Regulation for Artificial Intelligence and Robotics in Transportation, Logistics, and Supply Chain Management: Background and Developments

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Digital solutions and artificial intelligence applications provide innovation potential for transportation, logistics, and supply chain management. However, the question of competencies, motivation, and acceptance of the human workforce is important for the practical success of such initiatives, in firms and in comprehensive transportation systems and networks. This section addresses the background for an inquiry into the framework conditions, recent developments and necessities for regulation of robotics and artificial intelligence in this field.

Background

There are a multitude of digitization and automation developments in the transportation, logistics and supply chain management domain, highlighted by concepts such as *Internet of Things, Industry 4.0*, or *Physical Internet* (Zhong et al., 2017; Fawcett & Waller, 2014). Technological aspects are the main drivers for these developments, and in most cases, they are aligned with economic factors such as cost savings or increasing customer reaction and time to market speed (Masoud & Jayakrishnan, 2017; Wojtusiak, Warden & Herzog, 2012). But besides these technical and economic issues, questions of competencies, motivation, and acceptance with the human workforce are also increasingly entering the discussion and emerging as a crucial topical area for overall economic impact and success (Mavrovouniotis, Li & Yang, 2017; Zijm & Klumpp, 2016). In this context, regulation in robotics and artificial intelligence (AI) is commonly seen as an important yet underrepresented field related to the human perspective on increasing automation. This point was highlighted in 2017 by a European Parliament report and a public consultation (Delvaux, 2017), which indicated that many citizens in Europe regard developments in robotics and AI as positive innovation fields, but require further discussions and regulations (Table 1).

It can be recognized that in an overall perspective, AI as a future development trend is seen more critical than the use of robots – who are in many cases perceived as support and help to humans. In detail, this is connected to a majority of 83% of all respondents agreeing or strongly agreeing to the statement that robots are good for society as they help people – whereas only 34% of respondents agree or strongly agree to the statement that robots steal peoples' jobs. Still, a huge majority of 92% also agrees or strongly agrees that robots are a technology that requires careful management, i.e. regulation and oversight. On the other hand, half of all respondents (52%) agree or strongly agree towards the statement that AI is a threat to privacy. However, favoring AI application is the fact that only 26% of respondents agree or strongly agree to the statement that AI is a threat to fundamental human rights. Altogether, these statements represent the mixed perception of citizens

	Strongly agree	Agree	Neither agree/ disagree	Disagree	Strongly disagree	Don't know
Robotics						
Technology requiring careful management	57 %	35 %	4 %	2 %	2 %	-
Necessary for hard or dangerous jobs	57 %	35 %	5 %	2 %	1 %	-
Efficient way for transport/delivery	37 %	34 %	16 %	9 %	3 %	1 %
Good for society as they help people	34 %	49 %	11 %	3 %	3 %	-
Steal peoples' jobs	9 %	25 %	31 %	25 %	9 %	1 %
Create inequity	5 %	13 %	21 %	32 %	24 %	5 %
Artificial Intelligence (AI)						
Threat to privacy	20 %	32 %	22 %	14 %	8 %	4 %
Threat to humanity	13 %	16 %	23 %	22 %	22 %	4 %
Threat to fundamental human rights	12 %	14 %	25 %	22 %	20 %	7 %

Table 1. Public Perception on Robotics and AI Applications in Europe (Question: Please indicate if you agree or disagree with the following statements).
Source: Evas (2017), p. 11-12 (n=259)

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towards automation (robots) and digitization (AI) trends – hinting at a positive attitude of citizens towards a political regulation role in these fields. Regarding regulation fields, the report outlined the following six key areas of regulatory action in detail regarding robotics and AI application in the European Union, namely (European Parliament 2017, p. 8):

(1) Rules on ethics

(2) Liability rules

(3) Connectivity, intellectual property, and flow of data

(4) Standardization, safety, and security

(5) Education and employment

(6) Institutional coordination and oversight.

