

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

Original

Automation and digitalisation on the transport workforce: How can the shock be prevented? / Karakikes, Ioannis; Thanopoulou, Helen; Polydoropoulou, Amalia; Pronello, Cristina. - ELETTRONICO. - (2023). (Intervento presentato al convegno World Conference on Transport Research - WCTR 2023 tenutosi a Montreal (Canada) nel 17-21 July 2023).

Availability:

This version is available at: 11583/2992350 since: 2024-09-10T13:21:10Z

Publisher:

Elsevier

Published

DOI:

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

AAAS preprint/submitted version e/o post-print Author Accepted Manuscript

preprint/submitted version e/o post-print Author Accepted Manuscript

(Article begins on next page)



World Conference on Transport Research - WCTR 2023 Montreal 17-21 July 2023

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

Ioannis Karakikes^{a*}, Helen Thanopoulou^a, Amalia Polydoropoulou^a, Cristina Pronello^b

^a*Department of Shipping, Trade and Transport, University of the Aegean, 82100 Chios, Greece*

^b*Interuniversity Department of Regional and Urban Studies and Planning, Politecnico di Torino, 10125 Torino, Italy*

Abstract

This paper analyses the results of the discovery, discussion, formulation and ranking of a list of actions to address barriers, and gaps, but also locate opportunities related 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 during a sequence of thematic area group convocations and focus groups, with the WE-TRANSFORM project. The exploration of actions to counteract negative impact and strengthen opportunities required transcribing over 70 suggestions recorded during about 25 meetings; the proceedings of the latter were reported through the rapporteurs of thematic groups' and focus groups run within thematic areas. A two-round Delphi-type of survey was then used to formulate a narrower list of the most significant actions put forward through collective intelligence, whereby a larger consensus was achieved. The survey rounds produced additionally a list of interesting candidates to be explored by next work package of the project, which is to formulate the final policy agenda. Before that, it is planned that action options will be exposed to the validation of larger numbers through parallel dissemination activities while expert and larger audience rankings will be then compared and contrasted.

© 2023 The Authors. Published by Elsevier B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)
Peer-review under responsibility of the scientific committee of the World Conference on Transport Research – WCTR 2023.

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

* Corresponding author. Tel.: +30-697-366-5697

E-mail address: ikarakikes@aegean.gr

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, a great deal 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 a brief background description of this research. Section 3 outlines the methodological steps and elaborates on the survey design, profile of participants and survey communication. It also presents the results of the two rounds of the adapted Delphi survey. Finally, Section 4 concludes by providing also suggestions for future research.

2. Background to the research

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:

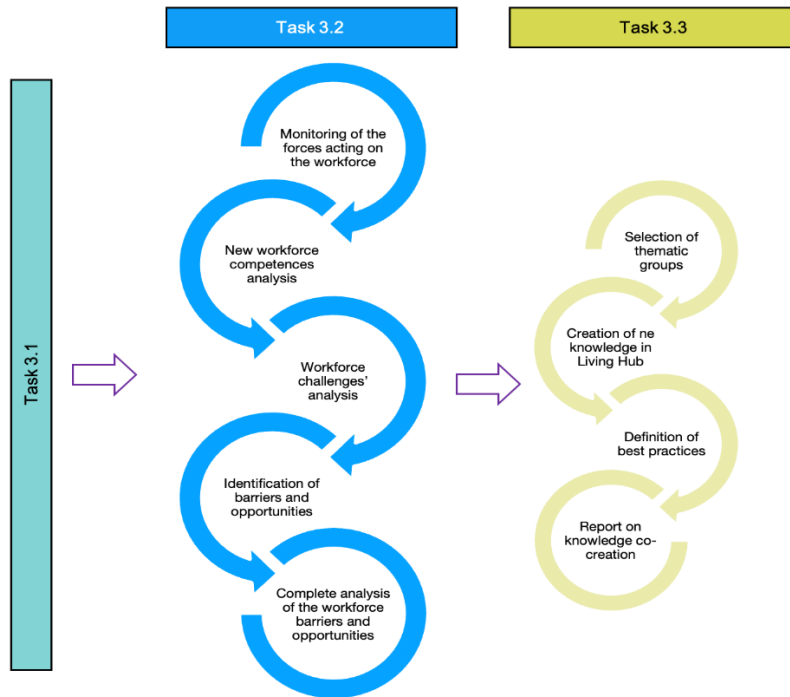


Fig. 1. WE-TRANSFORM T3.3 subtasks in the sequence of the WP3 implementation plan.

