees and employing organisations that can be delivered in a variety of formats to suit different learning styles and work schedules.

By introducing continuous upskilling and reskilling programs, Action 6 will help to ensure that the members of the workforce are equipped with the skills and knowledge they need to thrive in the new technological landscape. It will also enable more flexibility within the work force and strengthen the adaptation capability to future changes introduced

or inspired by continuous innovation and societal change. The workers will also be better equipped for mobility within their existing sectors or beyond them. This section is related to Action 3 suggesting that training courses related to soft skills enhancement cannot ignore the inclusion of emotional intelligence as a key competency for improving leadership in challenging and changing contexts. Interventions must be preceded by individual, team and whole-organization assessments that map key needs, which will be responded to with customized projects using integrated training, coaching and mentoring methodologies.

Action 7: Explore the funding of the cost of reskilling the workforce

The cost of reskilling the workforce to meet the demands of automation and digitalisation in the transport sector can be significant, and it is important to explore ways to define the sources and modalities to fund these costs to ensure that the members of the workforce have realistic sufficient opportunities to upskill and reskill. Such funding sources/modalities may include government funding, employer contributions, or partnerships between employers and educational institutions.

To carry out this action, policy makers can:

- work with industry experts, employers, and the workforce to assess the current state of funding for reskilling in the sector, and to identify the challenges and opportunities associated with funding these costs;
- explore different funding models, including government subsidies, employer contributions, and public-private partnerships, and develop recommendations for funding reskilling that are tailored to the needs of the transport and shipping sectors;
- work with employers to encourage the uptake of reskilling programs by their workers, and to create opportunities for workers to access these programs;
- engage with educational institutions to ensure that reskilling programs are aligned with the needs of the sector, and that they provide the workforce with the skills and competencies required for success in the new automation and digitalisation landscape.

By exploring the funding of reskilling costs, Action 7 will help to ensure that the members of the workforce have realistic and systematically provided opportunities to upskill and reskill.

Action 8: Invite research and education cooperation to cater for Automation and Digitalisation created gaps including legal ones

As the transport sector continues to evolve due to automation and digitalisation, there is a strong probability that gaps in knowledge, skills, and expertise that need to be addressed will appear. These gaps may include legal, technical, and management issues, and may require research and education cooperation to resolve.

To carry out this action, policy makers can:

- work with experts from industry, academia and workforce organisations promoting exchange of knowledge and cooperation among them to assess the current state of change in knowledge, skills, and expertise requirements in the sector in order to identify the gaps that need to be addressed;
- engage research and education institutions to collaborate – and cooperate with policy makers – to address such gaps, including through research on the design of gaps' monitoring mechanisms assisting in turn to the design and organisation of training programs targeting gaps;
- encourage the development of the appropriate legal framework to support the transition to automation and digitalisation address the related needs of all stakeholders focusing on the workforce in the context of the sector as a whole;
- foster mechanisms of cooperation between industry and educational institutions to ensure that the content of education and training programs follows the needs of the sector at an appropriate pace.

By encouraging research and education cooperation, Action 8 will help to fill gaps that create barriers to the adaptation of the workforce, all in minimising negative impact, to the challenges posed by the pace of automation and digitalisation developments in the areas of shipping and transport.

5. Conclusions and further research

The adapted Delphi method was used to conduct two successive surveys of internal and external stakeholders in the transport and shipping industry. The stakeholders participated in thematic area groups or focus groups organized by the former. The surveys identified areas of agreement among the stakeholders regarding the importance of various related actions. Unsurprisingly, these were areas related mostly to skills with only cybersecurity risks disrupting this uniform tendency.