In order to discuss such regulatory action further, it can be distinguished between regulatory approaches, arguments for regulation and areas of regulation. Approaches can be divided into law regulation, agency-based regulation or industry-based approaches for establishing safeguards towards effective but risk-mitigating settings. Relevant impacts from the public consultation indicate significant public support for political regulatory action in this field due to the reports of citizen opinions and anxieties (Table 2).

As Table 2 shows, arguments for regulation are headed by the items 'data protection' (85% of respondents are concerned or strongly concerned) and 'values and principles' (81% are concerned or strongly concerned). In addition, liability rules are an important argument in the eyes of citizens with 74% being concerned or strongly concerned about this issue. Smaller shares of the respondent group are listing arguments such as EU competitiveness (66% are concerned or strongly concerned), physical safety (54% are concerned or strongly concerned), or intellectual property (44% are concerned or strongly concerned). Regarding areas of regulation, transportation is present very prominently in the top five areas with autonomous vehicles being number one (87% regard it as important or very important) and drones being number four (73% deeming regulation in this area important or very important). In-between medical and care robots are seen as necessary area of regulative action (with 80% and 73% deeming these areas to be important or very important respectively). In addition to this, the world of work has to be recognized too since this is where robotics and AI applications are implemented and people encounter them actively in cooperation.

	Strongly concerned	Concerned	Neutral	Not concerned at all		Don't know
Arguments for Regulation						
Data protection	51 %	34 %	8 %	6 %		1 %
Values and principles	51 %	30 %	9 %	10 %		-
Liability rules	35 %	39 %	19 %	6 %		1 %
EU competitiveness	29 %	37 %	22 %	8 %		4 %
Physical safety	26 %	38 %	22 %	11 %		3 %
Intellectual property	17 %	27 %	27 %	24 %		5 %
	Very important	Important	Neutral	Somewhat important	Not at all important	Don't know
Areas for EU Regulatory Action						
Autonomous vehicles	55 %	32 %	5 %	4 %	4 %	-
Medical robots	48 %	32 %	12 %	5 %	3 %	-
Care robots	38 %	35 %	15 %	8 %	4 %	-
Drones	42 %	31 %	12 %	6 %	3 %	1 %
Human repair	40 %	32 %	13 %	4 %	2 %	4 %

Table 2. Public Expectations regarding Regulation Motivation and Areas in Europe.

Source: Evas (2017), p. 11-12 (n=259)

Human Work and Digitization

The EU study presented indicates how citizens perceive robotics and AI applications, their anxieties and highlights certain approaches for the regulation of new technologies. The citizen's perceptions are likely to match the perceptions of the workforce. Likewise do the key areas of regulatory action take into account the human factor in automated and digitized work settings which is important with regard to the employer's due diligence obligations. Moreover, the human factor is of crucial relevance since workers' perceptions affect the acceptance and their handling of robotics and AI (Ventakesh & Davis, 2000), and is, thus, central for the economic impact and success of these new forms of work organization. A positive attitude towards work settings usually comes along with intrinsic motivation – defined as behavior coming from within an individual, out of interest for the activity and enjoyment – leading to high job performance and satisfaction, commitment and innovation (Deci & Ryan, 2000). Accordingly, if digitization in the working context is perceived as positive and supportive, it will promote

pro-organizational behavior. In this respect, the careful management and design of digitization in the working context plays a key role and is the central leverage to orchestrate the workforce. Measures of Human Resource Management (HRM) therefore need to consider the use of robotics and AI in the work process based on an overall strategy implying specifications and rules, e.g. in terms of ethics, safety and security issues. Moreover, an adequate information of and communication with the workforce will promote liability and trust (Lewicki et al., 1998). For a positive attitude and efficient use of new technologies in work processes, it is crucial that workers perceive the support of the management, that the organization values their contributions and cares about their well-being (Eisenberger et al., 1986). To foster intrinsic motivation in digitalized work contexts, workers attach great importance to experiencing autonomy and their tasks as meaningful (Hackman & Oldham, 1980). This would also mean that the interaction between robots, AI and workers is seen as equally and free, meaning that workers perceive locus of control (Rotter, 1966). Therefore, it is essential that workers obtain the qualifications required for working with new technologies. Consequently, the alignment of the workers' competencies towards changed work requirements is a basic prerequisite for the acceptance of robots and AI in work contexts. The acceptance of new technologies in work settings will also be supported when the process of automation and digitization is not only organized top-down but also bottom-up, i.e. when workers have the opportunity to participate in organizing and designing digitization processes, contributing their ideas and perspectives (Boxall & Purcell, 2003). Finally, the use of new technologies in organizations is not only designed in cooperation with management and workers but also involving actors like employee representatives (e.g. works council), securing the workers interests in data protection as well as general values and principles. This would eventually help to promote the understanding of robots and AI supporting the workforce and establishing a regulatory framework securing workers' positive attitudes.