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;

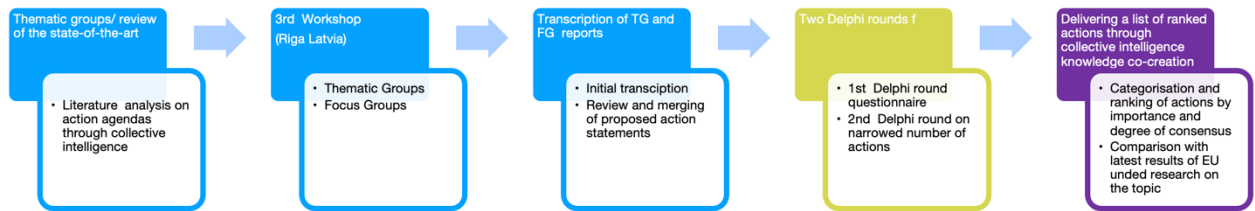


Fig. 2. Knowledge creation chain of WE-TRANSFORM and main methodology steps.

2.1. 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 TAs was formed by a group of WET partners participating in the co-creation knowledge process and was expanded through external stakeholders participating in the relevant project workshops.

2.2. 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.

2.3. 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. Survey and results

3.1. 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.

3.2. Sample characteristics

The final sample size of the first round comprised 23 participants who fully completed the questionnaire and successfully returned the excel with the responses, 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, while the frequency distribution per organization type and membership in a TG, for both rounds, can be seen in Figure 4.

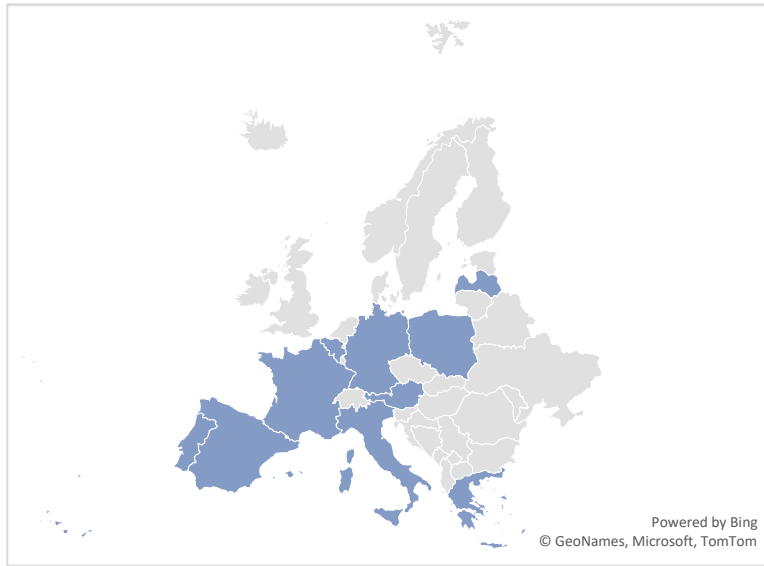


Fig. 3. Map of participants’ organization country.

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.