Policy agendas need agreement and on the specific broader area of skilling and upskilling of both workforce and management, including in the latter case in the area of management of change, is a totally expected result. However, the consensus is not by itself proof of efficacy of actions. Putting to the test of larger numbers of stakeholders, especially within the workforce, measures which display a high degree of variability in terms of standard deviation is a parallel exercise that may show the areas where social dialogue between stakeholders must intensify. Results discussed in the paper also highlight the need to revisit factors such as power imbalances, differing interests, contestation, which vary based on stakeholders' points of view and engagement. For example, workers have different views and concerns compared to employers or policymakers. Engaging with all stakeholders can help to address these differences and develop policies that are more acceptable and equitable for all. It is also important to consider the potential power imbalances and contestation that may arise during policy development and implementation. Workers may have different interests and concerns compared to employers, and it is important to ensure that workers' voices are heard and taken into account. Monitoring and evaluating the impacts of actions by providing data and evidence on the impact of automation and digitalization on different stakeholder groups, can also help to address power imbalances and divergent interests. The monitoring process is essential to identify potential negative impacts and enable policymakers to develop measures to mitigate these impacts.

5.1. Limitations

One major limitation of this study is that, in order to facilitate data collection and avoid complications of holding identifying personal data, it does not capture the position of the participants in the organisation. First-round Delphi results showed that F4 Action "Expanding the minimum income to mitigate automation and digitalisation impact on workforce" scores the lowest value. This can be partially attributed to the fact that lower-income workers or associations of workers do not often have an active role in EU research projects – neither in think tanks as the WET Thematic Areas' discussions. Another limitation of the study is related to the recruitment process. Recruiting participants solely from entities that are related to the WET project introduces a potential bias in the study, as these participants may have a higher level of familiarity and acceptance of automation and digitalization technologies, and therefore may report differently compared to other entities.

The above limitations can be addressed by expanding the exposure of the actions to a wider audience. By doing so, not only will the robustness of the results be increased, but also subgroup analysis across different sectors will be enabled.

5.2. Further research

Further research could facilitate cross-comparisons between the key list of actions emerging from the Delphi rounds and recommendations by recent similar exploratory funded research. This comparison would strengthen the validity of the actions proposed in this study and could lead to an EU research-based policy agenda that could ultimately prevent the forthcoming shock.s

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Appendix A. Full list of actions as they have emerged by the Thematic Groups

A. BUSINESS MODELS FOR THE AUTOMATION & DIGITALISATION ERA	
A1	Encourage a more social approach of business on the impact of Automation & Digitalisation
A2	Explore new models of governance in the new Automation & Digitalisation era
A3	Promote a new business paradigm with more customer care jobs replacing job losses caused by Automation & Digitalisation
A4	Support a holistic local approach of Automation & Digitalisation, combining planning, communication and PPP strategies
A5	Use a stakeholder approach for sharing benefits of Automation & Digitalisation
B. SKILLS AND COMPETENCIES FOR THE NEW ERA	
B1	Encourage the development of stronger soft skills
B2	Identify common competences such as basic digital skills and transport-mode specific new competences required for Automation & Digitalisation
B3	Reskill the workforce to assist placing users at the center of the Automation & Digitalisation transition especially in terms of inclusiveness
B4	Strengthen workforce analytical skills
B5	Strengthen workforce digital skills
B6	Strengthen workforce skills in the areas of communication
B7	Strengthen workforce skills in the areas of decision-making
B8	Strengthen workforce skills in the areas of supervision and monitoring
B9	Strengthen workforce soft skills
B10	Strengthen workforce STEM skills
C. TRAINING STRATEGIES, MENTORSHIP & AMBASSADORS FOR AUTOMATION & DIGITALISATION	
C1	Consider training users for the new era of Automation & Digitalisation
C2	Designate peer automation ambassadors from the workforce
C3	Encourage tailor-made, different level, cooperative reskilling strategies
C4	Explore the impact of Automation & Digitalisation on users' behaviour to assist training of the workforce
C5	Introduce mentoring of the ones left behind by Automation & Digitalisation
C6	Support mentorship of members of the workforce for transition in the Automation & Digitalisation era
D. MANAGEMENT TRAINING IN AUTOMATION & DIGITALISATION	
D1	Address management training in management of change skills for Automation & Digitalisation
D2	Address management training in soft skills for Automation & Digitalisation
D3	Address management training in technological skills for Automation & Digitalisation
D4	Address training of older management generations in Automation & Digitalisation
E. COOPERATIVE AUTOMATION & DIGITALISATION TRAINING of MANAGEMENT AND WORKFORCE	
E1	Encourage a participatory Automation & Digitalisation process with workforce representation in company management
E2	Encourage co-creation of innovation related training
E3	Encourage participatory cooperative workforce and management engagement for the Automation & Digitalisation transition
E4	Encourage setting up workforce and management cooperation mechanisms for transition to Automation & Digitalisation
E5	Encourage Automation & Digitalisation training through team cooperation of the workforce
F. RISKS	
F1	Address cybersecurity risks created by transport Automation & Digitalisation

