



ADDRESSING **SOCIETAL CHALLENGES**

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INTRODUCTION: ADDRESSING SOCIETAL CHALLENGES

Johan Frishammar and Åsa Ericson

As an area of excellence in research and innovation, Effective Innovation & Organization (EIO) at Luleå University of Technology (LTU) represents an important initiative aimed at addressing societal challenges by combining engineering and social science research. EIO enables the pooling of resources from various scientific disciplines to address many of the societal challenges Sweden is currently facing. This book is one result from such pooling of disciplines, resources and cross-disciplinary discussions. Here, some leading EIO researchers have jointly analysed and reflected upon five key societal challenges to identify some of their implications and future pathways for research at LTU. All of these challenges span multiple scientific domains, and competence in innovation and organisation will be critical if they are to be addressed effectively.

Innovation has sometimes been described as ‘disciplined problem solving’ (Brown & Eisenhardt, 1995). Today, in-depth understanding of complex relationships between human needs, technologies and value are vital to problem solving (Christensen, 2015) as innovation centers on creating new products, services, processes, solutions or business models. Organizations, and the way we organize, are critical in bringing innovation about. Innovation is never the effort of a single individual, but instead a collective effort (Lynch et al., 2017).

In today’s complex world – often described in terms of disruption or even spinning out of control – problems do not arrive gift-wrapped and clearly delineated. Rather, the key societal problems of today are highly complex, or what Rittel and Webber (1973) termed ‘wicked problems’. Wicked problems are defined by the fact that they cannot be solved once and for all because of incomplete, contradictory and changing requirements that are difficult (if not impossible) to recognize up front. Wicked problems need be continuously addressed. Often, the problem itself is not understood until a plausible solution has been formulated, and perhaps not even then. And when a solution starts to emerge, the problem is always multi-dimensional, implying that the solution is outside the realm of one single knowledge area or academic discipline. That is, wicked problems require competences and knowledge from multiple scientific domains.

The societal challenges we face today, such as the unfolding climate and environmental crises, the declining results in the Swedish school system, the disruptive force of digitalization, or gender and equality issues in our workplaces all resemble wicked problems. Such problems require the search for innovative solutions and place new demands on the way we organize. It may no longer be effective to organize research based on the problem alone, but rather organize our efforts so that it has the potential to formulate both the problem and a sound solution simultaneously. This requires the input from multiple perspectives, for example engineering, human work science, entrepreneurship, social sciences, policy studies, environment and humanities.

About a year ago, the Swedish government’s research proposal (Regeringskansliet, 2016) outlined a number of societal challenges ripe for future research over the coming 10-year period, but with a particular focus on the period of 2017-2020. The intended purpose was to make Sweden a leading knowledge-based nation, and a world leader in science and innovation. Five societal challenges were specified, out of which three were perceived to be of global and national relevance, and the remaining two of

a more national character. The three of global and national relevance were Climate and environment, Health, and Digitalization. The two of national relevance were to create a safe, including and sustainable society (below relabelled as ‘Future work’), and to improve the results of the Swedish school system (below relabelled as ‘Improving learning outcomes’).

Over the past year, leading EIO researchers have jointly worked on all these five societal challenges by describing them, breaking them into important sub-challenges or problems, pairing those problems and challenges with current LTU competences, and then theorizing a future research agenda for our university. Each chapter in this book describes the reasons why these social challenges are considered, what has and could be done to address them, and discusses the future implications. The chapters are:

Climate and environment addresses global and fundamental challenge for the future, including problems such as global warming and pollution into air and water. The transition to a “greener” economy requires a re-assessment of firms across a wide range of industries, and concerns government regulation and policy. Patrik Söderholm, Professor in Economics with a focus on environmental and resource economics, discusses green capitalism and sustainability entrepreneurship as potential catalysts of such a transition. He also reflects upon organizational and societal innovations as an approach to achieving radical green technology transitions and exemplifies that both sustainability entrepreneurs and efficient policy mixes may be the disruptive forces required to manage the such transitions.

Digitalization, at its simplest, refers to the connectivity supported by digital technologies including machines, vehicles, buildings and the like, and is the major force driving the current industrial revolution. Digitalization is currently reshaping customer and business relationships, thus requiring new ways of organizing and innovating business models. Vinit Parida, Professor of Entrepreneurship & Innovation, discusses recent business development and innovation management to effectively address social and business values in a digitalization context. Further, he reflects upon upcoming changes of workforce requirements and the need for new skill development, and exemplifies that digitalization not only create new types of jobs, but also make some others obsolete.

Future work is a central part of most people’s concerns, and what it will look like is shaped here and now. A “good” future work environment arguably eliminates risks, physical and psychological problems, simultane-

ously creating a sense of participation and the possibilities to enjoy autonomy. In short, people should be able to influence their work. However, such a workplace is not easy to create. Jan Johansson, Professor of Human work science, discusses future work in an increasingly digital world in which robots can become our new workmates. Further, he reflects upon changed gender patterns and the possible shaping of an “A” and “B” labour market and problematizes future organization of knowledge work in terms of upskilling and deskilling of tasks.

Improving learning outcomes in the Swedish school system is a national concern enflamed by recent PISA tests which drew attention to a decline in success and learning rates in particular in the areas of science, mathematics and reading comprehension in our compulsory schools. Teaching performance and leadership arguably need to be ensured to improve learning outcomes, although the means for doing so is up for debate. Lydia Kokkola, Professor in Education and English, together with Anna Öqvist, Docent in Education, discuss the problems and how inclusive practices will be important to reduce the number of pupils who fail. Further, they reflect upon the future for Sweden’s educational system, in which OECD has identified the same systemic weaknesses, and provide arguments for how it needs to be addressed both an organizational problem and a shortcoming of current pedagogical practices.

Future health and healthcare are crucial for wellbeing, as previous efforts and advances in both technology and lifestyle have made us live both a longer and a healthier life. The challenges of today are different, however, for example due to an increase of immigrants, but also due to an increase in mental ill-health problems among Swedish youth. Catrine Kostenius, Professor of Health sciences, discusses health issues in our rapidly changing society. Furthermore, she reflects upon health inequality and the particular challenges of a future digital world. A digital future may bring us new constantly online-related problems, but it may also support wellbeing, for example through e-health solutions for sparsely populated areas.

There are, of course, links and overlaps between these societal challenges. The contributions in this book all tell a story of what has been done so far, as well as proposing some future paths for LTU. The intention is not to predict the future - the human world is far too complex for that - but rather to provide direction and inspiration, and fuel the debate concerning future research investments, vision and profile for LTU.

REFERENCES

Brown, S.L., Eisenhardt, K.M. (1995). Product development: past research, present findings, and future directions. *Academy of Management Review*, 20(2), 343-378.

Christensen, C.M., Raynor, M.E., McDonald, R. (2015). What is disruptive innovation? *Harvard Business Review*, December, 44-53.

Lynch, M.P.J., Kamovich, U., Andersson, G., Steinert, M. (2017) The Language of successful entrepreneurs: an empirical starting point for the entrepreneurial mindset. *Proceedings of the European Conference on Innovation and Entrepreneurship, ECIE*.

Regeringskansliet (2016) Kunskap i samverkan - för samhällets utmaningar och stärkt konkurrenskraft. Prop. 2016/17:50. Retrieved 2018-01-06 from: <http://www.regeringen.se/rattsdokument/proposition/2016/11/prop.-20161750/>,

Rittel, H.W.J., Webber, M.M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4, 155-169.

CLIMATE AND THE ENVIRONMENT: MANAGING THE TRANSITION

Patrik Söderholm

The global community faces fundamental environmental challenges, such as climate change, chemical risks, air and water pollution, and natural resource depletion, in turn concerning all sectors of the economy. While meeting these challenges requires knowledge about the natural environment and about engineering solutions, the societal response must also address several non-technical barriers. For instance, green technological development to address the problem of diffuse pollution, such as hazardous substances in consumer products, involves altered business models, institutional reform etc.

The transition to a green economy likely requires a re-assessment of the roles of the private industry and the state, respectively. The advent of so-called green capitalism and sustainability entrepreneurship can be catalysts to this process. Still, the extent of the contribution of green capitalism is uncertain; there is likely to be key roles for the state. Policy instrument mixes, including direct support to green technology, will be required to address the challenges associated with diffuse emissions and green innovation. This is, though, in itself a challenge to policy-making at different levels, e.g., understanding how various policies interact and how the institutional contexts can affect the effectiveness of various instruments. For LTU the above suggests that efforts aimed at green technical innovation must acknowledge the subsequent need for new and complementing organizational and societal innovations.

THE GREEN ECONOMY VISION

In 2015, countries world-wide adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals. These goals recognize that the promotion of economic growth and ending world poverty must go hand-in-hand with environmental protection and addressing the threat of climate change. The sustainable development goals thus establish a real link between the ecological system and the economic system, and during the recent decade this has been translated into the vision of a 'green' economy. This chapter discusses key challenges in managing the green economy transition. It does not cover other important aspects of sustainable development; albeit a few of these – health, education and work – are discussed in other chapters of this report (see the contributions by Kostenius, Kokkola, and Johansson).

Addressing climate and environmental challenges, clearly requires natural scientific knowledge as well as engineering expertise concerning the technical solutions that can be adopted to mitigate the negative impacts (e.g., carbon-free energy technologies etc.). However, the transition towards a green economy is also an organizational, political, economic and social endeavor; it involves key non-technical challenges. The so-called transitions literature recognizes that sectors such as energy supply, water supply etc., can be conceptualized as socio-technical systems or innovation systems (Geels, 2004). Such systems consist of networks of actors (individuals, private firms, government authorities, etc.), the knowledge that these actors possess as well as the institutions (legal rules, norms). For instance, the development of new carbon-free technology typically requires the establishment of new value chains hosting actors that have not interacted before; this necessitates a relatively long process that can alter society in several ways, e.g., legal amendments, changed consumer behavior, infrastructure development and novel business models.

In other words, beyond technical progress, economic and organizational innovations are necessary in order to achieve the green economy transition. In fact, our history is full of examples illustrating the need to address the organizational and institutional challenges associated with technological change and innovation. In hindsight, the societal impacts of electricity in terms of overall productivity have been tremendous during the 20th century and onwards, but it actually took up to five decades before the manufacturing sector was able to take full advantage of the new technology (David, 1990). Existing firms had to change the entire systems of operation, i.e., production processes, architecture, staff training etc.

This key argument, i.e., that the adoption of new and more efficient technology has to be accompanied by systemic changes, applies both to the company as well as the societal levels. Any solutions being developed must take into account the complexity of the interdependencies between different types of actors, overall market dynamics, and a need for knowledge development and institutional reforms. As noted below, the need for systemic changes may actually be particularly relevant in the case of green technologies. LTU should be capable of contributing to both the technical as well as the societal domains of the green economy transition.

Against this background, the objective of this chapter is to discuss important avenues for future research at LTU with particular emphasis on innovation and organizational challenges. The discussion centers on the following five challenges:

1. Dealing with diffuse and global environmental risks
2. Achieving radical green technology transitions
3. Green capitalism: the uncertain baseline scenario
4. Role of the state: designing appropriate policy mixes
5. Dealing with distributional concerns and impacts

The first two points address the types of structural tasks that are required to achieve the green economy transition, and barriers that need to be overcome when pursuing these tasks. The remaining points concern the role and the responsibility of different key actors in the transition process, not least firms and government authorities etc. The chapter concludes by briefly outlining key implications for future research.

DEALING WITH DIFFUSE AND GLOBAL ENVIRONMENTAL RISKS

With the advent of modern environmental policy in the 1960s, stringent regulations were imposed on emissions into air and water. However, the focus was on stationary pollution sources (industrial plants), which are relatively easy to monitor and regulate. In addition, during this early era there was a strong emphasis on local environmental impacts, e.g., emissions into nearby river basins.

Over the years, though, the environmental challenges have increasingly been about targeting various types of diffuse emissions. These stem from scattered sources such as road transport, shipping, aviation, agriculture etc. Individually they may not be of concern, but in combination with other diffuse sources they can cause serious overall impacts. The advent of global environmental challenges such as climate change in combination

with globalization (and more international trade) adds to this challenge; addressing these challenges requires international negotiations and burden-sharing, which in itself have proved difficult.

Diffuse emissions are difficult to monitor and therefore also to regulate. For instance, environmental authorities may wish to penalize improper disposal of a waste product, but such behavior is typically clandestine and difficult to detect. Plastic waste is an apt example; it stems from millions of consumer products, is carried around the world by the currents and winds, and builds up microplastics, particularly in the sea. Many dangerous substances (e.g., chemicals such as solvents, phthalates, etc.) are also embedded in consumer products, out of which many are imported. Technological innovation that permits better tracing and tracking of materials is therefore needed.

In order to address these environmental impacts, society has to find alternative – and more indirect – ways of monitoring and regulating them. In large, this translates into attempts to close material cycles and promote a circular economy in which the “value of products, materials and resources are maintained as long as possible,” (European Commission, 2015). This implies an increased focus on recycling and re-use of virgin materials, material and energy efficiency, as well as sharing of resources (e.g., with the help of digital platforms such as Uber, Airbnb etc.). Hence, rather than regulating emissions as close to damage done as possible, regulators support specific activities that can be assumed to correlate with reduced environmental damages.

Addressing diffuse emissions in such indirect ways, though, is not straightforward. In several countries, waste management adheres to the so-called waste hierarchy. It postulates that waste prevention should be given the highest priority followed by re-use of waste, material recycling, recovery of waste and landfill (in that order). Even though research has shown that this hierarchy is a reasonable rule of thumb from an environmental point of view, it is only a rule of thumb! Deviations from the hierarchy are necessary, e.g., it is typically less negative for the environment to landfill mining waste such as hard rock compared to recycling. Recycling is a key issue for LTU research, which needs to focus on the effects of such deviations from the hierarchy.

Moreover, product design should factor in the reparability and reusability of products to a greater extent, and improved recyclability can also benefit from modular product structures. However, companies often manufac-

ture products in ways that increase the costs of recycling for downstream processors, but for institutional reasons there is no means by which the recovery facility can provide manufacturers with incentives to change the product design. One example is the use of multi-layer plastics for food packaging, which is often incompatible with mechanical recycling.

Promoting material and energy efficiency is a mixed blessing. Such measures imply that the economy can produce the same amount of goods and services but with less material and energy inputs, but they also lead to a so-called rebound effect. Along with productivity improvements, resources are freed and can be used to increase the production and consumption of other goods. Hence, the efficiency gains are at least partially cancelled out by increased economic activity elsewhere. For instance, if consumers buy very fuel-efficient cars, they are able to travel more or spend the money saved on other products, which themselves may exploit resources and generate emissions.

