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The '4th wave of industrial revolution' – a promise blind to social consequences, power and ecological impact in the era of 'digital capitalism'

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Executive summary

In many countries, government agencies, business and employers' associations, CEOs from big corporations, but also academia and even trade union leaders seem to be convinced that the 'digitalization' of society and economy is an unstoppable accelerating process, which can and should be shaped in favour of workers. Furthermore, it is argued that digital technologies offer potential for low-carbon transformation of energy and mobility systems, the circular economy and the protection of ecological systems. Yet it is not very clear how far digitalization can be linked to societal goals and whether it can be placed at the services of a global transformation towards ecological sustainability.

It will be argued that a digitalization of the economy (and the society at large) is still a concept of what could be rather than what is. Therefore, this concept should not be taken as a given. Instead we should consider all the challenges and risks of this trend and then consider, whether we should resist or foster the trend. Therefore, in addition to the social consequences of a further substitution of human labour by machines and algorithms also the ecological implications of digital production system must be considered.

It can be taken for granted that producers will only automate if doing so is profitable. But for profits to occur, producers need firstly, cheap raw materials and cheap energy and secondly, a market to sell. Keeping this in mind might help to highlight the critical flaws of digitalization: if robots would replace as many workers as predicted by international institutions and numerous think tanks, thereby creating even more mass unemployment and if wages are pushed further down because only the highly qualified workers could expect to receive a decent salary, two questions arise: first, to whom would the producers sell all their 'intelligent products' and second, can the material inputs of production really stay cheap if all advanced economies and even some developing countries will follow the same route towards a '4th industrial revolution'?.

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In many countries, government agencies, business and employers' associations, CEOs from big corporations, but also academia and even trade union leaders seem to be convinced that a fourth wave of industrial revolution is under way which will reconfigure the global production system and even societies at large. In the Anglo-Saxon context, this wave is rather referred to as 'internet of things', while in Germany and other European countries, the digitalization of production and distribution is more at the center of the debate and operates under the term 'industry 4.0'. These terms not only describe the digitalization of horizontal and vertical value chains of companies, but also formulate a vision of the future that promises new market and export opportunities as well as a new sustainable way of doing business. It is argued, that digital technologies offer potential for low-carbon transformation of energy and mobility systems, a circular economy and the protection of ecological systems.

An analysis of the digital economy, also coined as 'cognitive capitalism', assumes that a ´new spirit of capitalism´ would allow a certain margin of autonomy and non-hierarchical cooperation between firms, workers and the so called 'prosumers', a term to catch the convergence of boundaries between consumers and producers, actually referring to the unpaid work of the internet user, done without awareness. Other contemporaries are more sceptical with respect to the wonderful promises of digitalization since their discussion is mainly focused on the social impact on both labour and on social relations in the society at large as well on the corporate crusade against data governance, which is just getting started.

However, at present there are still several technological bottlenecks that stand in the way of a widespread use of digital infrastructure. Furthermore, it not very clear how far digitalization can be linked to societal goals and in favour of workers. It is also questionable, whether the ongoing process of technological change can be placed at the services of a global transformation towards ecological sustainability. Furthermore the 'dual-use' character of the new technologies which combine robotics and artificial intelligence (AI) must be considered, as it can be applied to civilian and military purposes. The following argumentation attempts to subject these different aspects of the digitalization hype to a critical debate.

The promises

In a first step it might be necessary to recall the arguments of those advertising a wonderful new world of 'smart factories' and a 'greener future', for both the advanced industrialized countries and developing countries alike. It is expected that digital infrastructures could open additional value creation potential because a decrease in average cost of production due to automation could boost output and would allow for more exports, which finally could translate into increasing labour demand. The generation of data and its subsequent use in the different parts of the value chain as in the entire economy is expected to allow for a merger of the physical and the virtual world. Such a system of physical-to-digital technologies embodied in machines and equipment (such as robots, scanners and actuators) would enable sensing, monitoring, and control of the entire economy. While artificial intelligence and algorithms will help to determine the optimal size of production and even the makeup of working teams which will perform those tasks which cannot be digitalized/automated.

An increase of efficiency and flexibility of manufacturing is expected, but also a new wave of mass consumption, since new 'smart' products will be produced such as wearable tech, autonomous vehicles, biochips, bio sensors all kinds of new materials. In addition, also a more human world of work arises at the horizon – through an upgrading of jobs, better cooperation and participation between groups of employees, a substitution of stressful and unattractive tasks, comprehensive training opportunities and upward mobility of workers. This is exactly the reason why, in Germany, not only government agencies and the business communities are very much in favour of what they call 'industry 4.0', but also trade unions support this view. They are assuming that we have entered a new industrial revolution which is about to change the future of work in a profound way, because intelligent machines will be able to interact self-reliantly with the physical world. Representatives of the industry mainly expect substantial improvements in both the mitigation of production errors and increasing production agility, thus productivity and profitability. Currently, manufacture must choose between producing fast and efficient or flexible and individual. With the help of a cyber-physical production system (also coined the 'smart factory') companies could use movable, modular production machines which are connected to the company network and can be dynamically reconfigured. Potentially, a 3D-printer could enable companies to produce at a lot size of just one.

However, one should be aware that Germany is a special case in far as manufacturing still accounts for 22 percent of GDP and the tradable manufacture sector is the backbone of its industry accounting for 80 percent of German exports. Before this backdrop 'industry 4.0' seems to be promising - because digitalization of manufacturing might lower prices, increase demand and create employment in automation-producing firms. Therefore, also the metal workers’ union is actively engaged in an alliance between government and business associations on 'Platform Industry 4.0'. However, a survey conducted by the German trade union congress DGB indicate that two third of all workers say that they have no influence on how the digital technology is used at their workplace and half of the respondents complain about an increase of their workload due to digitalization. Nevertheless, the metal workers’ union does not wish to block these changes, since it believes it can benefit from the ongoing technological changes. There is a common point of view that German companies could be the vanguards of this process and the expected job losses could be compensated – at least to a large extent – by new jobs which will be created by increasing exports. But that means exporting unemployment abroad. Hence, is seems to be logical that somewhere else workers will lose their jobs.

In addition, digitalization should contribute to solving social problems (such as the implementation of the Agenda 2030 and the 'Sustainable Development Goals') and help to meet environmental challenges. It is promised that the new wave of technological progress will contribute to the 'dematerialization' of production and consumption and thus reduce our ´ecological footprint´. A study by the UN Industrial Development Organization, UNIDO, stresses that digital technologies can drive the switch to renewable energy consumption in industrial production, therefore reducing energy use and CO_2 emissions (Nagasawa et al. 2017). The use of Apps, electronic platforms and other technological innovations should benefit the countries of the global South in particular – by enabling electronic access to education; by encouraging Good Governance through improved transparency and online citizen participation; by contributing to increasing agricultural productivity through the targeted use of fertilizers and economical irrigation; through better integration of SMEs into global commodity chains (UNDP 2018). Other contemporaries would go even further and can imagine that there might be a technologically inspired route out of fossil fuel dependence which would free us from capitalist imperatives (Mason 2015).