F2	Create a risks' map for the management of the transition to Automation & Digitalisation
F3	Encourage non-structured, non-official and ideological barrier-free communication on Automation & Digitalisation impact
F4	Expand minimum income to mitigate Automation & Digitalisation impact on workforce
F5	Focus on the risk by Automation & Digitalisation for middle-range jobs
F6	Protect life-work balance at risk through 24/7 digitalisation pressure
F7	Provide for health & safety risks for remaining workforce as physical presence is reduced through Automation & Digitalisation
F8	Provide for health & safety risks for users as physical presence is reduced through Automation & Digitalisation
G. WORKERS RELATED	
G1	Address the gaps and difficulties of transition for white collar workers
G2	Address the impact of Automation & Digitalisation on pay of the workforce
G3	Address the specific gaps and difficulties of transition for blue collar workers
G4	Encourage cross-generational training to bridge and exchange knowledge between workforce generations
G5	Encourage workforce training into soft "management-of-change" skills
G6	Explore shift of transport workforce replaced by Automation & Digitalisation to physically present emergency response teams
G7	Introduce new contract typologies to cater for workforce rights in the Automation & Digitalisation new environment
H. COMPANY RELATED	
H1	Explore and define new occupational profiles arising through Automation & Digitalisation
H2	Fill gaps between technological innovation and frontline work current practices
H3	Identify resources and initiatives to create a competences' framework, using latest technology incl. digitalisation and Artificial Intelligence
H4	Introduce continuous upskilling and reskilling training programs
H5	Investigate the sharing of decision responsibility between Artificial Intelligence and human management
H6	Investigate user needs for discovering employment opportunities related to quality of service and transport uses
H7	Promote diverse and engaging training in Automation & Digitalisation
I. HIGH LEVEL REGULATORY DECISIONS AND EXTERNAL AID	
I1	Address increased concentration in industry caused by Automation & Digitalisation with a focus on SMEs
I2	Address the difficulties for public transport operators and small cities recruiting personnel skilled in Automation & Digitalisation
I3	Create a generally acceptable typology to be used for measuring impacts of Automation & Digitalisation on the workforce
I4	Create a map of legal voids to be filled
I5	Create a network of local authorities, users and industry to address the Automation & Digitalisation impact
I6	Directly enforce reskilling/upskilling through government related contracts
I7	Enable local authorities to prepare and educate the public for the Automation & Digitalisation transport transition
I8	European Social Partner Framework* principles should be used to manage the impact of the Automation & Digitalisation transition on the workforce *(for info see link) https://www.eurofound.europa.eu/observatories/eurwork/industrial-relations-dictionary/european-social-partners
I9	Explore the funding of the cost of reskilling the workforce
I10	Factor-in in policy measures a necessary transition period for Automation & Digitalisation
I11	Introduce EU regulation making reskilling of the transport workforce affected by Automation & Digitalisation mandatory
I12	Introduce new definitions of working time and place of work in collective agreements