Connected to these general HR concepts, one central motivation for regulatory action is to promote the worker's acceptance and to mitigate possible human resistance towards robots and AI applications in transportation, logistics and supply chain management. Therefore, it is helpful to understand the structure of typical workers' resistance towards automation within the field of transportation, logistics and supply chain management – this is depicted in the following Figure 1.

In many business application contexts three major resistance hurdles can be identified before a full human cooperation mode can be reached. First, workers have to accept single automation steps as AI competence, e.g. the competence of an automated steering system to handle truck cruise control orders. Second, it is even harder and usually met by a higher level or hurdle of human resistance to accept independent AI decisions, e.g. suggestions by a navigation system in driving trucks. There might for example be higher rates of neglect, meaning navigation

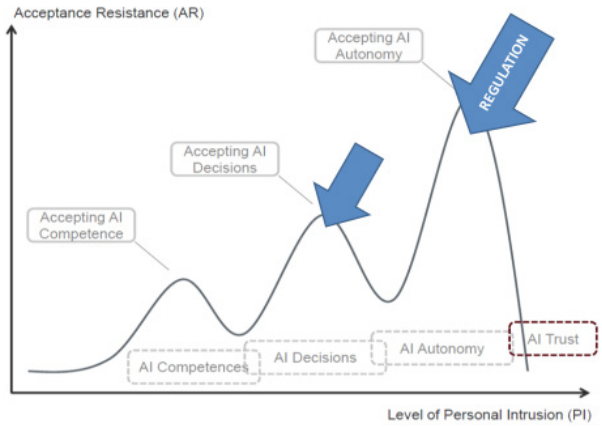

Figure 1. Motivation for Regulation in Robotics and AI Applications in Logistics.

Source: Adapted from Klumpp (2018), p. 234

suggestions are overturned in practice. Third, human actors have to accept AI autonomy, for example an autonomous steering system for trucks. In this case, the resistance might be highest as autonomous behaviour of automated systems brings about the highest level of fear and insecurity among human coworkers. In this area, regulation might therefore be needed the most and provide the most benefit: Regulation may help to reduce the volume and impact of these human resistance hurdles for an efficient human-computer interaction (HCI). This can be achieved as human workers may be able and motivated to start HCI settings with a lowered resistance of they know that regulations are in place safeguarding their physical safety and their personal data protection and employment rights.

Areas of Regulation in Transportation, Logistics and Supply Chain Management

Applying the six defined key areas of regulation as outlined in the EU study specifically towards the transportation, logistics and supply chain sector, the following observations can be derived:

(1) *Rules on ethics*: Especially in transportation – as public traffic is concerned – ethical rules of engagement are important, e.g. if accidents occur and split-second decisions have to be taken by automated systems like which deviation route to take with specific casualty impacts. The major problem in this area is, that such decisions have to be implemented beforehand within the automated and AI transportation systems, as in many cases reaction times will be too short for any human driver to contemplate and interfere with the autonomous steering e.g. of trucks and

cars.

(2) *Liability rules*: Again, transportation as far as public transportation is affected will be a major development field for liability rules and within their wake insurance markets and products for automation and digitization. But also in the production logistics environment many important liability questions will arise, e.g. who might be liable for incorrect order volumes (order volume too high with subsequent warehousing costs or order volume too high with resulting production interruptions and market costs from customer contracts).