Even from the perspective of the United Nations Development Program it is advisable for developing countries to accept purely technical solutions for long standing and constantly increasing social problems. No wonder that the initiative 'IBM Digital – Nation Africa' launched during Africa's Official Ministerial Summit on Innovation in 2017 in Maputo/Mozambique, was warmly welcomed by representatives from African countries. During this meeting IBM had announced its intention to invest $70 million for a cloud-based learning platform designed to provide free skills-development programs for up to 25 million African youth over the next five years, thereby enabling digital competence and helping to support a 21st century workforce in Africa (cf. www.invovation-africa.com).

Technical bottlenecks of a 'digital revolution'

Before discussing the foreseeable consequences digitalization of manufacturing will have on overall employment opportunities in the different parts of the world, on the employment relationship and on trade unions representation of workers’ interests, it might be helpful to address, at least very briefly, the technological challenges of a 'digital revolution'.

Fiber-Optic networks are commonly regarded as the future of networks, as they enable significantly higher transmission speed than their copper-based counterparts. However, these networks are quasi non-existent in many parts of the world. A second technological precondition for 'smart factories' would be a standardized application programming interface, common data language and increasing integration of largely self-sufficient systems, e.g. from the areas of production, logistics, energy supply or building management. Finally, the transition of companies to the digital landscape exposes them to the dangers of cyber-attacks by individuals, inside or outside the firm, by computers, social networks, the 'cloud' and by nefarious organizations. Not astonishing, proponents of the digitalization trend in advanced industrialized countries assume that most of these technological challenges will be addressed successfully soon – no matter what this would cost for companies and for government. While for the danger of cyber-attacks, which impact on democracy and privacy, no solution is in sight until now neither in high income countries nor in the developing world. However, it seems to be that ordinary cybercrime including social engineering attacks against the financial sector and data breaches is a growing problem in developing countries, particularly in Africa, where customers often conduct financial transactions over insecure mobile phones and transmissions lines that are not designed to protect communications (cf. Nduati 2018).

No wonder that problems with digitalization in developing and emerging countries are almost exclusively addressed as a technical challenge and as question of investment in the development of digital infrastructure. When risks of digitalization are mentioned, they are often limited to the 'digital divide', meaning the lack of internet access for almost 4 billion people in the global South. Indeed, the 'digital divide' is quite broad, even though it might not become broader in the near future: At the end of 2018, a little bit more than half of the global population was using the internet - more than 80 percent of the population in developed countries, but already 45.3 percent of those living in developing countries. Even though the strongest growth of all regions was reported in Africa, still not more than a quarter of its population is using the internet and the proportion of households with access to a computer is still very low[1]. But what is even more problematic: in all developing countries the overall fixed-broadband penetration and especially subscriptions at higher speeds remains very low (cf. ITU 2017).

Occasionally, the rapid spread of smart phone usage in countries of the global South is seen as an indicator of their openness to innovation and an imminent 'digital revolution'. Many studies therefore refer to the widespread use of electronic purses in Kenya since 2007, which has made banking services accessible to the poor. And as in Kenya, in other developing countries, where many people have mastered the *lingua franca* of globalization, that is the widespread reaches of English, there are off-shore call centers and other ambitious large-scale projects that are intended to create many new jobs in the long term. However, most African internet users still must go to Internet cafes, where access is slow and expensive. Indeed, access to advanced technology in Africa is constrained by infrastructure parameters such as lack of electricity, IT penetration, teledensity, internet density and broadband penetration (ITU 2017). But also, the 'analog

[1] Apart from South Africa which has a high penetration of the Internet in the country. However, most of the communication infrastructure is concentrated in the hands of the white affluent population which has both the access to computers and the Internet, and the skills required to run them.

complements' for a 'digital revolution' in African as in other developing and emerging economies still would need a lot of improvement – in particular: providing skills to labour and making all stakeholders and institutions accountable. The technological bottleneck in the area of broadband expansion and the deficits in education and vocational training certainly represent an even greater obstacle for developing countries than for the rich countries of the global North. Even more difficult is their starting position regarding the key technology of 'artificial intelligence' (AI) [2] which is based on four components: algorithms or computer programs [3], computing power, huge amounts of data, and people developing programs and applications thereof. It is a technology which can be integrated into virtual everything.

In the US and China, billions are being invested in AI research from public and private sources in order to apply AI to a multitude of functions, including image identification, voice recognition and self-driving vehicle technology. As announced in its two agendas 'Made in China 2025' and 'Internet-Plus', China would like to outperform the US high-tech leaders and become the world champion in AI by 2030, pumping $60 billion into the industry each year (cf. Staab and Butello 2018). The country's tech-trio of Baidu, Alibaba and Tencent has a distinct advantage over their Silicon Valley rivals Google, Apple, Facebook and Amazon, that is the data of more than a billion people. But Russia, Japan and South Korea are also trying to set up their own AI systems. Even France, Germany, the UK and small countries such as Estonia, Finland and Iceland have developed AI-initiatives in order to improve national productivity. The EU views AI as a technology that can boost a European single market and helps the region to achieve greater industrial leadership; therefore, for the period until 2030 R&D investment in AI will be increased at EU level, together with more investment at the national level and by private actors.

However, the global competition for supremacy in this key technology of the 21st century is essentially between a handful of US and Chinese companies. Today, technological sovereignty can only be found in the economic area which can boast a closed value chain, from chips, to computers, batteries and software. The greater or lesser technological sovereignty of a country or region will ultimately also determine where the greatest gains in employment will come from digitalization and who will be the focus of its negative consequences. Usually, digitalization of nearly everything, from 'smart housing' to electrical cars and particularly the new wave of merging the physical and the virtual world through data-based production organized from the 'cloud', is associated with the expectation that good quality and high paying jobs can be attracted nearly everywhere, provided that the basic technical infrastructure is ensured. However, at a second glance even some 'best-case'-examples of high-tech production in the US send an ambivalent message around. As the case of Foxconn's 'green plant' in Wisconsin where displays are built, Apple's data center in Iowa or Tesla's lithium-ion battery factory for electric cars in the desert of Nevada indicate, often local authorities can attract high-tech firms, which create very specialized and very few permanent jobs (and often generate even a lot of toxins) only by exempting these firms from sales, property and general business taxes for 10 or even 20 years. These tax-break deals often soak up most of the additional tax revenue from the local budget, while at the same time tech workers' influx is driving rents for residents on fixed incomes up or causing an overcrowding of schools and hospitals (cf. The Guardian, July 3 2018).