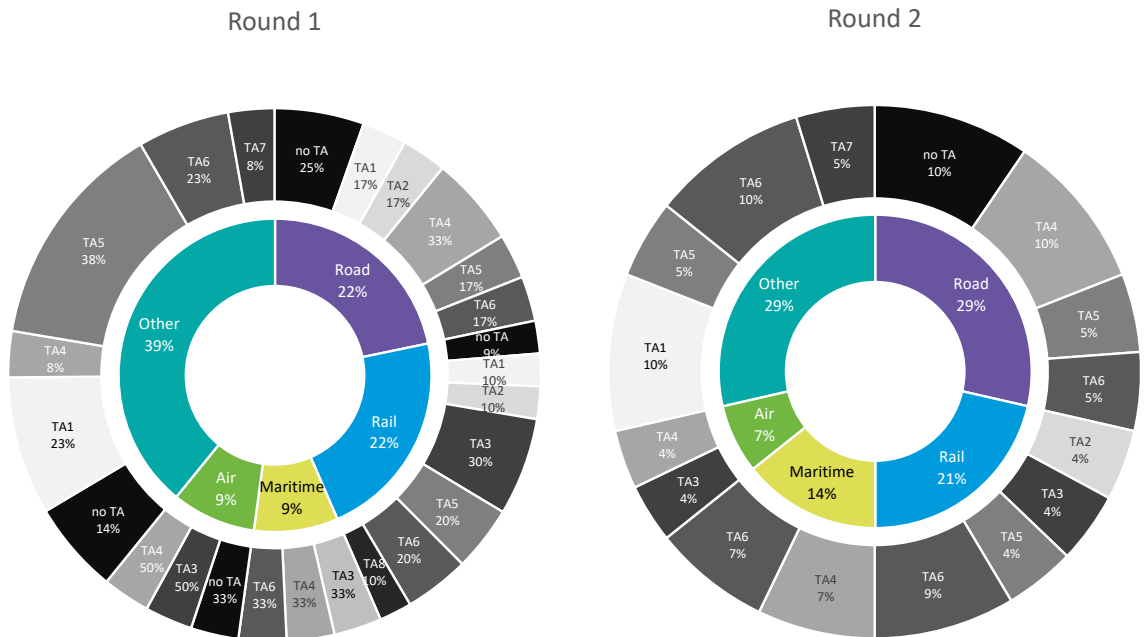


Fig. 4. Participants’ distribution per organization type (Road, Rail, Maritime, Air, Other) and membership in a TA (1-8).

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).

3.3. 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 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.