(3) *Connectivity, intellectual property, and flow of data*: Connectivity is a major concern for the transportation, logistics and supply chain management field as a global sector. Therefore, many research endeavors already explore the use of standardized industrial data spaces also for transportation. This will be increasingly important as many applications (like with smartphones) will arise for transportation and logistics settings, requiring a unified communication and interaction framework.

(4) *Standardization, safety, and security*: As transportation always includes a physical component, safety and security issues are highly important, affecting many public hubs (ports, stations and airports) as well as main lines throughout the countries and around the globe. Security issues might easily clog up passenger and cargo traffic, resulting in large economic losses as well as private burdens in terms of lost time and increased stress. Therefore, automation and digitization developments are urged to enhance the overall safety and security level in transportation, as well as providing this increase at lower economic and societal cost.

(5) *Education and employment*: Work and qualification issues are very relevant in the logistics sector as it represents a personal-intensive service industry. Digitization is seen as an ambivalent trend regarding this as there are at the same time effects of eased work burden and facilitated training and education by electronic means as well as increased work burden and stress by the way of increased transparency and oversight or even job losses in specific areas – though it has to be emphasized that the total number of jobs is not expected to be reduced in the transportation sector for a long time to come. But it cannot be neglected that qualification requirements will change and therefore the importance of education and training, requiring also structuring and evaluation regulatory action from the authorities in this field.

(6) *Institutional coordination and oversight*: The interaction of different institutions in supply chains and global transportation will change, as on the one hand digitization and the use of AI will facilitate many processes and services along the transport ways. For example, document translation can be automated in the near future, lower cost and time requirements in customs, transportation and logistics. This will on the other hand also require coordination among supply chain partners, as they have to agree on standards and cost sharing regimes for automated services.

An interdisciplinary perspective from different science disciplines is helpful in implementing such regulatory areas. This includes the perspectives of industry and logistics actors, researchers in the economic, computer sciences, law, and sociology domains, as well as other relevant parties from the field of political actors and associations. This could be an invitation to start an open discussion about what sorts of regulation are necessary in order to secure human trust and motivation in robotics and AI developments without placing too much of a burden on the economic development in the transportation, logistics, and supply chain management sector (Klumpp, 2018; Petit, 2017; Fors, Kircher & Ahlström, 2015).

Contributions and Outlook

The contributions of this issue are aligned with a multi-perspective analysis regarding the question of regulation for robotics and AI applications in transport, logistics, and supply chain management, intending to provide a sort of mapping of future research topics in this (Wieland, Handfield & Durach, 2016). At the same time, they are addressing different aspects from the described six key areas of regulation of robots and AI: The first two contributions start with a business practice perspective. *Julian Sanders* emphasizes the dynamic innovation requirements for logistics service providers on a global scale, hinting at the necessity of regulation in the area of 'institutional coordination and oversight'. While following that, *Dominic Loske* outlines the challenges of a day-to-day transportation and logistics situation in urban food retailing, focusing on the question of human training for truck drivers facing ever-faster digital innovation steps; this is discussing the 'education and employment' area of regulative action as outlined above. From a production logistics research perspective, *Francesco Pilati* and *Alberto Regattieri* provide an outlook on what big data analysis can do for an improved ergonomics situation in production. This again is addressing the regulation areas 'standardization, safety and security' as well as 'institutional coordination and oversight', including the role of unions and other work safety institutions in the production logistics context. *Giuseppe Contissa, Francesca Lagioia* and *Giovanni Sartor* analyse the impact of automation in the allocation of liability within autonomous cars. They discuss the tasks allocation between human and automation, and the resulting responsibilities.

Altogether, the issue is aimed at sparking a discussion regarding future questions for regulation towards the application of robotics and AI in the transportation, logistics and supply chain sector in order to allow for a smooth and efficient changeover with digitization trends. As can be recognized from this issue, there are manifold open gaps and research items to be applied in this context in the upcoming years.

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