[2] The so-called 'artificial intelligence' are artificial neural networks that can learn both in a monitored and in an unsupervised mode. They consist of an input layer of data over which 100 or more layers are placed to transform the input data. The output layer then contains an assignment of data that makes a forecast possible. However, no explanation is provided that could explain the interrelationships.

[3] Algorithm can be understood as regulations that process structured data (such as measured values, names, addresses) and unstructured data (such as images, films, texts, language files) and recognize pattern and rules and then apply them to classify the data sets.

Employment impact of the new wave of automation

Initially, digitalization means nothing more than a new level of automation, more precisely, the use of robots paired with AI and this in almost all economic sectors, automobile and electrical industry, metal processing and metal engineering, plastic and chemical industry, beverage and food industry, not forgetting arms and security industries. Also, many jobs in agriculture, in retail trade, in administration, banks and insurance companies, the work of lawyers, radiologists and call center workers, virtually all activities that are well measurable and repetitive, can be replaced primarily by robots and software systems. In short, in the future not only blue-collar but also white-collar jobs can and will be automated in years ahead. This was the provocative finding of the first comprehensive study on the employment effects of digitalization which has been conducted by two researchers from the university of Oxford (Frey and Osborne 2013).

In the future, taxi, courier and freight forwarding companies will probably increasingly use autonomous driving systems. This also applies to many activities that require thinking along with others, i.e. cognitive performance; computers can take on such tasks, and then reorganize and restructure them. In the service sector of banks, it will be the software and no longer the individual bank employee who decides who receives a loan and on what terms. Even in the area of care, there is already an increase in robotization; machines support the transfer of patients and ensure that medicines are always ready to be taken in time. In the US it is even permitted for the computers to make personnel decisions, in Germany this is (still) prevented by the co-determination rights of employees and their representatives. Even the activities of teachers and social workers are also likely to change considerably as a result of the use of learning programs.

Many scenarios discussed today assume that one third and later far more than half of the activities carried out by people today will no longer take place. New occupational fields will emerge for tasks such as social media management, the interior design of virtual rooms or the insurance of algorithms. This might fit into the dreams of many young people in Europe, Africa or in other places of the world who prefer to become 'influencers', 'You-tubers' or 'gamers' rather than waiters, administrative employees or skilled metal workers. However, there seems to be no controversy anymore that lower paid positions requiring the least amount of education are more likely to disappear.

As already mentioned, the development of AI and robots is being driven forward particularly in China. One important reason for this can be found in the demographic development of a rapidly aging population which is exerting corresponding wage pressure on Chinese companies. Robots are supposed to be used in the manufacturing industry and many other sectors of the economy to keep company costs low and increase profits in times of slower economic growth. But so far only every fourth robot is manufactured by a Chinese company. In 2017 there were just 97 robots per 10,000 employees in China, much less than the 710 in South Korea. Also, in Singapore, Germany and Japan the quotas are already quite high, with peak values in the German automotive industry, where more than 1,000 robots per 10,000 employees have been counted at the end of 2017 (IFR 2017). This is the basis of calculations of the German mechanical engineering industry, which views itself among the winners of industry 4.0' – because it produces already the robots which will substitute human labour elsewhere. But China is catching up very quickly, with the help of the Swiss industrial group ABB that will build a state-of-art production facility in Shanghai in the next two years in which robots will produce robots together with human workers. AI will be used to produce around 100,000 robots per year, this represents a quarter of the previous robot production in the whole world. The International Federation of Robotics expects that in only two years' time nearly 500,000 robots will be used in Asia, while in Europe there might be less than 100,000 and only 64,000 in the US. Thus it seems plausible that also in the near future the majority of all robots' sales will be concentrated in the five markets of China, South Korea, Japan, the US, Europe and probably Singapore, while the use of robots in developing countries as whole, and in particular in Africa, is far lagging behind, even though e-commerce, another indicator for digitalization, is growing quite quickly. At first glance one would expect that as a result of rather few robots deployed so far in developing countries, the impact of digitalization on their labour markets will be comparably lower than in the advanced industrialized countries of the global North. However, this might change in the future, since according to the very influential study of Frey and Osborne from 2013 nearly 50 percent of all occupations across all sectors are at risk of being automated within the next two decades or in a longer period (see McKinsey 2017). In principle, companies all over the world expect the digitalization of all production and business processes to reduce costs by savings in manpower, energy and raw materials. As a rule, and like technological changes in past decades, this leads to the disappearance of jobs in the companies affected by the restructuring. However, it might be argued that 'the pace, scale and impact of change was nowhere near as catastrophic as initially feared]…] if technology is accompanied by investment in training, education and compensation, its worst effect can be much reduced […] New technology will lead to change in the bundles of tasks that make up many jobs. Some will go, and new ones arise' (Figeroa 2018).

Indeed, in the present early stage of development quantitative effects of digitalization on the labour market are hard to estimate. However, the numbers which are available so far are frightening. In the study of Benedikt Frey and Michael Osborne, who made a first estimate of the extent to which existing jobs in the US are threatened by developments in the areas of AI and robotics, it is concluded that, from a technological point of view, with a high probability almost half of all jobs in the US alone could fall victim to automatization (cf. Frey and Osborne 2015). A similar study has been carried out in other advanced industrialized countries, for the Netherlands, France, Belgium, the UK and Germany. Studies referring to the European Union have concluded that in the less competitive economies of Romania, Bulgaria, Greece and Portugal 40-60 percent of all jobs might get lost due to digitalization (Bowles 2014). But the results of recent studies on the potential impact of digitalization on the labour markets of advanced industrialized countries continue to diverge widely. This applies particularly to Germany, where significant changes in the labour market attributed, among other things, to progressive automation and digitalization, were already identifiable between 2003 and 2007, a tendency which was accompanied by a significant decline in activities with a skilled worker profile and the spread of new occupations (such as drone operator or apps developer). However, unlike in the US, robots so far have not led to a reduction in total employment (cf. ING-DiBa 2018).

Regarding the situation in developing and emerging economies, available prognoses are even less promising. In its 'World Development Report' from 2016 the World Bank Group assumes that the share of jobs threatened by automation would be almost 70 percent and that most of those countries which are only using, but not producing robots and automation machinery will have to face huge losses in employment. For some emerging markets such as Brazil, India, Indonesia, Malaysia, Mexico, Thailand and Turkey the World Bank identifies some evidence for 'smart production' processes. But for most of the developing countries which are constrained by scarcity of trained technicians and engineers and by infrastructure issues such as a reliable electricity support, the Word Bank offers a quite dark future scenario. The Bank expects that because of the emerging technologies combined with a slowdown in trade and Global Value Chains remaining concentrated among a small number of countries, manufacturing will no longer offer a pathway to growth in low- and middle- income countries (cf. World Bank 2016, Hallward-Driemeier and Nayyar 2018).