Finally, circular economy business models imply that different economic sectors need to become more interdependent. In some instances, though, this may be difficult to achieve. For instance, excess heat from process industries can be used for supplying energy to residential heating or to greenhouses. Such bilateral energy cooperation is quite common in Sweden, but pushing this even further may be difficult or too costly. Investments in these collaborations are relation-specific, i.e., their economic returns depend on the relationship's continuation. Nevertheless, the involved firms may be too heterogeneous in terms of key goals, business practices, planning horizons etc., thereby making long-term commitment difficult. Moreover, the excess heat is in an economic sense a byproduct, implying that its supply will be constrained by the production of the main product. Of course, this is valid for many other types of waste products as well (e.g., secondary aluminum from scrapped cars, etc.).

In brief, the importance of addressing diffuse emissions implies that environmental protection has to rely on indirect pollution abatement strategies. Still, pursuing such strategies (e.g., promoting recycling) is not easy. There are important barriers (e.g., for product design, byproduct use) as well as negative rebound effects. A focus on recycling must also not distract from the need to improve the tracing and the tracking of hazardous substances, as well as provide stronger incentives for product design. Both technological and organizational innovations are needed. LTU should play a key role in this research endeavor given the university's focus on materials, energy, and process industries.

ACHIEVING RADICAL GREEN TECHNOLOGY TRANSITIONS

Incremental innovations, e.g., increased material efficiency in existing processes, are key elements of the green economy. However, more profound – and even radical – technological innovations are also needed. For instance, phasing out fossil fuels in iron and steel production requires a technological shift and not only incremental improvements. At least three factors, however, make more radical transitions difficult.

First, one obstacle is the risk facing firms that invest in technological development (e.g., basic R&D, pilot tests etc.) in combination with the limited ability of the capital market to handle the issue of long-term risk-taking. These markets may fail to provide risk management instruments for immature technology due to a lack of historical data to assess risks. Research also suggests that due to agency problems within private firms, their decision-making may be biased towards short-term payoffs thus resulting in myopic behavior also in the presence of fully efficient capital markets (Stein, 1989).

Second, private investors may have weak incentives to pursue investments in long-term technological development. The economics literature has noted the risks for the under-provision of public goods such as R&D and learning-by-doing. Thus, private companies will be able to appropriate only a fraction of the total rate-of-return on such investment, this since large benefits will also accrue to other companies (e.g., through reverse engineering). Due to such knowledge spillovers, investments in long-term technological development may become inefficient and too modest.

Third, new green technologies may face unfair competition with incumbent technologies. The incumbents, which could be close substitutes to their greener competitors, will often be at a relative competitive advantage since they have been allowed to expand during periods of less stringent environmental policies as well as more or less tailor-made institutions and infrastructures. This creates path-dependencies, where the future tends to be locked-in to certain technological pathways. Technology choices will be particularly self-reinforcing if investments are characterized by high upfront costs and increasing returns from adoption (i.e., scale, learning and network economies).

There are reasons to believe that the above three obstacles to long-run technological progress could be particularly troublesome for green technology. The protection of property rights represent one way to limit knowledge spillovers, but the patent system is subject to limitations. For

instance, many green technologies “consist of a large set of components and require the expertise of several firms to improve the system. A consortium will face difficulties in sharing the costs of ‘learning investment’, as it is difficult to negotiate and fix the allocation of future profits,” (Neuhoff, 2005, p. 98).

Furthermore, the electric power sector exhibits several characteristics that will tend to induce path dependent behavior. Investments are large-scale and display increasing returns. Path dependency is aggravated by the fact that the electricity outputs from different sources are more or less perfect substitutes. In other words, the emerging green technologies can only compete on price with the incumbents, and therefore offer little scope for product differentiation. Finally, in this sector existing technological patterns are embedded in a complex set of institutions and infrastructure.

In brief, the transition towards a green economy requires radical technological shifts; this process is characterized by long and risky periods during which new systemic structures – i.e., actor networks, value chains, knowledge, institutions etc. – need to be put in place and aligned with the emerging technologies. Private sectors cannot alone be expected to build-up these structures; some policy support is needed. Nevertheless, in order for any policy to be efficient it has to build on an understanding of the obstacles for long-run technological innovation. For LTU there should be scope for combining research in economics, history of technology and innovation management with that taking place at the engineering departments.

GREEN CAPITALISM: THE UNCERTAIN BASELINE SCENARIO

Economic and environmental values are often perceived to be in conflict. Business decisions build on profit-maximization, and incorporating environmental concerns will imply lower profits and reduced productivity. Still, with the growth of, for instance, organic products, material waste recycling, climate compensation schemes etc., sustainability issues have begun to move into mainstream business activities. Many large companies often no longer distinguish between environmental innovation and innovation in general; the environmental footprints of business operations are always taken into consideration during the innovation process.

Some even put this in Schumpeterian terms and argues that the green economy transition implies a “new wave of creative destruction with the potential to change fundamentally the competitive dynamics in many

markets and industries,” (Larson, 2000, p. 315). Research has recognized the potentially important roles that so-called sustainability entrepreneurs can play as they attempt to combine traditional business practices with sustainable development goals. These entrepreneurs are believed to be able to disrupt established business models, cultures and consumer preferences, as well as help reshape existing institutions. Still, the research in this field has also been criticized for providing a too strong focus on individual success stories, while, for instance, institutional and political factors, which are deemed to shape the priorities made by these individuals, tend to be neglected.

It is very difficult to anticipate how far voluntary, market-driven initiatives will take us along the road to a green economy. Apart from a range of incremental developments, such as increased material efficiency following increased digitalization (see chapter by Parida), industrial firms and sustainability entrepreneurs are likely to help develop new or refined business models and adopt innovations commercially. Businesses are also likely to devote attention to avoiding future environmental liabilities, such as the potential costs of contaminated land clean-up, flood risks due to climate change etc. In other words, there is increased demand for businesses that work across two logics that have been perceived as incompatible: the commercial and the environmental. There is, though, huge uncertainty about the scope and depth of green capitalism.

As indicated above, there are reasons to assume that in the absence of direct policy support, businesses will not be well-equipped to invest in long-term green technology development. Green *product* innovations may often be easier to develop and nurture since firms then may charge price premiums to consumers. Product innovations also do not require gradual up-scaling and optimization of the production process. In fact, many high-profile sustainability entrepreneurs in the world (e.g., Anita Roddick of The Body Shop) have been product innovators. In contrast, green *process* innovation is harder to pursue. It is hard to get consumers to pay premiums for such innovations. Moreover, taking results from basic R&D, which appear promising on the laboratory scale, through “the valley of death” into commercial application is a long and risky journey. For small- and medium-sized firms, in particular, this will be a major hurdle.

In brief, it remains more difficult than ever to anticipate what a baseline scenario, i.e., a scenario involving no new policies, would look like from a sustainability perspective. Overall it is likely that green capitalism and sustainability entrepreneurship alone may have problems delivering the green economy transition in at least two respects. Due to the presence

of knowledge spillovers and the need for long-term risk-taking, this scenario may involve few radical technology shifts. The baseline scenario is likely to involve plenty of digitalization and automation, considerably increasing the prospects for material and energy efficiency improvements. Still, due to rebound effects these gains are not sufficient to address the sustainability challenge. Policy is thus needed to support the green innovation processes. One important implication of the above for LTU is to establish stronger links between the research on entrepreneurship and the social science research (economics, political science, history and law) addressing the role of policy and societal institutions for the green economy transition.

THE ROLE OF THE STATE: DESIGNING APPROPRIATE POLICY MIXES

A key task for policy is to set appropriate “framework conditions” for the economic markets, i.e., the legal framework such as immaterial rights and licensing procedures. Traditional environmental policy that regulates emissions through taxes or standards will remain important, as will the removal of environmentally harmful subsidies. The role of such policies is to make sure that the external costs of environmental pollution are internalized in firms’ and households’ decision-making. Still, given the challenges associated with diffuse emissions and radical socio-technical changes in combination with the private sector’s inability to adequately tackle these two challenges, the role of the state must go beyond providing framework conditions. There exist several arguments for implementing a broader mix of policy instruments in the green economy.

Policy mixes are needed in the waste management field. In the cases where diffuse emissions cannot be directly controlled and monitored, a combined output tax and recycling subsidy (equivalent to a deposit-refund system) can be an efficient second-best policy instrument mix. An extended policy mix in this field may also be motivated by limited incentives for manufacturers to consider product design and recyclability, which would decrease the costs of downstream recycling by other firms. Finally, the establishment of material recycling markets is also hindered by different information-related obstacles, such as the buyers’ inability to assess the quality of mixed waste streams. In these cases, information-based policies (e.g., screening requirements at the waste sites) could complement other policies.

More generally, fostering green technological innovation must build on policy mixes. The transitions literature has proposed an innovation policy mix based on three broad categories of instruments (Rogge and Reichardt, 2016):

1. Technology-push instruments that support the provision of basic and applied knowledge inputs, e.g., through R&D grants, patent protection, tax breaks etc.
2. Demand-pull instruments that support the formation of new markets, e.g., through deployment policies such as public procurement, feed-in tariffs, quotas, etc.
3. Systemic instruments that support functions operating at the innovation system level, such as providing infrastructure, facilitating alignment among stakeholders, and stimulating the development of goals and various organizational solutions.

A key task for green innovation policies is to support the development of generic technologies that entrepreneurial firms can build upon. Public R&D support and co-funding of pilot plants help create variation and permit new inventions to be verified, optimized and up-scaled. As technologies mature, though, they must also be tested in (niche) markets with real customers; the state will have to create the conditions for private firms to raise long-term funding in areas where existing financial organizations are not yet willing to provide sufficient funds. In the renewable energy field, this has been achieved by introducing feed-in tariffs or quota schemes for wind power and solar energy. At last, systemic instruments could influence the other instruments; while technology-push and demand-pull instruments are the engines of innovation policy, systemic instruments will help that engine run faster and more efficiently.

The implementation of policy mixes will in turn be associated with several challenges, such as gaining political acceptability, identifying specific designs of the instruments, etc. One issue that is particularly relevant concerns the need for technology-specific policies. In contrast to, for instance, pollution taxes or generic R&D subsidies such policies support selected technological fields and/or sectors. There are two motives for considering technology-specific instruments: (a) regulations cannot target the diffuse emissions directly – at least not without incurring very high monitoring costs; and (b) the need to promote radical and directed environmental innovation.

The innovation systems surrounding green energy technology tend to be technology-specific. Different technologies are exposed to unique and multi-dimensional growth processes, e.g., in terms of bottlenecks, learning processes, dynamics of the capital goods industries etc. The nature of the knowledge spillovers and the long-term risks will also differ as will the

likelihood that green technologies suffer from technological lock-in associated with incumbent technologies (e.g., Lehman and Söderholm, 2018). For instance, the technological process related to wind power has largely been driven by turbine manufacturers and strong home markets, while equipment suppliers and manufacturers that own their own equipment have dominated solar PV development.

Technology-specific policies are difficult to design and implement; regulators typically face significant information constraints and their decisions will often be influenced by politico-economic considerations such as bureaucratic motives, lobby group interests etc. In addition, the prospects for efficient green technology-specific policies may also differ across jurisdictions; some countries will be more likely to implement policies that can live up to key governing principles such as accountability, discipline and building on arms-length interactions with the private sector. “Government agencies need to be embedded in, but not in bed with, business,” (Rodrik, 2014, p. 485).

In brief, the climate and environmental challenges facing society today require a mix of policy instruments, not least because the barriers facing new green technology are multi-faceted and heterogeneous across technologies. Supporting green innovation should build on the use of technology-specific policies as complements to traditional environmental policies. This in itself poses a challenge to policy-making, and requires in-depth understanding of how various instruments interact as well as increased knowledge about the institutional contexts in which these policies are implemented. LTU research currently addresses these difficulties in a variety of research settings, such as in ongoing collaborations between innovation management and economics. Still, the above policy challenges should also open up for broader multi-disciplinary research collaborations, involving also engineering research at the university.

DEALING WITH DISTRIBUTIONAL CONCERNS AND IMPACTS

The green economy transition affects the whole of society. It is therefore necessary to not only optimize the performance of the new technologies and identify efficient policies; the distributional impacts must also be understood and addressed. All societal changes involve winners and losers, and unless this is recognized and dealt with, the transition may lack in legitimacy across various groups in society.

This challenge concerns different distributional impacts, out of which one is about income inequalities. Economics research has shown that environmental policies, not least taxes on pollution and energy use, tend to have regressive effects, implying that the lowest-income households are most negatively affected in relative terms. Such outcomes may prevail also in the case of policies that rely on direct support to certain technologies. For instance, high-income households are likely to benefit the most from subsidies to solar cells and electric cars, this since these households are more likely to own their own house as well as to be more frequent car buyers. Of course, technological change (e.g., digitalization), including that taking place in green technology, may also lead to profound distributional impacts in more indirect ways, not the least through its impacts on the labor market (e.g., wages).

The regional dimension of the green economy is also important. The challenge in this case is that people increasingly expect that green investments taking place in their own community should promote regional growth, employment and social goals. The emphasis on the distributional effects at the regional level can also be attributed to the growing assertion of the rights of people (e.g., indigenous rights), and increased demands for more direct participation in relevant decision-making processes. Still, new technology can often fail to generate such impacts. For instance, a combination of scale economies and increased capital intensity has profoundly increased the investment capital requirements of typical energy facilities such as wind mills, biofuel production facilities etc. The inputs into modern green energy projects also have to satisfy high standards in terms of know-how etc., and these can therefore not always be supplied by local firms. Indeed, with the implementation of digital technology, the monitoring of, say, entire wind farms can today be done by skilled labor based in other parts of the country.

Ignoring distributional effects may create social tensions, thereby increasing business risks for companies and sustainability entrepreneurs. In fact, while the economies of the world become more integrated, political trends tend to suggest a stronger focus on the nation state and regional independence. If anything, this will further complicate the green economy transition; it will need to recognize the difficult trade-offs between efficiency, which typically requires international coordination (e.g., in terms of policy design, and R&D cooperation), and a fair distribution of benefits and costs, which instead tends to demand a stronger local perspective.

In brief, the distributional effects of the green economy transition require increased attention in both scholarly research and the policy domain. These effects call for an even broader palette of policies (e.g., benefit-sharing instruments such as regional natural resource funds), but they also call for difficult compromises between efficiency and fairness. Norrbotten County, with LTU as a key actor, represents a perfect case study for studying – and dealing with – such impacts.