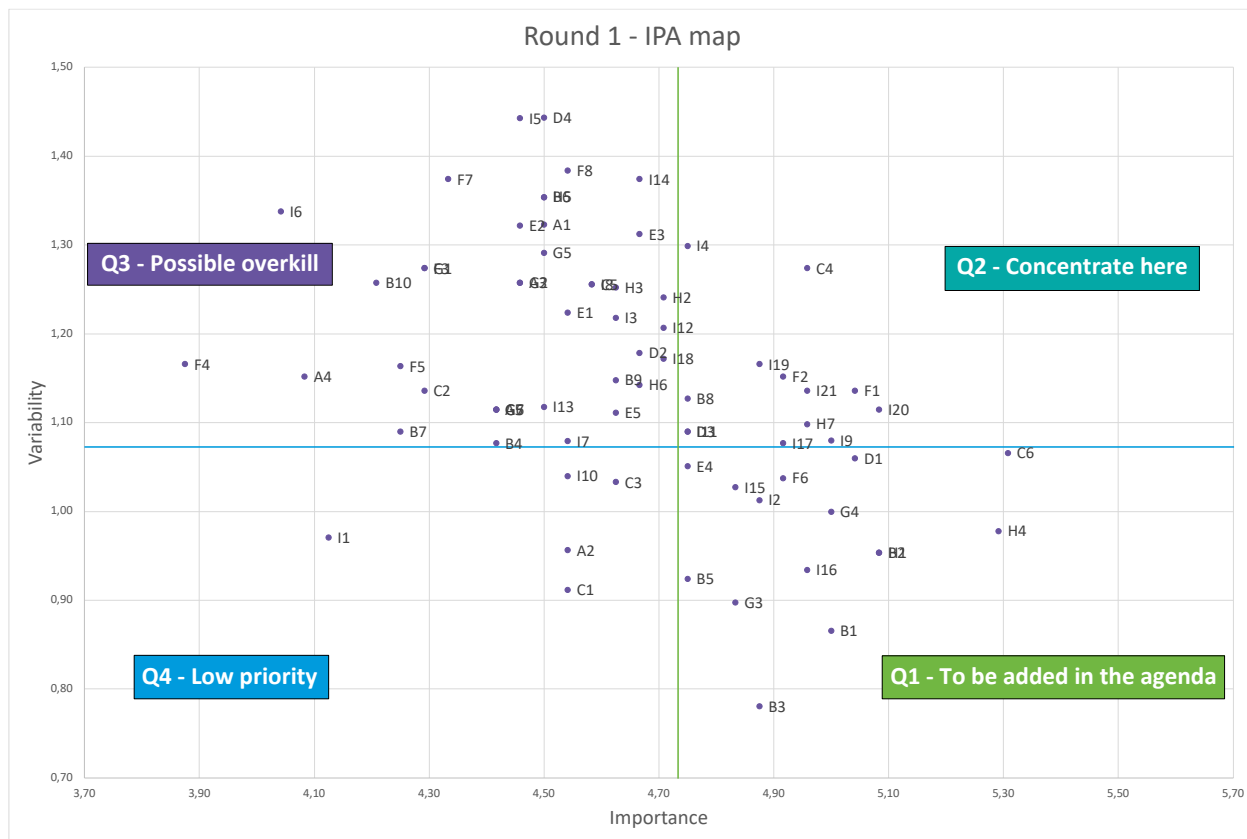


Fig. 5. R1 Importance - Variability map (as an adjusted version of the Importance Performance map).

Actions lying in Q1 are directly appropriate for inclusion in the policy agenda’s formulation process, as they combine high importance and lower variability, thus high convergence while Q4 area contains actions that respondents scored unanimously as least important; thus, actions in the latter area are considered with low priority. Likewise, in the Q2 and Q3 areas 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.

3.4 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.