This picture is supported by numerous findings presented by other organizations including well-known consultancies such as McKinsey Global Institute (2017) and PriceWaterhouse Cooper (2018) but also the

OECD; findings of recent reports are summarized in a literature review by the ILO (cf. Balliester and Elsheikji 2918). All newer studies assume that job destruction is likely to accelerate under the pressure of technological change, therefore machines, robots and computers will increasingly have an absolute advantage over labour and not merely a comparative one. The most severe impact of digitalization in manufacturing is expected in South-East-Asia, where during the last decades export production in sectors such as clothing, footwear, textiles and electronics have become a backbone of economic development. Also, automobile and automotive parts manufacturing in the region is at risk from automation. Findings indicate that up to 70 percent of all manufacturing jobs in Cambodia, Laos, Vietnam, the Philippines and Thailand are at risk, meaning that some 137 million people in the region will be impacted. Some companies, such as the shoe company Adidas, have already re-established manufacturing in Germany, with heavy use of automation. Similar tendencies are expected for Africa. In its report from 2017 McKinsey Global Institute estimate a high percentage of jobs at risk of being automated in a number of African countries including South Africa (-41 percent), Kenya (-52 percent), Ethiopia (-50 percent) and Nigeria (-46 percent) (McKinsey 2017). In its report from 2018 the British Oversea and Development Institute expects that if more production will be re-shored back to Western countries due to falling automation costs with operating robots in the US set to become cheaper than wages in Kenya within the next 15 years (cf. Banga and Willem te Velde 2018).

In Verisk Maplecroft's Human Rights Outlook 2018 a tendency linked to this dynamic of re-shoring industrial production back to advanced industrialized countries is highlighted which is even more frightening. The report assumes that the risk of slavery and trafficking appearing in supply chains will spiral, particularly in the five Asian countries mentioned, since these countries are already today rated as 'high risk' countries in the Modern Slavery Index. In Vietnam and Cambodia, where over 85 percent of jobs in the garment, textile and footwear industry are at high risk of automation, most of these being held by women who might lose their jobs – and then will have to look for work further down the supply chains, where abuses are more likely to occur and regulations as well as workers' rights can be more easily ignored (Human Rights Outlook 2018).

The 'new normal' of work in the era of 'digital capitalism'

At first hand, the proponents of 'industry 4.0' are promising that routine processes and physically strenuous activities will be automatically carried out by machines. Thus, humans are becoming machine supervisors rather than active producers. For high-skilled workers, digitalization will go together with further delimitation of work, acceleration and more intense work, more stress and new challenges of work-life balance. At the same time, companies will rely less than today on a workforce permanently attached to the company and instead will hire on demand. For many workers the employment relationship will become a work assignment and the new jobs which will be created are supposed to lack a clear allocation to an organization. The ties to the firm will be cut and trade unions will have even larger difficulties than today to communicate with the employees and represent their interests. All routine work including standardized and anonymous processes, but particularly digital services will become subject to off-shoring and further efficiency pressure, while activities which involve direct human interaction will be more highly valued. This will include that digital services are divided into ever smaller parts and delegated to 'virtual labourers' who perform tasks which can be done in some seconds and these tasks are remunerated with a few cents per tasks. Therefore, 'cloud' and 'crowd'-working (via Amazon Turk, Clickworker, Crowdflower, Microtask), but also forms of work-on-demand (such as Uber, Lyft, TaskRabbit, Handy, Wonolo) will flourish, both using online-technologies to link supply and demand – and both will increase the trend towards casualization of work and an informalization of the formal economy (De Stefano 2016).

As we already know, like other sorts of casual work, earnings of 'crowd-' or 'click-workers' who provide their service as piece work as 'working on-demand', are often lower and erratic, while workers are isolated and often even invisible. Also, incorrect designation of workers as independent contractors is not a new phenomenon; comparable to other sectors (garment, construction or trucking) fake labeling aims to avoid benefits, payment of taxes and respect of labour laws. In addition, the transnational character of 'crowd work' being distributed worldwide (across countries such as China, India, the Philippines and Indonesia) makes it harder to find and use the national jurisdiction which might be responsible for the regulation of working time, salary and social security provisions. Furthermore, a division between work and private life is vanishing and this will increase new stress factors. In this sense the future world of digital work bears resemblance to the 'putting-out-system' of early capitalism, which allowed workers (especially women) a certain amount of flexibility, in order to balance household, farm and putting-out work.

However, the neoliberal ideology ensures that some micro-tasks are not even viewed as dependent labour but are pursued as 'just for fun' or even boredom. Since digital workers have very different social backgrounds and professional experiences, students are competing with single mothers and pensioners from the global North with programmers in India whose income should feed an entire family with a couple of young children. This is indeed a new feature of the so called 'gig economy' and working on-demand via Apps which will become an even more severe problem in the future, finally for trade unions. The neoliberal ideology has been able to capture the minds of ordinary people, especially the young ones. Many of them do understand themselves as 'micro-entrepreneurs' or as being 'their own boss' even though they only in rare cases are working autonomously. But usually, their self-employment is not associated with an upward career trajectory or with an escape from poverty. Very often the work as a formally independent contractor is a trap for young people who are shifting in a cycle between self-employment and often poor-quality jobs with bad working conditions and low pay – and being an unpaid family member.

Before this backdrop, we have good reasons to assume that irregularity, flexibility, uncertainty, unpredictability and different sorts of risk will be the 'new normal of work' in an upcoming era of digital capitalism across the globe. It does not matter whether these workers will be classified as 'precarious', as 'informal' or as 'own account' workers. On the global market place, they are subjugated to unstable employment, lower wages or incomes and even more dangerous working conditions; they will not regularly receive social benefits and will often be denied the right to join a union.

To put it in a nutshell, the capitalism of digital platforms and algorithms make labour discipline more rigid as it imposes seemingly 'scientific' measures and evaluations. A key difference to old manufacturing is that in exchange for their submission to discipline, workers are not getting social benefits and political representation. The majority of digital worker will be the ones who fill permanent or temporary job needs but are denied the protection by permanent and formal work contracts, including legal rights of employees. While only a tiny fraction of the total workforce – at the global, the regional and the national level – will succeed to find access to regular and regulated, higher skilled and better paid jobs. Therefore, the crucial question is not why the lack of security is returning also to workers in the advanced economies of Europe and North America, but why it was possible to reduce such insecurity for a small share of the world population for a couple of decades after World War II.

It is obvious that the growing disorder of the present mode of global capital accumulation is closely linked to the fading away of the state as a broker between capital and labour in the era of neoliberal capitalism, a development which contributed to the dynamics of escalating disparity and progressive inequality in all parts of the world. In a world of 'oligarchic globalization', where only the economically strong nations and the wealthy 20 percent but in particular the richest 1 percent can have realistic positive expectations, liberal welfare policies of progressive inclusion are no longer on the political agenda. Consequently, we see dissolution of classes and of class consciousness (see Mahnkopf and Altvater 2017).