CLIMATE AND ENVIRONMENT: FUTURE PATHWAYS AND IMPLICATIONS

The scope and the nature of the societal challenges that arise as a consequence of climate and environmental hazards are complex and multi-faceted. Understanding the nature of green socio-technical transitions and managing these represents a multi-disciplinary research undertaking. Collaborations between natural scientists and engineers as well as among social scientists are needed to translate environmental and technical challenges into societal action. In such collaborations it should be recognized that technological change is not a linear process. It entails phases i.e., concept development, demonstration projects, market formation and diffusion, and also important feedback loops among all of these phases. For LTU, it is important to consider how bridges between engineering and social science disciplines can be built; this would permit more in-depth understanding of how green inventions can be commercialized. Transition studies, innovation and environmental economics, and the innovation management literatures could provide such bridges. While examples of this type of research already exist at LTU, the potential for more intense collaborations ought to be high.

There is also scope for a role for more cross-fertilization among the social sciences, e.g., between the economics, history of technology and innovation management fields and between the research on sustainability entrepreneurs and transition studies. This could help improve the ‘micro-foundations’ of innovation system studies, i.e., better understanding of firms’ incentives, etc., but also highlight the need for considering socio-technical systems. For instance, the focus on individual ‘heroes’ that pervades much of the entrepreneurship literature may lead to a neglect of the multiple factors at work, not least societal institutions and infrastructure at national and local scales.

Green innovation in the public sector should gain more attention. This could focus on institutional innovations in the form of new and/or revised policy instruments and ideas. The challenges encountered when implementing technology-specific policies require such innovation. These poli-

cies represent processes of discovery, both by state and industry, instead of a list of specific policy instruments. Comparisons of green policies across countries and technological fields as well as over time could prove useful. The technological areas that are prominent at LTU, e.g., mining, hydropower etc., could serve as interesting cases. Given the context-specificity of these types of policies, such research must address the issue of how transferable innovation and sustainable practices are in different contexts. Also in this respect LTU is well-equipped to generate interesting research given its strong environmental social science research (e.g., in economics, history, management, political science, and environmental law).

Moreover, the growing importance of diffuse emissions also calls for green innovation in the public sectors. Specifically, the implementation of environmental regulations that can closely target damages demands monitoring technologies that can measure pollution levels. The development of technologies that, for instance, facilitates cheap monitoring of emissions ought to be promoted, but it remains unclear who has the incentive to promote and undertake such activities. Similar concerns can be raised about innovations that permit consumers to better judge the environmental footprints of various products. Private firms cannot be expected to pursue these types of innovations. Governments spend substantial amounts on funding R&D on pollution abatement technology but less frequently we see government programs funding research on technology that can facilitate policy enforcement and monitoring.

Finally, the green transition should benefit from research that involves various impact evaluations, including methodological development in evaluation work. This concerns the impacts of key baseline developments, e.g., digitalization, globalization etc., on environmental and distributional outcomes. The future prospects for green innovation collaborations, such as new business models, also need to be assessed. For LTU, such evaluations should be particularly relevant for understanding the greening of, for instance, the mining and iron and steel industries. Clearly is there also a need for improved evaluations of policy mixes. Given an increased role for technology-specific policies, such evaluations are not straightforward; they must consider the different policies' roles in the innovation systems and address important interaction effects.

REFERENCES

David, P. (1990). The Computer and the Dynamo: An Historical Perspective. *American Economic Review*, May, 355-361.

European Commission (2015). Closing the Loop – An EU Action Plan for the Circular Economy. COM (2015) 614 final, Brussels.

Geels, F. W. (2004). From Sectoral Systems of Innovation to Socio-technical Systems: Insights about Dynamics and Change from Sociology and Institutional Theory. *Research Policy* 33, 897-920.

Larson, A. L. (2000). Sustainable Innovation through an Entrepreneurship Lens. *Business Strategy and the Environment* 9, 304-317.

Lehmann, P., and P. Söderholm (2018). Can Technology-Specific Deployment Policies be Cost-Effective? The Case of Renewable Energy Support Schemes. Forthcoming in *Environmental & Resource Economics*.

Neuhoff, K. (2005). Large-Scale Deployment of Renewables for Electricity Generation. *Oxford Review of Economic Policy* 21(1), 88-110.

Rodrik, D. (2014). Green Industrial Policy. *Oxford Review of Economics and Policy* 30(3), 469-491.

Rogge, K. S., and K. Reichardt (2016). Policy Mixes for Sustainability Transitions: An Extended Concept and Framework for Analysis. *Research Policy* 45(8), 1620-1635.

Stein, J. C. (1989). Efficient Capital Markets, Inefficient Firms: A Model of Myopic Corporate Behavior. *Quarterly Journal of Economics* 104, 655-669.

DIGITALIZATION

Vinit Parida

Digitalization is a fundamental disruptive force triggered by Fourth Industrial Revolution and Internet of Things, which has changed the way we approach and think about business processes and activities. In this increasingly digital age, relationships between organizations (i.e. companies, governmental agencies, and others) and customers are being reshaped and new business models are being invented. Today, companies across industries need agility, speed, flexibility, and the ability to pivot rapidly to pursue new business opportunities and keep up with a fast-changing global business environment. Digitalization emphasizes the importance of placing advanced technology at the heart of all processes, products, and services. However, much of the promised value of digitalization for business and society has not yet been fully realized. Academia will play a vital role in developing the required knowledge and skills at the individual, company, and social levels. LTU can contribute to digital transformation by upgrading teaching and research so that students and researchers learn, understand, and apply digitalization for business development, innovation management, and social value creation.

DIGITALIZATION TO TRANSFORM INDUSTRY AND SOCIETY

In modern society and industrial environments, organizational operating systems are becoming increasingly complex and automated. These systems comprise people, machines, workstations, devices, robots, and other assets with appropriate monitoring, sensors, and control systems. A constant challenge in relation to these systems is that of new technology insertion, which includes digitalization, frequent changes in operating processes, random disruptions, and dramatically fluctuating market demands. The business world is full of disruption. New business models and innovative technologies are continually being invented, and these inventions demand a sharp focus on effective innovation and organization to stay relevant, engaged, and ahead of the future curve. Digitalization does not just mean going paperless; it means being able to integrate solutions to manage, organize, control, and generate value from digital data for value creation, sustainability, and new opportunity creation for business and society.

According to Gartner, digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; and it is the process of moving into a digital business. Digitalization clearly holds implications outside the industrial sphere; such as governments are faced with the issues of potential inequality and wage deflation or even social unrest due to uncertainty around workforce for the digital future. This radical technological transformation is based on networks of sensors, actuators, and other devices from the Internet of Things (IoT). The number of devices that make up the IoT is estimated to grow to 50 billion by 2020, forming a solid foundation for digitalization. The aforementioned networks integrate the physical system into the digitalized cyber physical system for applications in smart homes, cities, factories, services, transportation, and so forth. The three elements of digitalization are 1) sensors, 2) devices that make the smart system, and 3) connectivity integration from the devices to the computer and digitalized platform. These three elements combine to enable predictive and prescriptive analytics for business solutions and value generation (Porter and Heppelmann, 2014).

Industrial transformation through digitalization is particularly evident in the manufacturing industry, where the related term Industry 4.0 has been coined. Industry 4.0 suggests that digital enterprises are built using the industrial Internet or digital factories. Industry 4.0 focuses on end-to-

end digitalization of all physical assets and integration into digital ecosystems with value chain partners. PWC's 2016 Global Industry 4.0 Survey (2016) indicates that digitalization in manufacturing industry will drive a 2.9% increase in annual revenues and reduce costs by 3.6% per annum over the next five years. Additionally, products, systems, and services will be increasingly customized to empower customers and to meet their needs. The biggest challenge was found to be the lack of digital culture and skills in organizations, so the focus should be on people and culture to drive this transformation.

There is a general agreement that digitalization causes large-scale, sweeping transformations across multiple areas of industry and society. These areas include customers, employees' skills, and lack of digital culture. In addition, technology adoption by industries provides unparalleled opportunities for value creation, yet it also represents a major source of risk. In the digital age, certain companies, such as Google, Amazon, and Facebook, have become digital platform owners. This ownership gives them a monopolistic position and allows them to apply winner-takes-all logic, which leads to greater inequality in terms of exploitation of business opportunities. Thus, business leaders from all sectors are grappling with the strategic implications for their organizations, industry ecosystems, and society. The economic and social implications of digitalization are contested, and they raise serious concerns over the wider impact of digital transformation. Based on my own academic experience and learning from interacting with leading companies, I have identified five digitalization transformation challenges that we must further understand and discuss:

1. Implementing political digitalization agenda;
2. Digital platforms for entrepreneurship;
3. Workforce requirements and new skill development;
4. Digitalization forces business model innovation;
5. Unrealized value of big data analytics.

IMPLEMENTING POLITICAL DIGITALIZATION AGENDA

For most countries, digitalization has become a key issue on the political agenda. However, the way digitalization has been conceptualized and prioritized differs across countries. For example, the Industry 4.0 strategy was developed by the German government in 2013 (www.plattform-i40.de). Industry 4.0 is an integral part of digitalization, and vice versa. The technical core is automation. Digitalization has elevated automation to a new level, where technical components can be integrated and autonomous machines can be linked to autonomous factories. Industry 4.0 is described as the Fourth Industrial Revolution. This revolution consists of an implementation of the Internet of Things, Humans, and Services, where the entire production process is included in Internet-based networks. Industry 4.0 focuses on manufacturing in the current context. An Industry 4.0 factory, components, and systems can gain self-awareness and self-predictiveness, providing managers with greater insight into the status of the factory and helping them to make the right decisions.

Similarly, a cyber-physical system (CPS), developed in the US in 2006, is a mechanism that is controlled or monitored by computer-based algorithms that are tightly integrated with the Internet and its users. A CPS is used for cyber manufacturing that translates data from interconnected systems into predictive and prescriptive operations to achieve business performance. It intertwines industrial big data and smart analytics to discover and comprehend invisible issues for decision making. Examples of CPSs include smart grids, autonomous automobile systems, medical monitoring, process control systems, robotic systems, and automatic pilot avionics.

The Swedish government has recently presented its own digitalization strategy for industry under the report Smart Industry – a strategy for new industrialisation for Sweden (Regeringskansliet, 2016). The strategy is inspired by the German Industry 4.0 strategy, and broadly acknowledges that the Fourth Industrial Revolution has started. As with the steam engine during the First Industrial Revolution, mass production during the Second Industrial Revolution, and the mass use of electricity and electronics during the Third Industrial Revolution, and today, embedded devices and connected systems will save Sweden. The Swedish government identifies five strategic areas:

1. Stimulating the development, spread, and use of the digital technologies that have the greatest potential to lead the industrial sector's transformation;

2. Broadly exploiting the potential of digitalization, irrespective of industry, company size, and geographical location;
3. Encouraging new business models and organizational models to tap the potential of the new technology;
4. Meeting new knowledge requirements that are brought about by digital development;
5. Adapting framework conditions and infrastructure to the digital era.

Thus, digitalization occupies a key position at the top of the global and national agenda, dictating the course of business development, driving employment with unparalleled opportunities, and contributing to business and social growth for higher value addition. However, at this stage of digitalization, its full exploitation and implementation is a future challenge. The governments should be careful for not to be only policy based (top-down) rather leave the freedom for industries to implement the strategies innovatively. LTU can contribute to these strategic development and implementation through collaboration and supporting innovative digital organizations.

DIGITAL PLATFORMS FOR ENTREPRENEURSHIP

Digitalization is implemented for examples, through Industry 4.0 and CPS applications. In these applications, smart devices and machines, smart materials, smart warehouses, and other smart systems in factories continuously exchange information with each other and with human workers to increase productivity and business growth. Aspects of digitalization have led to the development of numerous digital platforms. Companies such as Amazon, Etsy, Facebook, Google, Salesforce, and Uber have created online structures that enable a wide range of value generation and entrepreneurship activities. However, these platforms are quite effective if started with the advantages of the development, but there could be disadvantages as well. For example; while Facebook is used for networking, dating, business, video and chatting etc, its negativity are maintaining the individual privacy, fake Facebook profiles and private status published publicly etc. A platform is a plug-and-play business model that allows multiple participants (producers and consumers) to connect to the platform, interact with each other, and create and exchange value. Thus, digital platforms offer new ways for radical changes in how we work, socialize, create value in the economy, and compete for profits (Kenney and Zysman, 2016).

The digital platform economy encompasses a growing number of digitally enabled activities in business, politics, and social interaction. These activities are transforming industries and livelihood opportunities. However, the challenge lies in understanding and developing the right digital strategy and action plan for implementation by all stakeholders. The digital platform encompasses integrated manufacturing 4.0 or digital factories and smart factories of the future. These changes will reduce the number of jobs. Greater automation and digitalization in industry means that fewer jobs are required, whilst the entrepreneurial opportunities increase in the non-manufacturing sector. Under digitalization, large-scale, sweeping transformations are taking place in multiple industries, affecting various aspects of businesses and providing unparalleled opportunities for value creation. Large digital platforms are changing the way firms do business, driving employment and thereby contributing to economic growth. For example, Uber, the world's largest taxi company, has only 6,700 employees, owns no vehicles, but employs an estimated 1 million drivers (part- and full-time) across 458 cities in over 70 countries. It received gross bookings of 20 billion USD in 2016, though Uber is also considered for violating laws in many countries and cities like NYC in US. However, whilst the co-existence of platform-based approaches challenge traditional industrial norms and represent new business opportunities, they also raise unforeseen challenges.

A related challenge is associated with large digital platform owners such as Facebook, Amazon, and Uber, which act monopolistically, enforcing rules and regulations upon platform users with solely their own interests in mind. According to recent reports, companies such as Airbnb, Uber, and Xiaomi have increased their revenue threefold in the last two years. Many experts argue that so much power in the hands of so few private companies threatens industrial norms and creates an unclear future scenario. However, digital platforms also represent a new form of business creation platform that can generate huge revenues and employment. Because digital platforms can facilitate exchanges between multiple groups (e.g. end users and producers) at lower transition costs, they provide unique opportunities for individual entrepreneurial activities. For example, digital platforms provide opportunities to students to drive Uber taxis at the weekend or in the evening, and they allow house owners to rent out rooms through Airbnb.

Among many examples in LTU, one is related to working on the cloud-computing platform for railways and mining. The goal is to manage big data

from sensors, instruments, and inspections and use this data for decision making. Similar platforms can be adopted in other industries and SMEs as part of their digitalization. LTU can facilitate and support development of the skills and competencies required for entrepreneurship while bridging the gap between SMEs and larger companies.