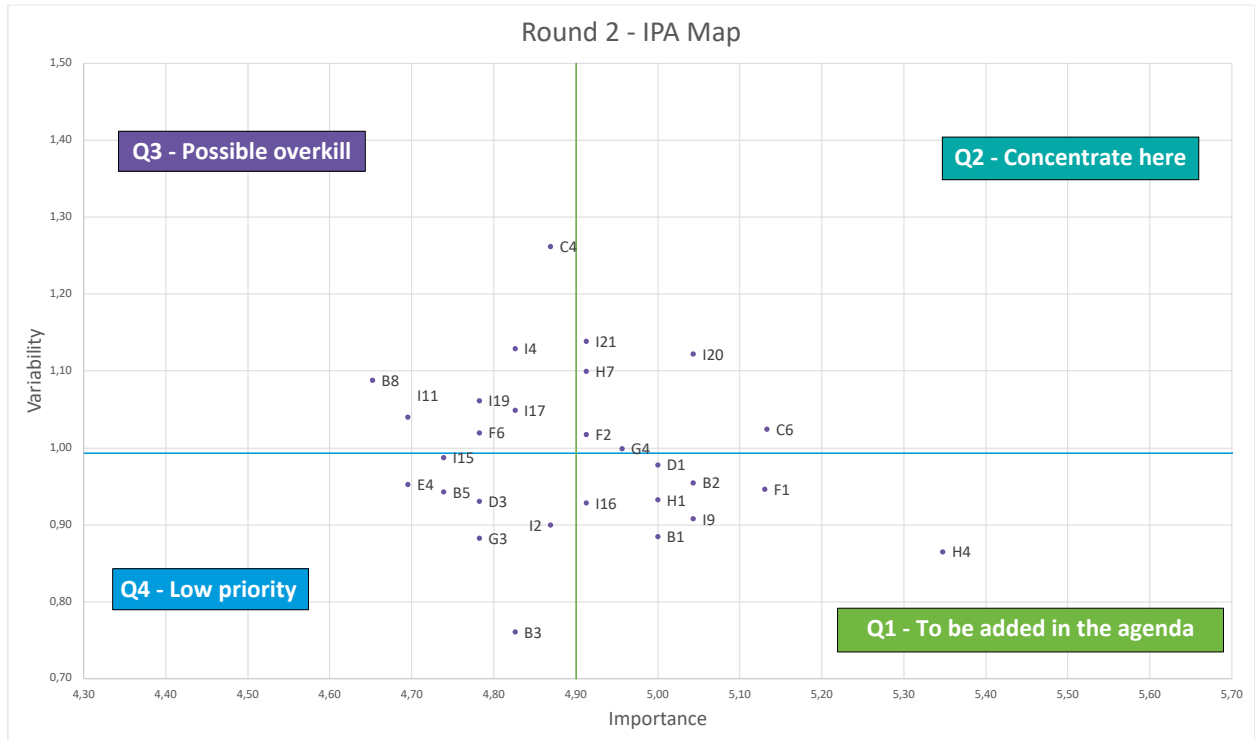


Fig. 6. R2 Importance - Variability map.

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

- B1. Encourage the development of stronger soft skills (Mean: 5.00 | STDEV: 0.88)
- B2. Identify common competencies such as basic digital skills and transport-mode specific new competencies required for Automation & Digitalisation (Mean: 5.04 | STDEV: 0.95)
- D1. Address management training in management of change skills for Automation & Digitalisation (Mean: 5.00 | STDEV: 0.98)
- F1. Address cybersecurity risks created by transport Automation & Digitalisation (Mean: 5.13 | STDEV: 0.95)
- H1. Explore and define new occupational profiles arising through Automation & Digitalisation (Mean: 5.00 | STDEV: 0.93)
- H4. Introduce continuous upskilling and reskilling training programs (Mean: 5.35 | STDEV: 0.87)
- I9. Explore the funding of the cost of reskilling the workforce (Mean: 5.04 | STDEV: 0.91)
- I16. Invite research and education cooperation to cater for Automation & Digitalisation created gaps including legal (Mean: 4.91 | STDEV: 0.93)

Similarly, as before, actions lying in Q1 are appropriate for inclusion in the policy agenda, which will define the European strategy for dealing with the social impact on the transport workforce transition towards a time in which automation in the transport sector will be increasingly pervasive.

4. Conclusions and further research

The two adapted Delphi successive surveys of a large number of external and internal transport and shipping stakeholders participating in the Thematic Area groups or in focus groups organized by the former highlighted areas

of convergence on the high importance of 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 perceptions on the efficiency of actions that can address an on-going process.

4.1. 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 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. This limitation is to be addressed by planning actions' exposure for validation by larger numbers through parallel dissemination activities, while expert and larger audience rankings will be compared and contrasted.

4.2. 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.

+++

Acknowledgements

This work has been supported by the We-Transform project (<https://wetransform-project.eu/>) and has been funded within the EC H2020 Research and Innovation Programme (grant agreement No 101006900).

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	
C2	4.29	1.14	
C3	4.63	1.03	4.72
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	
D2	4.67	1.18	
D3	4.75	1.09	4.74
D4	4.50	1.44	
Cluster E. COOPERATIVE AUTOMATION & DIGITALISATION TRAINING of MANAGEMENT AND WORKFORCE			
E1	4.54	1.22	
E2	4.46	1.32	4.61
E3	4.67	1.31	

Action	Mean	STDEV	Cluster's average
E4	4.75	1.05	
E5	4.63	1.11	
Cluster F. RISKS			
F1	5.04	1.14	
F2	4.92	1.15	
F3	4.29	1.27	
F4	3.88	1.17	4.52
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	
G2	4.46	1.26	
G3	4.83	0.90	
G4	5.00	1.00	4.56
G5	4.50	1.29	
G6	4.42	1.11	
G7	4.42	1.11	
Cluster H. COMPANY RELATED			
H1	5.08	0.95	
H2	4.71	1.24	
H3	4.63	1.25	
H4	5.29	0.98	4.83
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	
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	4.69
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	

Action	Mean	STDEV	Cluster's average
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	