Sure, labour rights have remained comparatively strong for the core work force in the big companies of the manufacturing sector, but millions of workers are trapped into a low-wage cycle with very little chances to advance. As those still working in factories and offices they will be controlled by Apps and algorithms. Algorithms are the equivalent of the old assembly line – but much harder to interrupt (Caselli 2017). As a result, there are more questions than plausible answers available today, among others: How can we imagine the future cooperation between people and machines that function optimally, continuously and emotionlessly? How can humans deal with the permanent pressure of efficiency emanating from soulless machines? How will the power asymmetry between employers and their employees/clients change, when, thanks to the software that will be used everywhere in the future, it will be possible to measure in detail how people work, who communicates with whom and about what? And what will happen to the many people who are not needed for development, repair and further development of the intelligent machines? Would it be plausible to assume that, thanks to the use of robots and AI, societies will become richer in all areas of life and work and will therefore increasingly demand care and other social services – in which all superfluous workers will find a good livelihood? And very importantly, in the future how will public services and social security systems be financed, if robots have taken over the production? How should free lancers, ´crowd´ workers and those ´working on-demand´ participate in financing social security systems? But above all, how can BIG DATA companies be called upon to finance and improve the quality of all public goods (on which they depend) according to their economic potential? By means of a machine tax or a guaranteed basic income for all people?

At least one thing can be taken for granted: already today producers will only automate if doing so is profitable. But for profits to occur, producers need *firstly*, cheap raw materials and cheap energy and *secondly*, a market to sell. Keeping this in mind might help to highlight the critical flaws of digitalization: If robots would replace as many workers as predicted by international institutions and numerous think tanks, thereby creating even more mass unemployment, and if wages are pushed further down because only the highly qualified workers could expect to receive a decent salary, then two important questions need an answer: *First*, to whom would the producers sell all their ´intelligent products´ and *second*, can the material inputs of production really stay cheap if all advanced economies and even some developing countries will follow the same rout towards a '4th industrial revolution'? These two aspects of the topic will be addressed with the next steps of argumentation.

In view of the enormous extent of social inequality in high as well as middle- and low-income countries, which has never been greater in the history of mankind than it is today, it would make sense to answer the question of who will buy all the digital devices by referring to the upper-middle classes and super-rich that have grown worldwide. But will their cumulative purchasing power really be large enough to demand the digital offers developed and advertised today? Doubts are justified. Today, the real large investments in digital infrastructures and 'problem solutions' are expected, as always, from the public sector. The large investments in digital infrastructure and innovative 'intelligent solutions' for the growing amount of problems we are faced with, are mainly expected from the public sector. But nearly everywhere in the world the public sector is impoverished. In the almost 50 years of the 'neoliberal counterrevolution' (Milton Friedman) against Keynesian deficit spending, the public coffer has been plundered to such an extent that 'intelligent' digital solutions for growing social problems simply overtax the ability of many states to pay or are only conceivable if government services are restricted elsewhere. However, there is one industry that today enjoys stable, and in many countries growing public support allover the world and that, as a buyer and user of digital products, can generate an almost insatiable demand for elaborate but also very expensive ´solutions´ to problems: the defense and security industry.

In the US, it is being shown that campaign promises by Donald Trump, who had pledged the renewal of the country's ailing (physical) infrastructure seems to be 'forgotten' – while rising defense spending is accepted as entirely legitimate. And it is not only in the US, that billions of dollars are going to be invested in 'intelligent' machines which are supposed to fight ´our´ wars.

Robotics and artificial intelligence: the proverbial 'dual-use' technologies

The Internet has emerged from an intensive cooperation between the US government, the US military and US elite universities that has existed since the 1960s; this cooperation has led to the development of ARPANET, the military precursor of the World Wide Web, which was then released for private commercial use in 1990. Today, the former 'industrial-military-complex' has become a much more powerful 'digital-capital-military-complex', in which the companies of the Silicon Valley, above all Google, play a decisive role in the development and use of AI-based autonomous systems – which are 'dual-use' goods in the truest sense of the word, i.e. they can in principle be used for both civilian and military purposes. This applies particularly to all variants of 'autonomous control' of machines and means of transport and locomotion, which perceive their environment with sensors and can than carry out independent actions. Technologies such as those already in use today for the autonomous transport of goods in ports and other manageable areas are also needed for the development of 'intelligent weapon systems': sensors, image recognition, software systems for autopilots, GPS and above all large databases and powerful computers.[4]

Today, the development of intelligent weapon systems is progressing very rapidly in the US and China. But also, Russia, Israel and South Korea and many more countries take advantage of military robots. Remotely piloted aircraft (RPAs) or drones fly independently into ´their´ area of operation. They have been used widely in Africa and in the 'Greater Middle East' to shoot down enemy combatants, but decisions about their attack are still made by human operators, often placed very far away. At present, some 90 countries have unmanned aerial vehicles for a wide range of tasks. Around two dozen nations have unmanned drones in their arsenals. The German Bundeswehr has an autonomous defense system (called MANTIS), the South Korean army has installed a self-firing system (called SGR-A1) at its northern border – and the US is not satisfied with its X-47B combat drone, but wants to fully integrate autonomous weapon and reconnaissance systems into the American army formation between 2031 and 2040 (cf. U.S. Army 2017). The U.S. is pushing for similar developments as in airspace also for their naval forces: underwater drones are being developed, for submarine reconnaissance and mine search, for the support of special operation forces and for communication purposes; unmanned combat ships for operations in coastal waters and in straits are in demand, and in the future unmanned combat squadrons will also be stationed on aircraft carriers.

Currently, the commercial sector is driving progress in robotics and AI, while the legal, technical, moral and security implications of autonomous weapon systems (AWS) are of utmost importance for recent foreign and security policy. There seems to be little doubt that 'meaningful human control' over weapon systems cannot be ensured if autonomous weapons are developed further. So far, 'in the last instance' people still decide when and under

[4] As part of the 'Project Mayen', Google has undertaken to further develop the TensorFlow recognition software for war conditions for the US Department of Defense, and for the Pentagon's 'Algorithmic Warfare' team, Google provides not only specialized engineers, but also its huge data set (cf. Rüggemer 2008).

which conditions explosive ordnance is used. But in the future, AI-powered target-identification in attack systems are expected to populate much of the battle space – replacing humans in many and even most combat functions (cf. Klare 2018a). The fighting machine of the future is invulnerable because it no longer has a vulnerable human body. It distinguishes in milliseconds between friend and foe and reacts without hesitation and with minimal doubt. Therefore, it would be of utmost importance to minimize the 'unanticipated situations', when computer failures are very likely – be it in the fog, when it is difficult to identify a target correctly, be it that the computer has difficulties to distinguish between an old woman in a wheelchair and a terrorist or be it that the computer has difficulties to recognize when a soldier is about to surrender. Further it is quite difficult if not impossible for a machine to follow the principle of proportionality, that is to decide whether it would be 'worth' to destroy a hospital and kill 50 children in order to destroy a selected target.[5]