WORKFORCE REQUIREMENTS AND NEW SKILL DEVELOPMENT

The digital revolution highlights the potential for skills development and a richer working life based on more challenging work tasks. Companies must adopt a sociotechnical approach, whereby worker participation in job design plays a central role. The organizations of the future must have flat structures, more organizational innovations and learning, enhanced human-machine interactions, and a more human-centred view of modern technology for the success of industrial production. A new idea of 'wisdom manufacturing' has emerged. According to this idea, devices, computers, and humans, as well as explicit and tacit knowledge, are integrated. This enlarged and in depth integrated knowledge requirements calls for skill revolution, which is a critical challenge. The development towards digitalization application provides a huge opportunity for the realization of sustainable manufacturing. The strategy also emphasizes that fewer employees and functions are needed as remote controls and preventive measures to reduce labour costs. It has also become apparent that new types of manufacturing jobs will emerge that require new skill sets and competencies.

Thus, the vision of fully automated factories, with the IoT, not only changes the technological landscape of industrial workplaces and organizations, but also leads to a qualitative knowledge and competency transformation. Under an optimistic view, future smart factories require workplace learning and continuous education and systems that use workers' skills. In other words, future smart factories are learning organizations. In terms of Kern and Schumann's (1974) concepts, this is a transformation from craftsman-like qualifications towards more technical qualifications. The new demands for teamwork, responsibility, and a comprehensive understanding of production flows can be seen as a shift from process-dependent qualifications to qualifications that are independent of the process. The workers' tacit knowledge must be formalised into theoretical knowledge that is digitalized and used in computers and smart phones. This transition highlights the contradictory movements of upskilling (rapidly changing skill demands and more theoretical, comprehensive, and communication tasks) and deskilling.

Under digitalization, the skills life cycle is shorter than ever. This change is happening on an unprecedented scale. The impact may be overinflated today, but as the cost and complexity of implementing technology falls, the pace is set to accelerate, giving rise to a Skills Revolution. In the Skills Revolution, the value we place on different skills will change. Digitalization and growth in skilled work will bring opportunities, as long as organizations and individuals are prepared. As a progressive society, we must be prepared for this change. We must develop new innovative solutions in education and include people as they undergo individual transformations.

LTU could introduce a programme and courses on various areas of digitalization to impart education and training to students and industry professionals to upgrade their knowledge and skills. The syllabus should match industry needs and technological developments. These students and upgraded professionals can support digitalizing organizations whilst giving themselves greater employment opportunities.

DIGITALIZATION FORCES BUSINESS MODEL INNOVATION

To stay competitive, numerous manufacturing firms are embracing service-oriented business models. The emerging literature on servitization, a transition from the traditional provision of products and basic services to the provision of higher-value advanced services provides novel insights into this transformation. This servitization-based business model transformation is enabled by digitalization, which provides significant opportunities for offering advanced services by exploiting digital technologies. Combining service components with smart and connected machines in the supply chain can lead to advanced service offerings. A practical example is Volvo Construction Equipment's offering of fleet management, in which Volvo retains full ownership of a fleet of machines and guarantees a certain production volume (e.g. tons/hour). Another example is Gestamp HardTech, which, by adding sensors and analytical capabilities to press-hardening tools, is able to sell 'strokes per hour' to its customers. Thus, the combination of servitization and digitalization enables companies not only to provide higher value to customers, but also to increase revenue by 20% because of product differentiation and stable income (Parida et al., 2014). Still, most manufacturing companies are unable to capitalize on servitization and digitalization. A major challenge for traditionally product-centric manufacturing companies consists of effectively using digitalization to exploit opportunities to undertake advanced service development and

commercialization activities. Many factors prevent manufacturing companies from exploiting digitalization-based opportunities such as data sharing and data ownership. Because companies do not fully understand the value that the collected data may offer in terms of promoting present business models or future business models, they adopt a conservative stance. Experts argue that greater value from digitalization can only be realized when companies across the industrial ecosystem start to share data and jointly engage in value creation for end customers. In turn, manufacturing companies currently have their own isolated digital platforms such as MyABB or MySandvik, which are used for advanced service delivery. If companies continue to restrict collaboration during this digital age, new actors like Google or Microsoft will take a leading role in the traditional manufacturing industry and will act as system integrators, leading to significant revenue losses for manufacturing companies.

In addition, companies need to revise and upgrade their internal product–service development processes through, for example, the stage-gate model. The stage-gate model provides an operational plan for development, which consists of a series of stages through which a development team carries out essential activities. Gates complement the stages, where managers evaluate (e.g. go/kill) interim project achievements. However, recent advances regarding the requirements for product- and production-based services and opportunities created by digitalization have not yet been integrated into traditional stage-gate methods. For example, smart and connected products provide unique opportunities to capture customers’ operational information. Current stage-gate methods, however, fail to effectively integrate and use such data to guide development activities or promote decision making. Thus, future development process may also build on brand new scrum or agile logics, which place a greater focus on interactive development processes.

A related issue is how companies develop their digitalization capabilities to enable servitization transformation. Scarce insights relate to conceptualizing subcomponents of digitalization capabilities and leveraging these subcomponents to co-create value with customers when offering advanced product services. Recent studies have cited three independent yet interrelated digitalization capabilities: intelligence capability, connect capability, and analytic capability. Intelligence capability represents the ability to configure hardware components to sense and capture information with low human intervention. A key part of this ability is to upgrade products with smart subcomponents such as embedded sensors, micro-

processors, embedded operating systems, software applications, and digital user interfaces. Connect capability represents the ability to connect digitalized products through wireless communication networks. A key function relates to the transmission of information or signals from intelligent products to storage and processing centres in the cloud. Finally, and most importantly, companies need to develop a strong analytic capability, which is the ability to transform available data into valuable insights and actionable directives for the company and customer. Analytic capability involves developing rules, business logics, and algorithms that process information or data into predictive insights that have operational value for the organization. Jointly, these sub-capabilities can provide ways to transform the product-centric business model towards an advanced-service business model, which focuses on higher value generation by engaging in value co-creation activities (Lenka et al., 2017).

LTU is in a unique position to address the issues that relate to digitalization and servitization. The extensive experience means that much attention has already been devoted to enriching our understanding of how Swedish manufacturing companies can transform their business models. However, further work is needed, and several research avenues remain unexplored. These avenues include but limited to using digitalization and servitization to influence sustainable industries.

UNREALIZED VALUE OF BIG DATA ANALYTICS

Big data, which involves a high volume, high velocity, high variety, and high variability of data, is growing at an unprecedented rate. Terabytes are old news for big data. The unit of data measurement will soon grow to petabytes, zettabytes, and beyond. So how can data mining exploit maximum value from rapidly expanding big data? Under digitalization, big data connects all stakeholders with assets and devices for automation. These assets and devices include networks of low-cost sensors and actuators for data collection, monitoring, decision making, and process optimization. The economic impact lies between 2.7 trillion and 5.2 trillion USD. The IoT entails the internetworking of physical devices, vehicles, buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. The IoT encompasses technologies such as smart grids, smart homes, intelligent transportation, and smart cities. Each device is uniquely identifiable through its embedded computing system, but it is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by

2020, offering advanced connectivity of devices, systems, and services that goes beyond machine-to-machine (M2M) communications and that covers a variety of protocols, domains, and applications. The IoT is one of the platforms of today's Smart City, and Smart Energy Management Systems (Disruptive Technologies, 2017). Big data includes cloud computing, where data is stored and computed for decision making. Examples of cloud computing systems are NASA's Open Nebula (2008), Amazon's Elastic Compute Cloud (introduced in August 2006), and Microsoft Azure (Disruptive Technologies, 2017).

Big data analytics and cloud computing bring the importance of cyber security to the fore. If big data is not secure and reaches individuals who are involved in sabotage and misuse, the results could be catastrophic. Thus, big data security is paramount. Today, established companies like Google use security layers for big data and cloud computing because greater value can be generated when data is secure and hard to access. One purpose of big data is to create value through big data management. As Industry 4.0 and automated systems show, big data can be used for descriptive, predictive, and prescriptive analytics, which supports decision making. Automated or real-time decision making enhances organizational performance and productivity, providing more business opportunities and creating greater value. However, if big data is not organized and implemented correctly, it could lead to value destruction.

Using big data at the industry level could pose a major challenge for SMEs, which may lack the necessary individual resources to fully exploit the data. Could these SMEs share the data across similar industries? Data security, data platform, and other issues are needed to be solved. However, if SMEs can work collaboratively, they can mutually benefit, thereby adding value to their business. Thus, there is a need for various big data business models to be developed and exploited at LTU, where industry professionals and University researchers can collaborate to enhance productivity and value at a lower cost.

DIGITALIZATION: FUTURE PATHWAYS AND IMPLICATIONS

Digitalization has entered all facets of business life cycles, processes and activities, and society besides transforming individuals. With 4th industrial revolution, more and more companies are expected to implement digitalization with customers as the centre of the change. Digitalization will provide the speed, flexibility and ability to pivot rapidly to move ahead with the fast-changing global business scenario. Advanced and rapidly

changing technologies coupled with digitalization are compelling the companies and universities to accept these challenges while preparing for its implementation.

In this report, we have identified and discussed numerous issues associated with digitalization. For examples, digitalization has been included in the global agenda of most of the developed countries creating conflicts at its early life cycle stage. The digital platforms need large investments and developed by the top global companies, which may lead to monopolization. With the digitalization, skill development needs to be matched, as with the business models' transformation. Big data which is part of digitalization has a scope for future value creation if appropriately developed and implemented.

Digitalization represents numerous opportunities for value creation for individuals, industry, and society. The dominant view among experts largely holds a positive outlook regarding digital transformation for all stakeholders. In contrast, this report provides a critical view on the future implications of digitalization and highlights the needs for further understanding and investigating five knowledge gaps for academia, in general and LTU, in particular.

- Government policies have an important role to play towards realization of digitalization-related advantages in Swedish industry and society. A key area for inquiry would be to explore how government only provides a policy framework with freedom for actors to act and benefit from digitalization.
- New digital platforms are becoming influential and challenging the industrial norms, this represents a “double edged sword”. On one hand platform provides standardization of practices and efficiency, while on other hand it reduces competition and creates high entry barriers. Under these conditions, understanding how SMEs and new ventures can capitalize on digital platforms to ensure their future competitiveness and level the playing field with incumbent firms is relevant.
- Digitalization transformation influences individuals' life through creation of new jobs while at the same time making certain jobs obsolete. We need further advancement of our knowledge on how we can ensure that the digital revolution matches skills revolution within Swedish industry and society.
- Industry is currently experimenting with numerous technological scenarios, which builds on smart and connected machines. Investigating

how technological innovations are coupled with business model innovations for greater benefit for the entire industrial value chain.

- Big data and analytics can create two sided advantages, i.e. reduce costs and increase revenue. Still, true value of data in most industrial settings has not been fully understood or realized, which led to restrictive approach on an individual company level. Examination of how big data and analytics are exploited towards value creations remains an open issue.

LTU represent a model university, where technological research intersects with business research. Digitalization requires alignment between university students and faculty in the frame of educational programmes and courses to develop competencies, skills, and collaborations. These needs place demands on the knowledge, competencies, and skills that are required for technology, social sciences, and digitalization. Technological changes take place faster and faster, now occurring over just a few months. This speed of change presents a challenge for universities and researchers alike. The digital skills gap must be mapped to create a digital skills catalogue that defines the required skills and competencies that should be imparted to students. Ubiquitous training and innovative ways of learning via social learning platforms and other online forums should be encouraged. More research and experiments should be undertaken using more flexible and agile ways of organizing digitalization in big data analytics, the IoT, social collaboration tools, and 3D/virtual reality interfaces. From a management perspective, other priorities include leadership behaviours that stimulate a digital culture, set clear directions, engage with the workforce using collaborative technologies, actively encouraging feedback and innovative thinking, and push out decision making to the edges of the organization.

Universities, businesses management, and industry need to prioritize these issues and act now. Students and faculty need to learn and understand technology selection, IT/OT, and cloud computing in addition to big data analytics and other aspects of digitalization. Time is the most critical resource when the world is changing, and technology is continually evolving. With different institutions and departments teaching and undertaking research projects in almost all areas of digitalization from business and technology perspectives, LTU has an important mandate. LTU has a long record of developing business and technology models for social value development and sustainability. To this end, the following questions demand our attention of LTU:

- How can LTU capitalize on digitalization through educational initiatives targeted towards right skills and competencies development? How should LTU run specialized programmes for industry professionals who lack digitalization competencies and skills so that they can re-enter the job market?
- How can LTU continue to collaborate with industries to conduct applied research into digitalization? Furthermore, how can LTU enhance researchers' capabilities to look beyond results and develop new business models to ensure sustainability and build social values?
- How can LTU collaborate with leading research groups and universities in Sweden and around the world to become a globally leading institution for digitalization?

REFERENCES

Disruptive technologies. (2017). Advances that will transform life, business, and the global economy. Retrieved on 15 January 2017 from: <https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies>

Industry 4.0. (2017). Manufacturing next act. Retrieved on 20 January 2017 from: <http://www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act>

Industry week. (2017). Retrieved on 16 October 2017 from: <http://www.industryweek.com/technology/preparing-manufacturing-s-future-in-industry-40>

PWC 2016 Global Industry 4.0. (2016). Retrieved on 16 October 2017 from <https://www.pwc.com/gx/en/industries/industry-4.0.html>

Kenney, M., and Zysman, J. (2016). The rise of the Platform Economy. *Issues in Science and Technology*, 32(3), 61–69.

Kern, H., and Schumann, M. (1974). *Industriearbeit und Arbeiterbewusstsein*. Frankfurt am Main/Köln: EVA.

Regeringskansliet. (2016). *Smart Industry – a strategy for new industrialisation for Sweden*.

Porter, M. E., and Heppelmann, J. E. (2014). How smart, connected products are transforming competition. *Harvard Business Review*, 92(11), 64–88.

Parida, V., Sjödin, D. R., Wincent, J., and Kohtamäki, M. (2014). Mastering the transition to product-service provision: Insights into business models, learning activities, and capabilities. *Research-Technology Management*, 57(3), 44-52.

Lenka, S., Parida, V., and Wincent, J. (2017). Digitalization Capabilities as Enablers of Value Co-Creation in Servitizing Firms. *Psychology & Marketing*, 34(1), 92-100.

FUTURE WORK - UTOPIA OR DYSTOPIA?

Jan Johansson

Work is a central part of our lives in many aspects. Half of our awake time is for most of us performed as paid work. At work, we create the values we need to live the life we desire. At work, we are socialized and shaped into the human beings we are. We are all concerned about how our work will be in the future; will we be able to handle the new technology or will we be replaced by a robot? These are important questions but at the same time we must be aware that the future work is shaped here and now. LTU should be an active part when we create the work of the future. This means that we need to get a picture of what is happening and then relate to that development but we also need a vision of where we want to go.