References

- Beddoe, L., Karvinen-Niinikoski, S., Ruch, G., Tsui, M., 2016. Towards an International Consensus on a Research Agenda for Social Work Supervision: Report on the First Survey of a Delphi Study, *The British Journal of Social Work*, Volume 46, Issue 6, September 2016, Pages 1568–1586.
- Eurostat, 2022. Modal split of passenger transport. Available here: https://ec.europa.eu/eurostat/databrowser/view/tran_hv_psmo/default/table?lang=en
- Gasana, J., Vainio, H., Longenecker, J., Loney, T., Ádám, B., Al-Zoughool, M., 2021. Identification of public health priorities, barriers, and solutions for Kuwait using the modified Delphi method for stakeholder consensus. *Int J Health Plann Mgmt*. 36(5): 1830- 1846. doi:10.1002/hpm.3270
- Hall, D.A., Smith, H., Heffernan, E., Fackrell, K., 2018. Core Outcome Measures in Tinnitus International Delphi (COMiT>ID) Research Steering Group Recruiting and retaining participants in e-Delphi surveys for core outcome set development: Evaluating the COMiT>ID study. *PLoS ONE* 2018, 13, e0201378.
- Hilbert, M., Miles, I., & Othmer, J., 2009. Foresight tools for participative policy-making in inter-governmental processes in developing countries: Lessons learned from the eLAC Policy Priorities Delphi. *Technological Forecasting and Social Change*, 76(7), 880-896.
- Holey, E.A., Feeley, J.L., Dixon, J., Whittaker, V.J., 2007. An exploration of the use of simple statistics to measure consensus and stability in Delphi studies. *BMC Med. Res. Methodol.* 2007, 7, 52.
- ILO, 2021. Shaping skills and lifelong learning for the future of work. Report. Available online: https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---relconf/documents/meetingdocument/wcms_813696.pdf
- Jones, G.C., 2002. A Delphi Evaluation of Agreement between Organizations. In *The Delphi Method. Techniques and Applications*; Linstone, H.A., Turoff, M., Helmer, O., Eds.; Addison-Wesley Publishing Company, Inc.: Reading, MA, USA, 2002; pp. 155–161. Available online: <https://web.njit.edu/~turoff/pubs/delphibook/ch3b4.pdf>
- Karakikes, I., Nathanail, E., 2020. Using the Delphi Method to Evaluate the Appropriateness of Urban Freight Transport Solutions. *Smart Cities*. 2020; 3(4):1428-1447. <https://doi.org/10.3390/smartcities3040068>
- Kezar, A., Maxey, D., 2014. The Delphi technique: An untapped approach of participatory research. *Int. J. Soc. Res. Methodol.* 2014, 19, 143–160.
- Martilla, J.A. James, J.C., 1977. Importance-performance analysis. *J. Mark.* 1977, 41, 77–79.
- OECD, 2019. Governments should step up their efforts to give people skills to seize opportunities in a digital world. Report. Available online: <https://www.oecd.org/newsroom/governments-should-step-up-their-efforts-to-give-people-skills-to-seize-opportunities-in-a-digital-world.htm>
- Rikkinen, P., Aakkula, J., Kaivo-oja, J., 2006. How can future long-term changes in Finnish agriculture and agricultural policy be faced? Defining strategic agendas on the basis of a Delphi study. *European planning studies*, 14(2), 147-168.
- SkillSea, 2021. Measuring evaluation strategies in Maritime Education and Training. Report.
- WE-TRANSFORM, 2021. D2.2. Methodology and knowledge creation tools. Report.
- WE-TRANSFORM, 2022a. D3.1. Report of actions and initiatives related to transport automation and other transitions. Report.
- WE-TRANSFORM, 2022b. D3.2. Analysis of workforce barriers, needs, skills and challenges. Report.
- WEFORUM, 2022. Here's why companies need to bridge the skills gap to benefit both business and society. Available here: <https://www.weforum.org/agenda/2022/09/upskilling-why-businesses-need-to-bridge-the-skills-gap/>, last accessed, January 10, 2023.