At international conferences it is debated whether AI-based weapon systems with or without humans 'on the loop' are more responsible, even though this is more of a fake debate. For it is questionable whether human decision makers will ever decide against an attack recommended by 'intelligent' machines in an emergency. The rapidly increasing speed of military operations due to the use of machines makes their control by commanders and military staff a difficult undertaking. Therefore, even the general staff action is in danger of being replaced by procedures as they are already applied on the international financial markets i.e. by a largely independent order fulfillment. Above all, the deployment of automatic weapon systems would allow that the inhibition threshold for the use of weapons against any ´opponent´ is lowered even further. It is foreseeable that control over deathly attacks could be lost – in the war business, but also in everyday life. In his article 'New Global Tinderbox. On the Road to WW III' Michael Klare sketches a not so distant scenario of future wars as 'You-Tube-wars' – where everything is recorded and the war is turned into entertainment, something like a video-game, he also calls it 'war-porn'. When distance will feed a new type of warrior, 'a man going for 12 hours to warfare and then driving home and talking to his children' (Klare 2018b), we should be worried about a growing lack of experience, context and humanity.

But drones first have become a key technology in the civilian sector, which is being averted particularly in the logistic area (cf. IFR 2018). In Germany already 470,000 drones are deployed, but their number will increase rapidly if they are used more for commercial purposes in the coming years. Drones are not only popular for use in leisure activities, in the future they will be applied for parcel delivery from the air, in agriculture and in the energy sector; they will be utilized for inspection of railway tracks, for the transport of medical equipment and medications in cases of emergency; for work in areas that are difficult to access such as offshore wind farms or for work in dangerous sites such as underground pipelines and decommissioned nuclear facilities. Furthermore, it is very easy to break 'geo-fencing' restrictions to fly a typical consumer drone over areas such as airports, prisons and sports facilities. With enough money, there is effectively no upper limits for professional drone operators to fly a drone anywhere with cellular reception. However, the case of the so-called 'Gatwick drones' which caused a disruption of air travel in London for several days in December 2018 or the use of drones to drop drugs to inmates of English prisons (both cases reported in the Guardian) might illustrate that this new key technology can be used for a variety of legal and illegal, if not criminal purposes. In short, drones are dual-use technologies – for which purpose ever!

[5] Before this backdrop concerned scientists such as Noel Sharkey (2016) and representatives of civil society organisations argue that 'human supervisory control over critical functions must be subject to scrutiny considering the legal, technical, moral/ethical, and security implications of AWS' (cf. Heinrich Böll Foundation 2018: 14).

Ecological constraints of the 'digital revolution'

So far, the consequences of the so-called '4th industrial revolution' for employment and the quality of future work are expected to have more negative than positive effects on people dependent on wage labour. Furthermore, if the dual-use character of digital technologies is accompanied by new dangers in the violent conduct of conflicts both within and between states. Before this backdrop, it remains to be clarified whether digitalization can at least deliver on the promise of promoting an ecological restructuring of economies through lower resource consumption.

There are calculations that electronic newspapers and books could save millions of tons of paper, which could theoretically lead to reduction in greenhouse gas emissions of some megatons. Admittedly, computers, smart phones and e-readers are usually missing from such bills[6]. Comparable calculations of other new technologies (such as electric vehicles or 'smart homes') do not include fiber optic cables, sensors (that can carry out predictive maintenance), high performance microchips, high resolution displays, lead-free solders, industrial robots and Radio Frequency Identification (RFID)-tags (required for the identification of objects, doors or persons via radio and a basic technology for connectivity of the 'Internet of Things'), all of which consume raw materials in large quantities. When calculating potential savings through digitalization also the electric current required by the many 'smart' products (labels, tickets, cards) in production and operation and the energy required for the disposal or recycling of older and defective products are generally not considered. Nevertheless, all these technologies have significant impacts on the 'real economy' of energy and matter´.

Certainly, new carbon-based materials that are light, cheaper and conduct electricity with limited heat loss, could transform numerous industries, including automobiles, aviation and electronics. Oil demand of transportation could drop, and global steel consumption could potentially be reduced further if more lightweight materials such as carbon and aluminum would be used in the automotive and the aviation industry. The consulting group McKinsey's latest automotive forecast estimates that by 2030 electric vehicles could represent about 30 percent of all cars sold globally, and even nearly 50 percent of those sold in China, the EU, and the US (Gao et al. 2018). However, the shift to electric cars and light airframes is not a synonym for a shift in the resource intensity of transportation, which today accounts for almost half of global oil consumption and more than 20 percent of GHG emissions. Rather it is a synonym for a rising demand for copper, an essential material for nearly every kind of electrical device. Compared to gasoline energy technology electric vehicles need a fourfold amount of copper, in addition to a larger quantity of metals such as cobalt, lithium, and heavy and light rare earth elements metal (DERA 2016). This means that if only every second fuel-based car already on the market were replaced by an electrical vehicle, and current trends in global sales are considered, the amount of metals needed for car production alone would accelerate deforestation as a result of mining, generating more ecological damages and social conflicts with the local population.

Algorithms that optimize robotic movement in advanced manufacturing can indeed reduce a plant's energy consumption and 'smart' thermostats and lighting controls at home might cut electricity usage. But 'rebound effects' must be taken into consideration. These include the electricity used for applying all the new 'smart' products and the growing ICT infrastructure

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[6] If the 'ecological backpack' of an 80g mobile phone would be measured over its entire life cycle, it would weigh almost 74kg. On average, 3.5kg of earth must be moved in order to maintain the 10g of copper required for its production. A laptop weighing 3.5kg brings it up to 300kg of 'Material Input Per Service Unit' (MIPS). Research at the German Wuppertal Institute for Climate, Environment, and Energy, which is intensively involved with the resource consumption of modern information and communication technology, can make it plausible that technical product have an average 'ecological backpack' of 30:1. However, a current 'smartphone' consumes as much as 600 unit of nature to produce just one item! See also the report of Greenpeace USA from Feb 26, 2017 which shows that roughly 968 terawatt was used to manufacture 7.1 billion smartphones in the ten-year period from 2007-2017, the equivalent of all the electricity supply for India in one year (Jardim 2017).

the system will rely on (cf. Gossert 2015). Today the 'cloud' has become a central metaphor of the internet and data has been termed as 'the fuel of the future'. But as oil, the older fuel of our economies and societies, also data have a material base, even though it is less visible. The 'cloud' where people shop, bank, socialize, borrow books and vote and on which the production, distribution and use of essential goods and services depend in the age of digitalization, is a physical infrastructure. It consists of phone lines, fiber optics, satellites, cables on the ocean and warehouses filled with computers, which consume huge amounts of metal, energy and water. These warehouses or information factories which are bigger than aircraft carriers, are called 'data centers', owned by the new industrial kings, the information traders Alphabet, Amazon, Apple, Facebook, Google and Microsoft (and in China by Ba Alibaba, Baidu, Tencent). With the explosion of digital content, BIG DATA, e-commerce, 'industry 4.0' and internet traffic of all kinds, big and smaller data centers have become the backbone of the digital economy. And data centers are one of the fastest-growing consumers of electricity in developed countries and one of the key drivers in the construction of new power plants (Delforge 2014).