THE SECURE, INCLUDING AND SUSTAINABLE SOCIETY

Let us start with a vision based on comprehensive and coherent research on what constitutes good work. In the good work, not only are physical risks and problems eliminated, and equipment and work sites are adapted to suit people's different physical and psychological make-up and designed to make work easier, but employees also enjoy autonomy and a sense of participation and influence in matters both large and small. These involve being able to influence the division of duties and the pace and method of working, in relation to both other people and to the technical system used. The good work provides physical, intellectual and cultural stimulation, variety, opportunities for social interactions, context and opportunities for learning and for personal and professional development. Here, workloads, demands, and challenges (both physical and psychological) are balanced at a reasonable level. The workplace is also characterized by gender equality, fairness, respect, trust, democratic leadership, and open communication and offers good opportunities for enjoyment and social support. There should also be good opportunities to combine work with a rich and sustainable life outside of work.

A poor work environment can result in a reduction in individuals' quality of life, commitment, and general stamina. There are also factors that are partially external to the workplace, but which affect it, the individuals who work there, and the work environment. These may include everything from an unstable or distorted local labor market and poor educational and rehabilitation systems to insecurity and violence, as well as heavy demands on, and responsibility for, unpaid care work carried out at home.

The secure society is given a broad interpretation in which we safeguard the democratic and free society through a politically open process. The secure society also includes security in the technical and social structures surrounding our everyday life where the safe workplace is specifically designated. We also include issues such as personal safety and privacy. The including society encloses all people regardless of race, gender and ethnicity. Good social planning provides the foundation for distribution of societal resources and creation of attractive environments. The including society offers a labour market for everyone in which the individual is developed through lifelong learning. The sustainable society has an economic, social and ecological dimension. The economy is about ensuring increased prosperity, the social to allocate prosperity in a way that receives social acceptance and the ecological to take into account the sustainability of ecosystems and the environment so that future generations can meet their needs.

I have chosen to focus on human work and its future development. One reason is that the work for most adults occupies half of their awake time, but also because human work should be a key part of the technology development that take part at a technical university. Based on my experience and the expertise in innovation and organization, I have identified seven social challenges that we have chosen to further develop:

1. Work in the digital world
2. The need for a new organizational perspective
3. The Swedish labour market model under attack
4. Upskilling, deskilling, or reskilling?
5. Changed gender patterns
6. Shaping an A and B labour market
7. Robots as workmates

WORK IN THE DIGITAL WORLD

The wolf is coming or God's gift to mankind are two expressions that follow many technical innovations, but perhaps especially digitalization and computerization. The wolf is coming indicates a fear that our lives will be deprived of something we want to maintain while we neither can nor really want to refrain from the computerized society. God's gift to mankind emphasizes the advantages and new opportunities that facilitate and enrich our lives. Society has participated in the technological development with these mixed emotions over the last 20 years, and now there are clear signs digitalization will take a greater leap into not only our everyday lives but also our work lives in very concrete ways.

The German's vision Industry 4.0, and its Swedish companion Smart Industry – a strategy for new industrialisation for Sweden, paints a bright picture of the future working life where smart machines continuously exchange information with each other as well as with human workers. The industrial worker will be an expert who makes sure that production runs smoothly. The worker may no longer be "locked" in a control room; instead the real-time process data and status of machines follow the worker as she moves around the factory. She can solve problems on the spot by remotely interacting with other production operators, experts, suppliers, or customers in multi-competent teams or she can interact with a humanoid robot that assists in decision-making and analyses. Production control can be done in a digital model far away from the factory. In short, the augmented worker has extended senses and extended memory through technology that takes advantage of and supports human skills, increasing situational awareness, for example, through sensors embedded in the

operator's clothes while keeping an uninterrupted operational vigilance. An interesting and perhaps scary vision is presented by Romero et al. (2016) who based on the technical core of Industry 4.0, forms a typologization of the future operators, Operator 4.0. This typology is built on eight characteristics that can be seen as the core of the new technology: Super-Strength Operator (physical interaction) using biomechanical support for increased limb movement, increased strength, and endurance; Augmented Operator (cognitive interaction) using Augmented Reality (AR) for integrating information from the digital to the physical world; Virtual Operator (cognitive interaction) using Virtual Reality (VR) for simulation and training of real situation that might contain risks; Healthy Operator (physical and cognitive interaction) using wearable sensors for monitoring health-related metrics as well as GPS location; Smarter Operator (cognitive interaction) using Intelligent Personal Assistant (IPA) for interfacing with machines, computers, databases, and other information systems; Collaborative Operator (physical interaction) using Collaborative Robots (CoBots) for performing repetitive and non-ergonomic tasks; Social Operator (cognitive interaction) using Enterprise Social Networking Services (E-SNS) for interaction between operators and between operators and Internet of Things; and Analytical Operator (cognitive interaction) using Big Data Analytics for discovering useful information and predict relevant events. The classification points to the numerous possibilities of integrating Industry 4.0 with human labour – some good and some bad.

There is much positive in this development, probably the most parts, but there is an urgent need to investigate not only how these technologies are designed, chosen and implemented, but also their impacts on work in the industry. As a technical university, we will participate in this technology development in many ways, but it is also important that we put a social perspective on development. There are a number of questions that need to be asked, and as academics we have a mission to be the social prosecutor who poses the uncomfortable questions.

THE NEED FOR A NEW ORGANIZATIONAL PERSPECTIVE

New internet-based technology can be discussed in relation to the complicated patterns and contradictory trends that can be seen in the rich flora of management models or even management fashion spreading across the world during the 1980s and 1990s. More models were added during the 2000s and 2010s, but with a narrower focus on Lean Production. The original impulses for these models often came from Japan, but their more prominent advocates were American researchers and consultants. Compared with the North European traditions and the sociotechnical

approaches of the 1970s and 1980s, which were based on bottom-up and workplace perspectives, these models had a clear management and top-down perspective focusing on individualization and similar normative messages. Even if reality has been more stable and slow than the organisational fashion, the models played a significant role at the discourse level and still influence power systems and the social constructions in organisations – how people view the organisation, the profession, the work, and themselves as workers.

Lean, still the dominant organisational model, is driven by higher demands of individualized and customized products and services, an approach that focuses on processes, creativity, and innovation and on temporary and liquid forms of organisation. Typical of the 2010s is also the technology optimism, a phenomenon that seems to recur cyclically in organisational fashion. For example, the concept Business Process Re-engineering (BPR) is process- and customer-oriented and the ideas of work organisation are flexible, multi-competent, and autonomous teams organized around the production flows. The idea was to build a totally new kind of organisation based on the emerging information technology. Although this approach was pre-Internet, we can easily recognize the same optimistic views on computerised networks as in Industry 4.0.

Industry 4.0, essentially a technology-driven vision, generally refers to a technological revolution with a strong focus on production rationalization, but we can also see that the organizational recommendations set up for the implementation of Industry 4.0 (e.g., production flow, connected processes and systems, horizontal integrated and flexible organisation, learning and production standardization, and diagnosis) have clear similarities with BPR, The Boundaryless Organisation, Learning Organisation, TBM, TQM, Six Sigma, and Lean. Therefore, there is a need for critical organisational analyses, discourse analyses, analyses of embedded conflicts in Industry 4.0, power shifts, and invisibility of power. In addition, there is a need for analyses related to other current organizational trends (e.g., centralization, monitoring, requirements for voluntary, storytelling, and corporate branding) and wider social changes. LTU should participate in this work. We cannot let the Industry 4.0's advocates set the discourse, alternative questions must be asked, other type of experts, such as academics, must be engaged, and alternative issues must be communicated and discussed by a wider audience.

THE SWEDISH LABOR MARKET MODEL UNDER ATTACK

Over the years we have witnessed an increase in labour flexibility, the decline of standard labour contracts, the sub-contracting or outsourcing of work, increasing self-employment, and mounting insecurity. However, it is the use of digital platforms by global enterprises to crowd-source labour to small and micro sized companies all over the world that is re-shaping work and employment conditions in the most visible way so far.

The term crowdsourcing was coined by Howe in 2006 and was presented as a new level of sub-contracting. For example, rather than relying on off-shore jobs at low-cost locations, companies can outsource functions once performed by employees to an amorphous and generally large pool of individuals using an open call over the Internet. The most significant differences between crowd-sourcing and a traditional workforce are the higher levels of flexibility, scalability, access to a broad range of skills, and experiences at significantly less cost, coupled with the lack of employment regulations. This strategy appeals to industrial firms as they are able to access a labour force that can expand and contract on demand without any significant transaction costs or logistical hurdles. Management control is simultaneously 'at a distance' while remaining all-powerful when directing work tasks and determining the nature of reward. Relationships are fleeting and largely anonymous, with no obligation to provide support or facilities for the workforce.

Another aspect of the new technology is related to Scandinavian industrial sociology. In this field, Lysgaard's (1961) book on the workers' collective is regarded as seminal, one of the classics of its time. Although it is well researched and documented that workers act collectively in the workplace, the term 'workers' collective' is rarely used in current Nordic research. It is, for example, well-known that the workers' collective functions as a set of norms, controlling the workers' relations to each other as well as the extent to which deviations from these norms (e.g., a certain type of masculinity, negative attitudes to management, and technological change) are counteracted or accepted. Materialized by this normative system, the workers' collective is based on a culture of resistance that attempts to gain informal control over the work situation. It can also function as a protector of practical and hard physical work, referred to as 'embodied competence' or 'body capital'. Consequently, new technology and new management models are often resisted by the collective system. In this context, Industry 4.0, automated factories, and Internet of Things represent a new technological and managerial landscape to which several reactions are possible. There is a need to analyse the opportunities and

challenges represented by the current technological and organizational development and to create a theoretical platform for the understanding of the transformation of work and workers based on the workers' collective.

On an aggregated level, this is about the survival of the Swedish labour market model. The Swedish labour market is one of the most harmonious in the world, based primarily on bi-lateral agreements between the parties rather than on legislation. In a global internet-based labour market, there are hardly any space for collective agreement and the Swedish labour market model, instead the legislative path seems to be the only way possible. Here is an interesting opening where the Swedish trade unions have long been more cooperative than their European colleagues. Relationship to new technology has often been characterized by "If you can't beat them, join them" (Johansson et al 2013). Here there is a field where Sweden can be leading as a role model and LTU one of the major research actors.

UPSKILLING, DESKILLING, OR RESKILLING?

The visions of fully automated factories, Industry 4.0, and Internet of Things not only change the technological landscape of industrial workplaces and organizations, but also cause a qualitative knowledge transformation – from bodily and tacit into more abstract and theoretical knowledge and skills. In the optimistic view, we can read that Industry 4.0 requires workplace learning as well as continuous education and systems that make use of the workers' skills – i.e., a learning organization. Using Kern and Schumann's concepts (1974), we can see a clear transformation from the craftsman-like qualification into more technical qualifications. The new demands for teamwork, responsibility, and comprehensive understanding of production flow can be seen as a movement from qualifications dependent on the process to qualifications more independent of the process. What was earlier the workers' tacit knowledge will be formalised into theoretical knowledge, digitalized, and used in computers and smart phones. In this transition, we can see contradictory movements of upskilling - rapidly changing skill demands and more theoretical, comprehensive, and communication tasks - and deskilling - fragmentation of individual craft knowledge and whole tasks.

Whether it is a question of upskilling, deskilling, or reskilling, the transformation of knowledge affects workplace cultures, community of practices, and identities. Individuals and organizations will have to create and recreate qualifications, identity, and gender when meeting new technology in a changing context. For example, the new knowledge and skills

needed may be more abstract and theoretical, but still based on bodily and tacit knowledge although in new and less physically demanding forms. A common optimistic scenario gives women and other previously underrepresented groups a chance to enter and master different types of industrial work such as in mining and process industries. Given that this scenario is realized, it does not entail a smooth and unproblematic process. The identity and symbolic aspects of work often lag behind the developments in, for example, technology and qualification demands, resulting in restoring responses during processes of organisational changes. As the workers' collective is built and sustained by processes of homosocial interaction and identification and on norms controlling likeness between workers, there is reason to investigate how new technology affects these processes. The seemingly robust gender and power relations will be challenged, renegotiated, and ultimately transformed.

As a technical university, we must be aware of this development and prepare our students on how to handle this development. The technology and its implementation is not written in stone, but something that is highly possible to influence. Our engineers are first-line actors in this work, both as designers and implementers.

CHANGED GENDER PATTERNS

One of the hopes of the technological development in the industry is that it will allow for changed gender patterns: a better work environment combined with higher qualification demands that will enable more women to work in the industry, creating better gender equality. But the picture is not so clear-cut. At many industrial workplaces where digitalization is taking place, it is quite common that technology is associated with masculinity. This masculinization of technology is evident in the discourse of the technology as well as in the culture of these companies. At traditional male-dominated industrial workplaces, such as mining, even if the workplaces undergo digitalization, the connection to masculinity lingers because of the old strong symbolic links to a traditional blue-collar masculinity. For example, the mine is often associated with explicit expressions of a special type of masculinity, "macho-masculinity", which is almost difficult to take seriously and analyse. The fear of being seen as less masculine is a common theme in these kinds of workplaces. Here men, more than in other workplaces, find it difficult to be associated with competences, attitudes, or behaviours that have a female gender-code or have associations with unmanliness. As a result, we can see an interesting and seemingly paradoxical tendency that workplaces and work tasks introduced as a result of automation, computerization, and roboti-

zation can undergo a process of “feminisation” while the men hang on to the old technology. One example of this is when the mining workers underground, half-jokingly give the remote control workers sitting above ground nicknames such as “the velvet workers”, meaning that they are of a soft unisex type of men, almost feminine, and not ‘real’ workers. On the one hand, this trend opens up for new gender constructions in industry; on the other hand, this trend can be seen as a symptom of a conservative organization, i.e., barriers to implementing the new technology and therefore important to study and understand.

At workplaces with a more gender-balance, male workers may attempt to restore the existing local gender order by telling macho-masculine stories, refusing to do ‘women’s work’ or ‘womanish work’, and openly resisting women at the workplace. In these workplaces, ideas about gender – femininities and masculinities – often are so conservative they can create trouble during organizational changes and the implementation of new technology.

Gender is something people do and construct in social interactions, embedded in work identities, work organisations, and technology, formed by complex societal processes and notions of masculinity and femininity. Many attitudes, norms, and cultural symbols at work that are learned through workplace socialization are connected to gender and the (unequal) gender order. Tacit collective agreements and a continuous dramatization of gender both restore and change our ways of seeing masculinity and femininity. This play does not become really visible unless the existing masculinity and femininity are threatened, such as in the transformation towards a digital industrial context. Even if such processes often are connected to the restoration of the unequal gender order they are situated in, these processes are continuously changing and there is a possibility to challenge and transform these processes.