I13	Introduce regulation and government intervention to address impact of Automation & Digitalisation on the workforce
I14	Introduce the obligation to provide in collective agreements digital training to the workforce
I15	Invite local authorities to cooperate to cater for Automation & Digitalisation created gaps including legal
I16	Invite research and education cooperation to cater for Automation & Digitalisation created gaps including legal
I17	Prepare an EU-wide legal framework of transport automation from good practices in existing national regulation
I18	Promote a harmonised European policy workforce transition to Automation & Digitalisation
I19	Support public dialogue by local and national authorities on Automation & Digitalisation impact on the workforce
I20	Use a three sides (state, industry, workers) collective bargaining for the Automation & Digitalisation transition to protect the workforce and include new rights possibilities (reskilling, etc.)
I21	Use negotiations between unions and employers to manage the Automation & Digitalisation transition
J. ADDED by participants IN ROUND1	
J1	Engage with users to evaluate needs regarding Automation & Digitalisation
J2	Evaluate the alternatives for those who are information-excluded
J3	Update traditional study programs in Universities -Introduce new cross-field educational programs to address the emerging need for combined technical & A&D skills of the workforce
J4	Awareness programs, social interactions, advertisements and deploy a skillful person within the territory of Digitalisation and Automation usage so that the users which are frequent travelers are skillful enough to use such applications if they are not familiar with the technology.
J5	Promotion of generational transition awareness inside companies

Appendix B. First Delphi round results

Action	Mean	STDEV	Cluster's average
Cluster A. BUSINESS MODELS FOR THE AUTOMATION & DIGITALISATION ERA			
A1	4.50	1.32	
A2	4.54	0.96	
A3	4.46	1.26	4.40
A4	4.08	1.15	
A5	4.42	1.11	
Cluster B. SKILLS AND COMPETENCIES FOR THE NEW ERA			
B1	5.00	0.87	
B2	5.08	0.95	
B3	4.88	0.78	
B4	4.42	1.08	
B5	4.75	0.92	4.65
B6	4.50	1.35	
B7	4.25	1.09	
B8	4.75	1.13	
B9	4.63	1.15	
B10	4.21	1.26	
Cluster C. TRAINING STRATEGIES. MENTORSHIP & AMBASSADORS FOR AUTOMATION & DIGITALISATION			
C1	4.54	0.91	4.72
C2	4.29	1.14	

Action	Mean	STDEV	Cluster's average
C3	4.63	1.03	
C4	4.96	1.27	
C5	4.58	1.26	
C6	5.31	1.07	
Cluster D. MANAGEMENT TRAINING IN AUTOMATION & DIGITALISATION			
D1	5.04	1.06	4.74
D2	4.67	1.18	
D3	4.75	1.09	
D4	4.50	1.44	
Cluster E. COOPERATIVE AUTOMATION & DIGITALISATION TRAINING of MANAGEMENT AND WORKFORCE			
E1	4.54	1.22	4.61
E2	4.46	1.32	
E3	4.67	1.31	
E4	4.75	1.05	
E5	4.63	1.11	
Cluster F. RISKS			
F1	5.04	1.14	4.52
F2	4.92	1.15	
F3	4.29	1.27	
F4	3.88	1.17	
F5	4.25	1.16	
F6	4.92	1.04	
F7	4.33	1.37	
F8	4.54	1.38	
Cluster G. WORKERS RELATED			
G1	4.29	1.27	4.56
G2	4.46	1.26	
G3	4.83	0.90	
G4	5.00	1.00	
G5	4.50	1.29	
G6	4.42	1.11	
G7	4.42	1.11	
Cluster H. COMPANY RELATED			
H1	5.08	0.95	4.83
H2	4.71	1.24	
H3	4.63	1.25	
H4	5.29	0.98	
H5	4.50	1.35	
H6	4.67	1.14	
H7	4.96	1.10	
Cluster I. HIGH LEVEL REGULATORY DECISIONS AND EXTERNAL AID			
I1	4.13	0.97	4.69

Action	Mean	STDEV	Cluster's average
I2	4.88	1.01	
I3	4.63	1.22	
I4	4.75	1.30	
I5	4.46	1.44	
I6	4.04	1.34	
I7	4.54	1.08	
I8	4.58	1.26	
I9	5.00	1.08	
I10	4.54	1.04	
I11	4.75	1.09	
I12	4.71	1.21	
I13	4.50	1.12	
I14	4.67	1.37	
I15	4.83	1.03	
I16	4.96	0.93	
I17	4.92	1.08	
I18	4.71	1.17	
I19	4.88	1.17	
I20	5.08	1.11	
I21	4.96	1.14	

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