In 2013 US data centers consumed more than 70 billion kilowatts of electricity, which was the equivalent to 8 big nuclear power plants or roughly 34 giant coal-powered plants or twice the output of all the nation's solar panels (according to research published by the US Department of Energy, cf. Shehabi et al. 2016). Obviously, the costs of operating physical data centers in the US[7] can be reduced by shifting data to the 'cloud'. But this means that the resource burden and carbon pollution is simply shifted elsewhere. Global data centers used roughly 416 terawatts or about 3 percent of the total electricity in 2016 which was 40 percent more than the entire UK and this consumption is expected to double every four years (cf. Andrae and Edler 2015, Walnum and Andrae 2016, Danilak 2016). Data centers might even consume as much as one fifth of earth's power by 2025, making these 'data warehouses' one of the biggest polluters in just 6 years (cf. Vidal 2017). To sum up: with the explosion of AI, internet-connected devises and increasing the speed of data creation both data center infrastructure and electricity consumption will rise and might put ICT's carbon footprint on a par with the aviation industry's emissions from fuel (cf. Jones 2018). And even more energy would be required for running the sophisticated calculations for the blockchain technology[8]. Before this backdrop, it is not at all good news that the big ICT industry is increasingly purchasing electricity from renewable energy sources, because the capacity of renewable energy is then no longer available for other purposes.

But the ecological burden associated with digitalization is by no means based solely on its insatiable hunger for energy. The digital infrastructure also needs a huge amount of metals, which must be mined (usually with tremendous ecological and social impact) and then transported from locations of origin to locations where they will be processed and consumed. Finally, digitalization also creates an increasing amount of electronic waste. Hence, supply chain risks of raw materials must be considered including price increase, price volatility and even physical scarcity of some 'critical materials' in times of 'peak minerals'[9]. Several metals and minerals are considered 'critical' because they are needed for many different purposes such as renewable energy production, transmission of energy, military systems and digitalization. Furthermore, nearly all these materials are concentrated in a small number of countries. In a study published in 2016, the German Mineral Resources Agency DERA looked at the commodity implications of the '4th industrial revolution'. The research institute concentrated on the raw material requirements of only 42 future

[7] Be it in Loudoun County, Virginia, which is home of the world's largest concentration of computing power or in Oregon, where Facebook is building giant data centers.

[8] The crypto currency Bitcoin is based on this technology and must chain many data sets together. Therefore, a single Bitcoin transaction requires 10,000 times more energy than accredit card transaction.

[9] For the debate about 'peaks' of non-renewable natural resources cf. Heinberg 2010, Bardi 2014.

technologies[10], thus ignoring the fact that other branches of the economy (including the fossil and nuclear-based energy production and the chemical industry) also depend on the same 'critical materials'. The shocking finding of this study is as follows: if the global demand for raw materials for the analyzed future technologies in 2013 and 2035 is compared with the world production quantity of the respective metal in 2013, four times the quantity of lithium, three times the quantity of heavy rare earths, one and a half times the quantity of light rare earth and tantalum have to be available by 2035. Global copper demand could even increase by between 300 and 400 percent in the decades. This view is shared by the business community: Besides expecting 'multi-billion dollar business opportunities' by electrification and autonomous driving in the next years the Swiss investment bank UBS calculates that electric vehicles alone could grow the battery market tenfold by 2025, which would drive a more than 40 percent increase in nickel consumption and more than double the use of cobalt; but also graphite demand is estimated to multiply from just 13,000 tons in 2015 to more than 800,000 tons in 2030 (UBS 2017).

In short, digitalization is a not at all a synonym for 'dematerialisation' of production. Ultimately it is only about replacing fossil fuels and some renewable materials (such as wood, which is needed for paper production) with metal and mineral ones. However, also geopolitical conflicts over access to the raw materials required for the '4th industrial revolution' will increase considerably, in addition to the ongoing geopolitical conflicts on access to crude oil and gas and the control of 'paper oil', that is the price of oil which (despite the growing role of 'data as the new oil') will stay the 'life blood' of a modern way of life in all regions of the world. China, where more than 90 percent of rare earth elements are produced, has already started to prioritize its own supply needs and thus has restricted exports. Also conflicts over access to the world's largest lithium reserves in Bolivia are just as foreseeable as the ongoing human rights violations taking place in the DRC, where the largest cobalt deposits are found. Claims to natural resources, no matter whether these are forests in India, plantations in the Philippines, wind parks established in the Mexican state of Oaxaca or platinum extraction in the South African province of Limpopo, usually conflict with the livelihoods and the participation rights of the affected communities and often lead to internal community dispute and challenges in authentically representing local interests.

In addition, the praised digitilization of economy and society usually sweeps one dimension under the carpet, namely waste and long-lived anthropogenic pollutants (e.g. electronic waste, new chemical compounds and alloys) which are part and parcel of the new 'intelligent' products and which pose environmental and health risks. The production of 'smart' technical devices will lead to a multiplication of the already environmentally and health-threatening export of electronic waste from rich countries to waste dumps in Africa and Asia. Only a handful of producers and few consumers in Europe and North America care about what happens to their old smart phones, displays and computers at the wild dump of Aghogbloshi in Ghana. There, as elsewhere in Africa, the increasingly scarce and therefore expensive copper from electric cables is simply 'mined' by burning the plastic sheaths.

At least one thing can be taken for granted: the future of 'digital capitalism' will depend on how the prices of both oil and of critical metals will behave when economies across the globe transition to renewable energy production and to electrical mobility, while at the same time consumers continue to buy all kinds of mobile devises and governments go ahead with their spending on modern military systems (including autonomous drones). All the industries and technologies involved depend on oil and water but also on the same 'critical metals' – such as copper, nickel, silver, uranium, lead and so called 'rare earth metals' (such as indium, gallium, germanium, lithium and

[10] Such as lithium-ion batteries, airframe lightweight construction, magnets, electric cars, wind power, superalloys, micro condensers, medical technology, new types of fuel cells, fiber-optic cables, transparent electrodes, lead-free solders, seawater desalination plants, displays, thin-film photovoltaic, Radio Frequency Identification (RFID)-tags, and electric motors.

many others). These minerals have become 'critical' for a number of reasons which will not disappear in the future: *firstly*, because some of these (i.e. copper) are already depleted and no new substantial findings of relatively high concentrated deposits can be expected; *secondly,* because the production of various metals will not increase, but more likely decrease, together with the concentration in existing production sites; *thirdly*, because the prices for rare and highly demanded metals will experience a substantial increase in the near future. Under these conditions, less concentrated deposits will become economically viable. But the lower the concentration, the more toxic chemicals and substantial amounts of water and energy will be necessary for the extraction – and the more disruptive will be the mining's impact on local nature, workers and population. Finally, what makes things worse is that most critical metals have a very low recycling rate; rare earth elements have one under 1 percent.