LTU has a unique position in gender and technology as one of the few universities that have manifested the importance of the subject by setting up a chair professorship.

SHAPING AN A AND B LABOUR MARKET

In the optimistic visions smart systems, automation, and remote control will take over dangerous as well as routine work so that production personnel can focus on learning, creating, and valuing work tasks in a safe environment. Even if the development will not be as the positive visions predict, depending on how the new technology is developed and interpret-

ed, there will most likely be new types of industrial work, new types of work environments, and thus new work environmental problems. For example, digital technology and remote control together with the emerging global and sometimes boundary-less work not only results in increased freedom to decide how and where to work but also results in higher demands of availability, perhaps 24 hours a day, seven days a week. This change may blur the boundaries between work and private life. Moreover, since the ability to control and monitor the individual increases, there will be a risk of new psychosocial stress. An increased information flow and accessibility could also lead to anxiety and job strain.

Other examples come from enhanced possibilities of production distribution, decentralisation, and outsourcing, both locally/regionally and in the global context. This creates dynamic systems of contractors, agency staff, and other actors temporarily active in the same physical workplace or in the same virtual/digital workplace. As mentioned above, the employment form as we know today might dissolve and be replaced with crowdsourcing and what can be called liquidised employment (Holtgrewe, 2014), complicating the coordination of work environment interventions and responsibilities.

We might also expect that old work environmental problems will appear in new contexts and for other groups of workers. Some workers may participate in shaping the systems while others will become machine assistants or handle the repetitive and low qualified work tasks that could not be integrated into the automated and smart systems and the learning organisation. Maybe it is time to revive the old debate about the A and B labour market (Braverman, 1974; Kern & Schumann, 1974)?

ROBOTS AS WORKMATES

Yet another field calling for research is the design of the technology innovations and systems forming the new industrial landscape. The research in this area makes it clear that much of the focus lies on the technological development and more specifically on how technology could replace humans. This approach is appropriate as one of the goals is to make machines sense and act without human intervention or with minimal human involvement. This development stems from a goal to increase effectiveness and reduce humans from dangerous or complex tasks. However, this development could in the end turn out to be ineffective if the human role within the human-machine system is disregarded. If the human role in the system changes, the skill and effectiveness of the human will probably change too. The design of systems and the interplay between human and machines may affect how the work force develops.

A poorly designed system and a transition from active to passive processing, as in monitoring, could reduce situational awareness and put the operator out-of-the-loop. If automation reduces the human work to monitoring, there will be problems with reduced manual control skills, cognitive skills, and vigilance and a risk of ending up with work tasks that are boring although very responsible. There is also an added risk when technology is overly-trusted (complacency) and this could eventually add to workload. A well-designed interface could reduce workload by helping the worker sort and pick relevant information. On the other hand, a “clumsy” interface, one that is hard to engage and that requires extensive data entering, could increase cognitive and physical workload demands. Another issue is the handling of integrity and privacy. The technology could be used to track users and to control workers rather than the process. In a safety critical situation, this type of human tracking might be welcomed, although the information could also be misused. These issues are important to address as technology develops towards the smart factory or Industry 4.0.

Robots as workmates will soon be a reality. A crucial gap that still needs to be filled before robots are integrated in real-world settings is that they must ultimately be accepted by humans in the human social sphere. An essential factor playing a role in acceptance of robots is their ability to react appropriately to human social signals and to follow norms of human behaviour. In short, it is crucial to identify parameters of robot behaviour that allow for social attunement with humans. Here, attunement is understood as the process of engaging brain mechanisms allowing for smooth communication and cooperation. An example of such a mechanism is joint attention. In the context of human-robot interaction, studies using robot faces presented on a computer screen have shown that robots do not evoke joint attention, as other humans do.

FUTURE WORK: PATHWAYS AND IMPLICATIONS

For citizens in a democratic societal context, it is a civil right to be involved in shaping their own future. For many, however, in organizational work contexts characterized less by democracy and more by hierarchical power asymmetries and (increasingly precarious) wage labour contracts, the diffusion of new technology into their working life is sometimes perceived as a rather deterministic process where their discretion is viewed as very limited. Our ambition is to create awareness of what the new technology can mean and for whom, and at the same time generate knowledge that development is possible to influence and control. There is always room to maneuver, for shaping how new technologies can be useful and relevant

to people and society. LTU research within this area is built on the firm conviction that the social dimension must have a prominent place in this process, both in designing the technology and in analysing it from several perspectives.

The design of new technology and new work organisation must be harmonized with both good working conditions and efficient production that can compete in a global market but the quite optimistic scenario described in the Industry 4.0 texts is not likely to become a reality by itself. New technology has not in itself a particular way to alter the effectiveness or working conditions, whether positive or negative. To enable a positive development, the technical and organizational development needs also to include knowledge of the human, the working environment and the organization of work, both the formal and informal organizing.

There are many questions which must be clarified when creating the work of the future. Based on our analysis above, we address four knowledge gaps that need more research in relation to the future work.

1. The relationship between new technology, working conditions, qualifications, identity, and gender must be explored further. This is a major research area that has to be highlighted by many perspectives.
2. The future of the workers' collective in a digitalized working life needs to be studied. On a more aggregated level, this is about the survival of the Swedish labour market model.
3. Crowd-sourcing in an industrial context is a new sector where research is lacking. Present research is largely about the business benefits and focused on knowledge workers.
4. Human-machine interaction must be explored further with a focus on integrity issues.

There are many positive aspects of new technology, probably most of the parts, but there are many questions that must be clarified. The development cannot and should not be stopped, but it requires reflections and considerations so we do not create more problems than we solve. LTU has an important role to play when new technology should be valued and introduced, but that role is not pre-given to us; we have to mark our position by highlighting issues that are perceived as important and relevant. A first step is to ask the right questions.

REFERENCES

Abrahamsson, L. (2014). Gender and The Modern Organization, Ten Years After. *Nordic journal of working life studies*, 4(4), Dec 2014, 109-136.

Braverman, H. (1974). *Labour and Monopoly Capital*, New York: Monthly Review Press.

Furusten, S. (1996). *Den populära managementkulturen*. Stockholm: Ne-
renius & Santérus.

Holtgrewe U. (2014), New new technologies: the future and the present of work in information and communication technology, *New Technology, Work and Employment*, 29(1), 9–24.

Johansson J., Abrahamsson L., and Johansson S. (2013). If you can't beat them, join them? The Swedish trade union movement and lean production. *Journal of Industrial Relations*, 55(3), 445-460.

Johansson, J and Abrahamsson, L (2009). The good work. *Applied Ergonomics*, 40(4), July 2009, 775-780.

Kern H & Schumann M (1974). *Industriearbeit und Arbeiterbewusstsein*, Frankfurt am Main/Köln: EVA.

Lysgaard S (1961). *Arbeiderkollektivet*, Oslo: Universitetsforlaget.

Polanyi M (1967). *The tacit dimension*, London: Routledge.

Regeringskansliet (2016). *Smart Industry – a strategy for new industrialisation for Sweden*. Retrieved on 2018-01-06 from <http://www.regeringen.se/informationmaterial/2016/07/smart-industry--a-strategy-for-new-industrialisation-for-sweden/>.

Romero, D., Stahre, J., Wuest, T., Noran, O., Bernus, P., Fast-Berglund, Å. and Gorecky, D. (2016). Towards an operator 4.0 typology: A human-centric perspective on the fourth industrial revolution technologies. *International Conference on Computers & Industrial Engineering CIE* 29-31 Oct, 2016.

IMPROVING LEARNING OUTCOMES IN THE SWEDISH SCHOOL SYSTEM

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The lack lustre performance of Swedish compulsory schools over the past few decades does not need to define its future. As this report will show, the main challenges facing the Swedish education system do not stem from a lack of resources. The effective implementation of research based innovations and improvements in organization could tackle many of the systemic weaknesses in the education system, thereby ensuring a brighter future. By addressing existing difficulties in the teaching and delivery of the curriculum and ensuring pupils who are at risk are able to flourish, learning outcomes will be improved. This, in turn, will reduce inequality, thereby improving the life-opportunities of young people and maintaining the high standard of living enjoyed in Sweden.

STATEMENT OF THE CHALLENGES FACING SWEDISH SCHOOLS

International comparisons of school performance, most noticeably those developed by the OECD, enable countries to identify trends in learning outcomes. Although these are blunt instruments for measuring the full complexities of learning outcomes, they can identify national trends, and contrasts with other countries can reveal ways to address problems. For several decades, the PISA tests drew attention to declining success in the teaching of science, mathematics and reading comprehension in Swedish compulsory schools. The National Agency for Education's (NAE, Skolverket's) recent initiatives – the Literacy Initiative (Läsllyftet), the Boost for Mathematics (Matematiklyftet) and programmes for improving teacher's knowledge in the natural sciences – appear to have halted the decline, but have not restored Sweden's international ranking. Moreover, these programs only addressed the delivery of the curriculum. Systemic weaknesses, including the recruitment of good teachers, remain so severe that even these gains made may not be sustainable.

The average scores used to rank the success of different nation's school systems disguise the main systemic failure facing the Swedish school system: the differences between high and low scoring pupils have increased sharply and are now well above the OECD average. Moreover, the recent stabilisation in the results is caused by increases amongst the highest performers, whereas the number of low scoring pupils has not significantly changed. Socio-economic factors proffer a partial explanation: in 2006 advantaged students scored on average 37 points more than their disadvantaged peers in science, by 2015 the difference had increased to 44 points. The differences for first or second generation immigrant students are even greater: on average they score 70 points lower in science than non-immigrant students. Even when socio-economic status is taken into account, the difference is almost 60% above the OECD average. These divisions are both a symptom and a cause of an increasingly divided society. Furthermore, the National Agency for Education has identified signs that pupils' psychosocial health is deteriorating. The deterioration of psycho-social health is also reflected in the high levels of truancy. Although only 9% of students had missed an entire school day in the two weeks prior to the PISA test, 54% had arrived late for school. Moreover, the number of High School students who have had their student aid (CSN) money rescinded due to truancy has risen to 7%, the majority (64%) are boys. Arriving late and skipping classes are associated with decreased school success.

The problems in the school system are not caused by a lack of resources. Sweden devotes 6.8% of its GDP to education, considerably above the 5.6% OECD average. The proportion of public funding (97%) spent on education is the highest within the OECD. What is needed is a clearer understanding of the nature of the problems and concrete strategies to address weaknesses. Through both research and education, universities have a pivotal role to play in the success of these endeavors. This report outlines how LTU can contribute to the improvement of learning outcomes in Swedish schools. Three key areas form the main loci of concern:

1. Teaching Performance and Leadership

Ensuring the supply of well-qualified teachers and supporting in-service education is pivotal in all attempts to improve learning outcomes.

2. Inclusive Practices

The education system needs to ensure that pupils who are at risk of exclusion receive the additional support they need. Improvements in the average scores need to be driven by reducing the numbers of pupils who fail.

3. Policy Analyses and Implementation

Policies need to be comprehensible to all actors. The organization and management of responsibilities and resources need to be transparent.

IMPROVING TEACHING PERFORMANCE AND LEADERSHIP

The Swedish Education Act specifies that educational practice, regulations and policies should have a “disciplined grounding of practice in research” but does not specify that the curriculum content should also be grounded in research (Education Act 2010:800 §5). Sweden needs to ensure that teachers’ knowledge of both the subjects they teach and the delivery of the curriculum is based on relevant, rigorously tested research findings. For instance, recent national initiatives, such as the ‘Literacy Initiative’ and ‘Boost for Mathematics’, may explain why the 2015 PISA tests signalled that the decline in learning outcomes has been halted. But they need to be evaluated and the causes of success identified so that accurate knowledge about best practice can be disseminated. In addition, subjects in which Swedish students currently score above the OECD average – such as English – also need to be examined. We need to establish that the success is, in fact, driven by the school system and not, as in the case of English, merely by language proximity. The drivers of success within the Swedish school system need to be clarified in order to build from strength.

Universities like LTU have a critical role to play in providing research-based knowledge of the school subjects. Recent years have seen disturbing developments in other OECD countries (e.g. the rejection of evolution and the promotion of abstinence-only sex education), which must be avoided in Sweden. Swedish universities need to provide future teachers with a strong command of the subjects and inform educational policy by highlighting the need for research-based subject content in schools. At present, pre-service training focuses on pedagogical delivery rather than subject knowledge to the extent that even High School teachers have only 1-1.5 years of subject studies beyond their own school education. In order to keep up to date with research in the field, regular in-service education for practicing teachers is needed. The OECD commission calls for the establishment of induction and mentoring programs to support new teachers and, thereafter, opportunities of in-service training and career development (2017, p.41-3). Swedish teachers are entitled to 104 hours per year for professional development, although this is not currently mandated by law. In practice, this means that the majority of these hours are devoted to planning and policy matters rather than curriculum content. Universities like LTU can provide opportunities for in-service teacher to update and refresh their knowledge of the subjects they teach.

Knowledge of how to deliver the curriculum also needs to be research based. This knowledge is best achieved through collaborations between schools and universities. Research on learning conducted in artificial environments (e.g. brain studies) are necessary, but the findings cannot be generalized to classroom situations without additional research in realistic settings. By involving teacher-researchers in research, universities like LTU can contribute to the maintenance and development of knowledge about effective curriculum delivery. Furthermore, practicing teachers should have opportunities to influence the direction of research by bringing the problems they face in practice to the attention of researchers.

On-going research at LTU has identified that leadership plays a vital role in producing good learning outcomes. Teachers who are strong leaders create environments that facilitate high student performance levels, better learning outcomes, a sense of well-being and the desire to learn. In contrast, teachers whose leadership skills are weak have the opposite effect. Supporting teachers' leadership skills directly leads to improved learning outcomes. At the pre-service level, LTU already provides widely appreciated courses in pedagogical leadership and has recently embarked on a one-year leadership program for teachers in one municipality in the northern part of Sweden (a total of five times over a five-year period), and

there are hopes to include other municipalities later. The content of these leadership programmes is based on research, and the method of disseminating this information will be assessed for its effectiveness in due course (see Öqvist and Malmström (2016) for a more detailed summary).