Open questions and outlook

What position could and should workers and their trade unions favour about the digitization of production, logistics and administrative processes and the closely related development and use of learning machines that are equipped with far-reaching analytical capabilities and can process huge amounts of data ultra-fast?

In Germany, at any rate, trade unions are reacting to the increased use of digital technologies and AI in the same way as they have already reacted to earlier advances in technological development. According to Rainer Hoffmann, chairman of the German Federation of Trade Unions (DGB), they want to 'accompany' and, if possible, 'help shape' the processes (quoted in Neues Deutschland, January 17, 2019). In any case, they do not want to stop the emerging developments, because they fear nothing more than to be described as 'machine breakers'. In the past, German industrial unions have always supported all measures that promised to maintain and strengthen the competitiveness of German companies on the world market. For their tolerance they demand today, as they did yesterday, collective bargaining and company regulations which oblige firms to be transparent, to let workers participate in the processes of developing automation further and to take further training measures.

Of course, only those employees who will still be involved in operational workflows at company level in the future can be included in these requirements. Whenever larger parts of employees or self-account workers are no longer concentrated in companies and when we return to a 'putting-out' system like the one in early capitalism, the question of how workers can jointly represent their interests remains largely unanswered. Certainly, there are numerous organizing efforts by established trade unions and labour federations in Germany, in Europe and in the US as well as autonomous approaches by ´crowd-workers´ to push for 'decent work' of digital labor and try to include 'gig' and 'platform' workers in existing employment status and provide some sort of services to isolated workers. But so far, regulatory reforms which aim to extend collective bargaining to include independent contractors have not been very successful (cf. Johnson and Land-Kazlanskas 2018; Balliester and Elskeikhi 2018).

Furthermore, it seems questionable whether, under the current trends of even more fragmentation, working-class solidarity across national boundaries will have a chance to emerge. At least the German industrial unions are working shoulder to shoulder with government and company representatives and are supporting their intention to continue to play a leading global role in future technologies in order to help generate higher productivity and growth for the domestic economy. In other advanced industrialized countries, the perspective is unlikely to be any different. The consequences of an accelerated digitalization of production, logistics and administration structures for the number and quality of jobs in countries of the global South simply do not play a role in the public debate.

Admittedly, the future of the '4th industrial revolution' depends on geopolitically securing the access of large information traders (in the US and China and, to a lesser extent also in Russia) to the data produced by all of us and equally securing the access for manufactures to all the raw materials that are needed to produce the 'smart' products and sell associated services. This includes 'critical metals', which are scarce in both economic and physical terms, but also access to large quantities of cheap energy and, of course, the availability of cheap labour. But at the same time the question arises where the large and growing sales markets for all the many new 'smart' product can emerge. Digital infrastructures and products cannot remain cheap in times of rising raw material prices and rising costs for the number one raw material for life, namely clean water. At the same time, it can be assumed that digitalization will increase unemployment in many countries and further reduce wages. Therefore, it remains a mystery as to where the demand for smart products and services should come from.

Equally unanswered remains the question of who is willing and able to take on the power of the oligarchically operating BIG DATA corporations and to squeeze their constantly growing market power. Not only do we need rules to tax their exorbitant profits, but we also need to intervene in the 'intellectual property rights' of data collectors and data brokers, which are protected by national and international (trade) law and we need to pressure for collective ownership of data. It is foreseeable that the technical progress that is hailed today as superior AI will probably not help to solve one of our pressing social problems. What is certain, however, is that the use of AI and digital technologies makes us even more dependent on the functioning of large technical infrastructures, in the fields of energy, water, communications, transport, financial services, global food supply and not to forget, the military and defense systems.

Even if this paper has not discussed the enormous surveillance potential of digital infrastructure in order to focus attention more on their implications for production and employment, it goes without saying that dependence on a few 'global players' threatens to narrow the political scope for action at national and even regional level further. Foremost, this applies to the countries of the global South. If they want to create their own digital policy that is geared to local and national needs, they will have to build their own public data infrastructure. They would have to strive to regain their data sovereignty and prevent the technological lead of the large IT companies from increasing further, by creating their own digital platforms, for example in the areas of mobility, health, finance and commerce. In order to at least have a vague chance of achieving such goals, the countries of the global South should under no circumstances sign bi- or multilateral trade agreements that deprive them of the opportunity to pursue a self-determined digital development in the longer term. These would include agreements under international trade law that prohibit countries from insisting on the local storage and processing of data or the levying of duties, taxes or customs on companies that are digitally present in their countries but do not have their own infrastructure there. But this is precisely what is currently happening under the pressure from the BIG DATA companies from the US and those industrialized countries that expect to benefit from the cooperation with the GAFAM complex[11].

Overall, skepticism remains appropriate. It is foreseeable that technological progress in the form of AI and digitalization will not transform itself into social progress in either the northern or the southern hemispheres of our endangered planet. Therefore, we should immediately start a broad public debate everywhere on the real issues in this context: Why should it be good to replace humans in so many functions and make ourselves redundant, not only as workers but redundant in all senses? What does it mean if we use machines that make decisions faster than we think, consider and finally decide – even when it comes to the use of lethal weapons? In which areas of society

[11] The 'Comprehensive and Progressive Trans Pacific Partnership' (CPTPP) Agreement between economically quite strong signature states such as Australia, Japan, Canada, but also Singapore, Brunei and New Zealand on the one hand and their weaker contractual partners Mexico, Peru, Chile, Malaysia, Viet Nam on the other hand, which has been concluded in 2018, regulate an unlimited and cross-border free movement of data flows. This deprives governments of an important instrument to regulate the digital economy and, in the longer term, to develop their own digital infrastructures.

could AI be used meaningfully and where should we prevent its use? How can we retain or regain control over our infrastructures? How can we build a digital infrastructure that serves all users and where do we neither need nor want digital structures?

Above all however, we need to debate the unavoidable tradeoffs that are looming between economic purposes and ecological constraints (cf. Mahnkopf 2016, Altvater and Mahnkopf 2018). We can now buy a selfie toaster, that burns an image of our face on our bread; and we can buy a toilet roll holder that send a message to our phone when the paper is running out. And certainly, 'Industry 4.0' will help to further make sure that we are buying goods and services we neither need nor want, induced by marketing. But the ecological and social sacrifices we will have to make for this type of 'progress' are simply not acceptable.

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