Evidence suggests that neither Swedish pupils nor their teachers set themselves sufficiently high goals in terms of learning outcomes. The OECD measures attitudes that are known to directly impact on the quality of learning. For pupils, this includes perseverance and feelings of responsibility for their own school success. In PISA 2012, Swedish pupils reported low levels of perseverance: 60% admitted that they gave up “easily” when faced with a difficult problem. The OECD average is 44%. Not only do Swedish pupils lack perseverance, they tend to believe that poor results are caused by something other than lack of effort, for instance, poor teaching. For their part, the vast majority (96%) of teachers in Sweden are satisfied with the quality of their teaching but, as the OECD observes, “some teachers may be too positive about their performance ... it is difficult to match the high sense of self-efficacy of teachers with the low performance of Swedish students in the various international assessments” (2017, p. 42). Among teachers, the problem does not appear to be lack of effort: teachers in lower secondary schools report working a total of 42 hours a week, 4 hours more than the OECD average. This indicates that teachers are willing to put in the necessary work, but need to raise their expectations about pupil performance.

The challenge is thus to raise both pupils’ and their teachers’ expectations for success. International benchmarks, such as the PISA scores, are not perfect, but they show that school systems with fewer resources than Sweden are able to achieve better learning outcomes. Through international collaborations, researchers at universities like LTU can establish realistic goals. The Common European Framework of Reference (CEFR) for languages is one example of such a research-based benchmarking system, but even this needs to be more nuanced if it is to be used to raise standards successfully. Both pupils and teachers need to raise their expectations and feel that they have the support they need to achieve their goals. Once again, teacher leadership has been identified as the key to success.

The features of leadership that pupils appreciate include 1) gaining and sustaining interest, 2) delivering the curriculum in an understandable manner and 3) enabling them to achieve more than they thought they could (Öqvist and Malmström, 2016). Teachers’ leadership skills are cen-

tral to promoting students' desire to learn which, in turn, has a direct impact on learning outcomes. Teachers who lead their students well engage in behaviours such as guiding, supporting, participating, and they are performance-oriented. This enables more students to reach their study goals than those who study under teachers who rely on their students' own self-efficacy to motivate their learning. Moreover, research at LTU has identified that – somewhat counterintuitively – students who have strong self-efficacy are most at risk if their teacher has poor leadership skills. This insight will hopefully push teachers to invest more effort in leading their pupil and encouraging them to strive to learn. The practices of highly successful teachers need to be understood and then disseminated to others. Universities can play a facilitating role in both the identification of factors that lead to success and in the creation of networks that enable the flow of information between actors.

The Swedish Government recognizes that the key to achieving better learning outcomes lies in the teachers, but teaching is less valued as a profession in Sweden than most other OECD countries. Recent government initiatives include salary increases and recruitment programs. Nevertheless, there are still shortages of qualified teachers and some schools are particularly hard hit. Currently, almost 1-in-4 teachers lack a university degree, and this is likely to worsen as more teachers are retiring than entering the profession. Short term measures, such as the 'Teach for Sweden' initiative, may help to alleviate the problem, but a long term strategy is needed. The Commission observes that Swedish teachers lack career development opportunities, and so many of the best teachers leave the profession (OECD, 2014). Teachers' dissatisfaction is not conducive to ensuring a supply of well-qualified teaching staff, which effectively inhibits the creation of a good quality education system. Universities can supply career development opportunities, but such efforts require a more consolidated effort from the government and local educational authorities if they are to be successful.

Teachers perform best when they feel autonomous with time to improve their own skills as well as those of their pupils. On this and the need to ensure guaranteed instruction time, the commission and teachers agree. However, they disagree on how to achieve these goals, the main point of contention is accountability. The commission demands improvements in the reporting and monitoring of instruction time, whereas teachers feel that reporting and monitoring reduces the time available for teaching. One way to interpret this mismatch is to reexamine the nature of the reporting and monitoring tasks. Teachers apparently see little value in

these tasks and would rather interact with learners. Those who receive the reports need to ensure that only genuinely valuable information is collected, and that the information is used in ways that teachers see the benefit. Specialists with business management and accountancy practice could work with education leaders to develop transparent, meaningful forms of reporting. Without a clear understanding of the goals and values of reporting procedures, teachers will not be able to bring about the desired transformations.

In sum, researchers at LTU can contribute to the improvement of teacher's performance and leadership skills by

- Ensuring that the subject knowledge in the curriculum areas is founded on research-based evidence.
- Providing research-based evidence on the best ways to deliver the curriculum.
- Developing and supporting both pre-service and in-service teachers' leadership.
- Creating meaningful international benchmarks and accountability practices.

INCLUSIVE PRACTICES

Promoting quality with equity – a contemporary educational mantra – refers to the need to ensure that at-risk students are identified and provided with the additional support they need to achieve school success. This is particularly important in Sweden where the disparity between rich and poor is growing at a faster rate than in any other OECD country. Nevertheless, some caution must be taken in interpreting the data that identifies which children are at risk. The data only reveal correlations between groups of pupils and their learning outcomes, not causation. In public media reports, this is often ignored. For instance, the data shows that boys are more likely to have problems reading, but this does not mean that boys should be treated as a separate group. If a class contains 5 boys and 3 girls who read poorly, it would be nonsensical for the teacher to treat the boys separately. Moreover, even when a causal effect does seem likely (e.g. in families with illiterate parents), caution is needed as the process of labeling them easily undermines efforts to promote inclusion and equity.

The differences in learning outcomes between advantaged and disadvantaged pupils have increased over the past two decades. The primary associated features are immigrant status and socio-economic background. In

mathematics, only 52% of immigrant pupils manage to achieve baseline competence, compared with 78% of non-immigrant pupils. The tendency for people with similar backgrounds to live together and attend the same local schools has exacerbated this problem and resulted in greater differences between schools. The majority of research on inclusive practices, however, has been conducted in urban environments in the major Swedish cities. The applicability of these findings to sparsely populated rural areas is not self-evident. LTU's location makes it an ideal site for conducting research on the best ways to promote inclusion in rural environments.

Whilst immigrant status is fairly easily identified, other factors that correlate strongly with poor learning outcomes are harder for teachers to detect. The national minorities are not immigrants, but face many of the same challenges, including maintaining their home language(s) whilst attending school in Swedish. Economically disadvantaged students' needs (e.g. lack of a quiet place to complete homework) may not be recognized. The same is true for psycho-social health problems which frequently intertwine with other forms of disadvantage. Whilst most of the profiling that identifies pupils who are likely to be at risk, profiling issues such as multilingualism and learning difficulties is known to cause poor learning outcomes, and the former is discussed below.

There is a delicate balance to be found between identifying pupils at risk and further damaging such pupils with negative labels. Fortunately, a success story in southern Sweden has provided research-based evidence on how to address these matters. In 2007, the first open comparisons of students' results in Swedish schools were published. In one municipality, this revealed that only 76% of the pupils were eligible for High School programmes. Within 3 years, so much had changed that all students were eligible for these programmes. The dramatic improvement was brought about by implementing research-based findings on effective inclusive practices. It is also worth noting in relation to our comments in the previous section that the catalysts for this improvement were bench-marking and raised expectations. The municipality observed that ability streaming was not supported by research, whereas there was considerable evidence that inclusive practices raise learning outcomes. Prior to 2007, 1-in-5 pupils were segregated; thereafter, no pupils were set apart and all classes in the core subjects were assigned 2 teachers. This enabled staff to provide support for those who needed it without labeling them. Once again, teacher leadership was the key to success. Teachers became more explicit in their communication of the learning goals and regularly discussed

learning processes with individual pupils. Other interventions included extra lessons during holidays or 1:1 teaching with a specific goal. More detailed descriptions of how the teachers worked with the pupils are summarized in Persson (2013), who takes care to refute the claim “that the improvement in academic results was directly brought about by moves to inclusion” (p. 1216). Inclusion was part of a larger set of changes implemented. This success story shows how it is possible to identify and address the genuine needs of individual pupils without labeling them. This reflected a changed mind-set for teachers and pupils alike. Another interesting aspect of this programme was that the budget was not changed: resources were reallocated and made more efficient.

In short, the school system has a critical role to play in ensuring that quality is promoted alongside equity. However, resources are not being strategically allocated. If these tasks are to remain with the teachers, more training and support will be needed. Universities such as LTU have a role to play in collaborating with both governmental and local educational authorities to analyze the allocation of resources and to determine strategic action plans. Universities must also incorporate these activities into both pre-service and in-service teaching education.

One group of pupils who are clearly not receiving the support they need at present are multilingual pupils, especially those categorized as “newly arrived”. This term refers to a pupil of school age who has moved to Sweden within the past four years. This is an eclectic group: some pupils are traumatized by war, some have missed extended periods of schooling, others come from highly privileged backgrounds and some are Swedish citizens. This diversity has always posed significant challenges, but the issues have become acute in the recent years. Sweden’s willingness to accept a proportionately higher percentage of immigrants on humanitarian grounds, whilst admirable, has increased the strain on existing resources.

Newly arrived pupils now account for 5% of all pupils in 13-15 age range, and 8% of the 16-18 year old population. Regional variation means that some classes have <20% newly arrived pupils (Swedish Migration Agency, 2016). In the past, these children would have been educated in specially designated schools or classes within ordinary schools by teachers who were specialists in both curriculum content delivery for non-Swedish speakers and in dealing with the special needs of traumatized children. The classes were typically much smaller than regular classrooms, which made addressing individual pupils’ needs easier. Children whose ‘only’

issue was learning Swedish could move swiftly through the program and out into regular classes, whereas children who needed more basic literacy education and/or psycho-social support could move at a slower pace. Unfortunately, this meant that some children remained in these specially designated schools and classes for many years, segregated from Swedish life and opportunities to socialize with their peers and thus feel included.

To address the lack of inclusion, an amendment was made to the Education Act (2010:800) in January 2016. This strengthened the rights of newly arrived pupils and delineated a clear limit as to how long pupils could be segregated (Utbildningsdepartementet, 2017). Newly arrived pupils must be included in regular classes within 2 years and, after 4 years, are no longer deigned to be 'newly arrived' regardless of how successful their inclusion has been. This has led to a sudden influx of pupils who speak little or no Swedish into regular classrooms, but without a support system or even education for their teachers. Well-intentioned as these policies are, research at LTU has shown that the pupils feel more excluded than their counterparts in the old system. Moreover, since these pupils are endeavoring to catch up to a moving target (their Swedish-speaking peers are also developing their language skills, particularly their scientific vocabulary), their language skills typically lag behind their monolingual peers by 6-24 months. The abrupt and arbitrary end to 'newly arrived' pupil status is not always desirable for individuals.

Other children from bilingual homes experience similar problems. Municipalities are expected to provide support for home languages, but in practice the level of support varies greatly between regions and between languages. The lack of qualified home language teachers is acute. Children with National Minority backgrounds are entitled to heritage language support, and they also have additional rights for language support in pre-school, but the form this support should take is not specified and so many municipalities fail to fulfill their obligations. Combined with the aforementioned issues related to newly arrived pupils, current practice cannot be considered inclusive. Moreover, multilingualism is treated as though it were a problem not an opportunity. The system focuses on these children's below average Swedish proficiency, and ignores their remarkable talents in other languages. Their skills should be harnessed. Researchers at LTU are responding to these challenges by providing research and education on successful inclusive practices, teacher leadership and the special needs of multilingual pupils.

In sum, researchers at LTU can promote inclusive practices that will lead to quality with equity by

- Providing research-based evidence on the best ways to promote inclusion.
- Developing and supporting both pre-service and in-service teachers' leadership skills and their ability to recognise and address learning difficulties.
- Providing research and education on the particular needs of groups such as multilingual pupils who are known to be at risk.

POLICY ANALYSES AND IMPLEMENTATION

The OECD and National Commissions addressing their findings have consistently identified the same weaknesses related to policy and accountability over several decades. The most recent report from May 2017 also identifies a lack of commitment and consistency in addressing the problems in the Swedish school system as a problem in itself. In short, the commission finds that Swedish policies are not conducive to supporting long-term change and that there is insufficient clarity concerning accountability. As a result, grass root actors such as class teachers are uncertain about the goals, and there is a general lack of knowledge about who is responsible for bringing about the desired changes. For instance, during their school visits in 2010, the Swedish Schools Inspectorate identified shortcomings related to areas that are the principal's responsibility in 62% of compulsory schools. During the follow-up inspection in 2012, half of these schools (i.e. almost one third of all Swedish schools) received the same criticism, typically because the principal had neither followed up on the 2010 findings nor used the information to develop strategies for addressing the problems identified. (See Lindström and Perdahl (2014) for a fuller overview of the Swedish Schools Inspectorate's view of Swedish schools.)

The challenges facing the Swedish compulsory education can and should be addressed as an organisation issue. As the previous two sections have demonstrated, there are few secrets as to why the learning outcomes in Swedish schools have been unsatisfactory. Good examples of how to address the problems have been identified, and there is sufficient funding. What is lacking is a transparent, consistent policy coupled with accountability that can direct resources, support teachers and raise both teachers' and pupils' expectations. Researchers at LTU are ideally placed to provide research based guidance on the formulation of successful policies.

To understand the main policy problems, a little historical background on the decentralization of education in the reforms of 1990s is needed. Prior to the 1990s, Sweden had one of the most centralized education systems in Europe. In 1990, full financial responsibility for education was devolved to the municipalities along with the power to decide on matters ranging from curriculum choice, as long as national requirements were met, to arrangements for children with special needs. Lump-sum payments were made to the local authorities, without earmarking the amount that should be spent on education. At the same time, reforms that allowed for the creation of independent schools came into force and parents were allowed to choose which school they wanted their children to attend. The impact of these reforms that saw Sweden shift from being one of the most centralized education systems in Europe to being one of the least centralized systems in the space of less than ten years are being debated. Those favoring the reforms value parental choice and argue that competition has raised standards. Those opposing the reforms argue that Sweden's sharp decline on international assessments such as PISA and the increasing disparity between advantaged and disadvantaged pupils are a direct consequence. The commission observes that the data they collect is correlational, which means that they cannot draw such conclusions themselves. However, they do observe that:

The *laissez-faire* approach to implementation of these reforms was deliberate, with the National Agency for Education staying at arm's length to give municipalities the space to allow them to proactively anticipate their new responsibilities. This sudden shift of many responsibilities from the central government to municipalities without the necessary support for capacity building, or human and financial resources meant that many municipalities in the early stages of the reform were insufficiently prepared in terms of organization, leadership and know-how. (OECD, 2017, p. 47).

This description could also be applied to the policy formation on inclusion in relation to newly arrived children. For all its good intentions, the abrupt change in policy has shifted responsibility for ensuring that immigrant children are fully included in school life from the municipalities to the schools without providing the necessary support. Quite simply, teachers have not been trained to address the special needs of these pupils. Their class sizes have neither been reduced nor joined so as to ensure that there were always two teachers in a classroom: options that would enable them to provide the individual support and input these children need. It is vital that teachers receive the support they need as they function as so-called 'street level bureaucrats'.

‘Street Level Bureaucracy’ is a term coined by Michael Lipsky (1980) to describe the actions of social workers, teachers, police, health workers and other public employees as they transform the letter of the law into the experiences of those affected by the law. Street-Level Bureaucrats, in this case teachers, school leaders and other school staff, have considerable freedom as to how they enact policy in their daily encounters with the pupils. Indeed, Lipsky claimed that they have more power than politicians who draw up the policies and thus are, in practice, the policy makers in the field. In other contexts, Lipsky found that street-level bureaucrats may have very different intentions from the authorities who mandate laws, and Schierenbeck (2003) observed that street-level bureaucrats can even undermine the authority of the law if they interpret the regulatory framework differently.

What this means is that the educational reforms demanded by governments through institutions such as the National Agency for Education and the Swedish Schools Inspectorate will only be effective if principals, teachers and other school employees have a shared understanding with the law makers and thus implement policy. In interviews with municipal leaders, the National Agency for Education found that these key actors did not always find the national goals stated in the curriculum and syllabi useful neither when making plans for school development nor when assessing success. The goals were interpreted as broad, long-term visions, not goals that should be achieved with the resources available. This mismatch will undermine all efforts on the part of national agencies until it is addressed.

Researchers at LTU have the expertise to advise regional education boards, teachers and other educational actors on how to form transparent policies that can be concretized in a manner that all actors understand the goals and the actions needed to ensure that the goals are fulfilled at the grassroot level. Clear benchmarking will enable actors to evaluate the success of the changes they implement, thereby making the demands of accountability realistic.

In sum, researchers at LTU can address the problems in forming the desired transparent policies by providing:

- Research based knowledge of how to improve learning outcomes
- Policy analyses that result in transparent documentation which can be understood by all the relevant actors
- Clarity as to which actors are responsible for ensuring each aspect of the policies to improve learning outcomes
- Clear benchmarks for learning goals
- Clear benchmarks for goals related to inclusion
- These benchmarks need to be communicated to pupils, parents and teachers in a meaningful (concrete) manner
- Advice on accountability practices resulting in meaningful measurements that have consequences.

THE FUTURE FOR SWEDEN'S EDUCATIONAL SYSTEM

For over two decades, the OECD has consistently identified the same systemic weaknesses in the Swedish education system. The majority are organizational problems, although the reports also identify a need to improve pedagogical practice. This report took the OECD proposals as its starting point and identified areas where research from an innovation and organization perspective could contribute to improving learning outcomes in Swedish schools.

Sweden's rapid decline in all the core curriculum areas needs to be addressed, and the successes of initiatives that have already been developed need to be evaluated. Long-term success demands consistent policies matched with accountability practices that make sense to teachers and pupils as well as those in governance. The rapid decentralization of responsibilities to the municipalities in the 1990s and the recent decentralization of newly arrived pupils from the municipality to schools were not matched with the resources and know-how to make the transition successful. The teaching profession needs to become more attractive to successful graduates. Improvements in salaries and opportunities for progression are important aspects of this, but a general change of attitude towards education needs to be nurtured. This includes a more general awareness of the challenges teachers are facing on a daily basis and their many successes. It also includes raising expectations across the board. Teachers and parents need to raise their expectations about what their children can achieve; teacher-educators, municipalities and government agencies need to provide realistic, comprehensible benchmarks drawn from international comparisons to set goals. The special needs of children who are at greatest risk of failure need to be identified and addressed.

Researchers at LTU can address many of the challenges facing the Swedish education system. Declining learning outcomes, the shortage of qualified teachers and the increasing disparity between those who succeed and those who do not are issues that need to be addressed in the classroom, through teacher education and through policy. LTU is well-equipped to find solutions and support the process of addressing each problem area. However, the first task that universities like LTU must shoulder is responsibility for ensuring that the general public, as well as teachers and others involved in education, understand the significance of international comparisons and other studies of the school system. By providing the expertise needed to interpret the studies, researchers from LTU can help to avoid sensationalizing the results and steer attention towards the practical implications for school practice. Researchers from LTU engage with the local and national media through interviews, debate columns and through the various forms of outreach such as seminars and workshops. These activities are vital to the improvement of learning outcomes in Swedish schools, as they provide the knowledge that teachers, parents and policy makers need in order to implement change.

The second step is to ensure that areas of strength are protected. One of the great strengths of the Swedish education system is the legal requirement that education should be based on researched evidence. This can protect the education system from short-term measures, but it demands that universities like LTU both produce relevant research and inform the public as well as the research community of their findings. Recent initiatives to address identified problems in literacy, mathematics and science need to be fully evaluated, and the strengths of the programmes need to be fully incorporated into daily practice. Other areas of strength include solid knowledge of the curriculum subjects, and the continuation of university education and basic research in these core subjects must continue.

Bringing about changes that will improve the learning outcomes in Swedish schools will require action on two fronts: policy and teacher education. Whilst it is not the place of universities to form policies, it is certainly important that universities like LTU inform policy makers, and ensure that the implications of policy documents are clarified and implemented appropriately. On occasion, researchers may be morally obliged to draw attention to policies that are likely to cause harm. Researchers at LTU have, for instance, drawn attention to problems in the way in which the legislation concerning newly arrived children is having a negative impact on not only the newly arrived children but also their classmates. LTU's history of examining how policy enactments function at the grassroot

level can play a critical role in ensuring that future efforts focus on maintaining strengths whilst identifying areas of weakness.

LTU is an established site for teacher education. The broad range of programmes available, and recent innovations in on-line teaching and programmes such as 'Teach for Sweden' reach out to a broad range of potential students. LTU enjoys a close working relationship with education boards, schools and daycare centres alike. Plans to improve these working relations further are underway. In terms of research, the challenge is to ensure that the students – whether pre-service or in-service teachers – receive a solid grounding in research-based knowledge of the curriculum, its delivery and the standards that can be expected. At the same time, the special needs of children at risk need to be addressed so that improvements in learning outcomes are also seen amongst students who are currently over-represented among those who are failing. Researchers at LTU have identified the pivotal role of teacher leadership in bringing about these changes; such research and its practical implications needs to continue.

In short, the learning outcomes in Swedish schools can be improved if the following three challenges are met:

1. *Teaching Performance and Leadership* Both pre-service and in-service teachers need research-based knowledge of the curriculum and how to deliver it. They need to raise their expectations and lead their pupils to expect more of themselves as well.
2. *Inclusive Practices* Improvements in pupils' average scores need to come from improvements among the lowest scoring pupils, not just improvements amongst the high scorers. Pupils who are at risk of exclusion, need to be identified without stigmatization and research based findings on how best to promote inclusion need to be implemented.
3. *Policy Analyses and Implementation* Policy analysis alongside research that reveals the practical implications of the policy at the grassroot level is needed to ensure that the above two points become established elements in the Swedish education system.

REFERENCES

Education Act (2010:800). Skollagen (2010:800): med Lagen om införande av skollagen (2010:801) [Education Act (2010:800): with Act on introduction of the Education Act (2010:801)]. Stockholm: Norstedts juridik.

Lipsky, M. (1980). *Street-level bureaucracy: Dilemmas of the individual in public services*. New York: Russell Sage Foundation.

Lindström, L., and Perdahl, S. (2014). The Swedish Schools Inspectorate's View of Swedish schools. *Journal of Education and Learning*, 3(3), 15.

OECD. (2015). *Improving schools in Sweden: An OECD perspective*. Paris: OECD.

OECD. (2017) *Education policy outlook: Sweden*. Retrieved from: <http://www.oecd.org/edu/Education-Policy-Outlook-Country-Profile-Sweden.pdf>

Persson, E. (2013). Raising achievement through inclusion. *International Journal of Inclusive Education*, 17(11), 1205-1220.

Schierenbeck, I. (2003). Vem bryr sig om regelverket?: om frontlinjebyråkrater, handlingsutrymme och förvaltningsdemokratisk legitimitet. In J. Pierre & B. Rothstein (Eds.), *Välfärdsstat i otakt: om politikens oväntade, oavsiktliga och oönskade effekter* (pp. 102-120). Malmö: Liber ekonomi.

Swedish Migration Agency. (2016). *Inkomna ansökningar om asyl 2015*. Retrieved from: <https://www.migrationsverket.se/Om-Migrationsverket/Statistik/Oversikter-och-statistik-fran-tidigare-ar/2015.html>

Utbildningsdepartementet. (2017). *Samling för skolan. Nationella målsättningar och utvecklingsområden för kunskap och likvärdighet* (SOU 2016:38). Stockholm: Utbildningsdepartementet.

Öqvist, A., and Malmström, M. (2016). Teachers' leadership: a maker or a breaker of students' educational motivation. *School Leadership and Management*, 36(4), 365-380.

FUTURE HEALTH

Catrine Kostenius

Good health has always been crucial to people's life situation. Throughout the history of health care, cures for diseases have been discovered, and great strides have been made to allow humans to live longer and healthier lives. However, new challenges arise, for example, mental ill-health in children and young adults, coping with an older population, and servicing sparsely populated areas, such as the Arctic regions. Moreover, increased migration brings unique challenges and living in a digital world increase health risks. However, in every challenge, there is an opportunity. At LTU, health is a prioritized area, with a focus on innovative interdisciplinary research, for example, including the perspective of health in Arctic living, widening educational research to include health promotion, and exploring technology within the e-health field. One possible approach is to support people to increase control over and improve their health at individual and organizational levels, as well as using social innovations to promote health with a "cool" northern perspective.

CHOOSING HEALTH

A common approach when trying to improve health and well-being is to identify problems and those approaches that are not working well. Disease and disparities are often the focus of such efforts. Risks, dangers, and threats to our health are an important part of the healthcare systems and are often talked about and reported on in the media. However, there is an alternative approach – choosing health. This perspective is found in the World Health Organization (WHO) Ottawa Charter on Health Promotion from 1986, which is defined as the process of enabling people to increase control over, and to improve, their health. By making a conscious choice to explore what is well, the possibilities instead of the problems, and finding strengths and positive assets is the starting point when reformulating the current situation.

Viewing what is good in the present can be an effective way to find solutions. Looking for good examples – success stories – and identifying what works well can be a learning opportunity to build ideas on (Ghaye et al., 2008). Inquiring about what is good does not mean overlooking or disregarding the problems, rather it can solve problems by amplifying the good. The importance of such an appreciative inquiry is easily looked upon as natural, obvious, and, therefore, self-evident. However, to claim a rightful place in research and practice, the consequences of such practices need to be critically examined. Sweden has been engaged in health promotion practice and research for over three decades. However, the strength-based perspective is often mentioned in policy documents but is not as widely used in practice as one could hope for (Haglund & Tillgren, 2016).

According to the WHO's Ottawa Charter, the definition of health is the same as in the Constitution of the WHO adopted by the first International Health Conference in 1946. According to this document, health is a state of complete physical, mental, and social well-being, and this definition of optimal health has been used by many over the years, as well as criticized and discussed, although not changed. However, one well-being dimension of health has been added to the WHO's documents concerning the quality of life, which is aspects related to spirituality, religiousness and personal beliefs. The spiritual dimension of health is widening the health definition to include meaning and purpose in life, the experience of awe and wonder, wholeness and integration, inner peace, hope, optimism, and faith. However, one small cultural adjustment in the choice of words is needed in the context of Sweden, which is a secular society. Instead of the word spiritual, the term existential is more appropriate when describ-

ing meaning-making systems and religious beliefs (Melder & Kostenius, 2016). Health can be objectively measured and subjectively perceived, and within these two perspectives, a balance is needed for an individual or group to be able to identify and realize aspirations, to satisfy needs, and to change or cope with the environment as stated by the WHO. To realize this goal, the practical applications of health promotion need to be further developed in future healthcare and healthcare organizations. Therefore, I suggest challenging the problem-based perspective of health once more, looking at the glass as half-full and making a conscious choice to choose health as a point of departure for effective and innovative development for future health.

I focus on five areas of health challenges, which all are highly relevant in Sweden and Norrbotten, fully aware that there is a range of other challenges, especially in the fields of disease prevention, rehabilitation, and care of the severely ill. The following five areas are further developed by keeping the health-promoting perspective in mind, including physical, mental, social, and existential well-being;

1. The unsolved question of health inequality
2. Keeping our children and young adults healthy
3. Young and old – a health journey across ages
4. Living in an (un)healthy digital world
5. Arctic perspectives of health – too cold or “cool”?

THE UNSOLVED QUESTION OF HEALTH INEQUALITY

A research field still current and in need of further development is handling inequality of health. Those newly arrived in Sweden, whether refugees or persons with residence permits, are one of society’s vulnerable groups. In Norrbotten, there has been increased responsibility to supply housing, schooling, and other integration efforts for refugees and unaccompanied refugee children. For this group, belonging and acceptance might be as important as nutritious meals and housing for the experience of health (Hertting & Karlefors, 2013). However, research is needed to be informed about health challenges and health opportunities from the perspective of migrants, especially those coming to the Arctic region. Encounters between people with different ethnic and cultural backgrounds are central in health promotion efforts, which can result in communication difficulties due to a lack of knowledge and preconceived notions. To create reciprocity built on tolerance, where diversity is encouraged, there is a need to examine health dimensions in integration efforts of migrants offered by national and local governmental organizations, as well as civil

society. Problematizing the division of “we and them” when meeting migrants and other people with foreign backgrounds by exploring the meaning of integration, inclusion, acceptance, and empowerment is in need of further examination.

The “we and them” perspective can play an important role in ill-health in other vulnerable groups, such as LGBTQ persons, people with disabilities, insecure finances or in association to gender and unemployment. To be a leader in the implementation of the UN Agenda 2030, the Swedish government aims to achieve gender equality and empowerment for all women and girls (UN, 2015). The recent #metoo movement reminds us how much work is ahead of us. Appreciation of diversity and gender equality based on the UN declaration of human rights permeating all care, rehabilitation, disease prevention, and health promotion efforts is still to be achieved. When promoting health, there is a fundamental need to involve the person. This is because empowerment is a prerequisite for health promotion efforts. Health promotion aims to reduce differences in current health status and ensuring equal opportunities and access to resources, thereby enabling all people to achieve their fullest health potential. Empowerment cannot only be seen as an increased sense of control over one’s own life; it also includes ideas of self-worth and experiencing one’s capacity to make a difference in the world. To realize this, there is a need for a secure foundation in a supportive environment, access to information, life skills, and opportunities for making healthy choices. However, there are limits and boundaries to be aware of, such as power structures influencing people’s lives.

Empowerment can be viewed in dimensions of 1) power to – the capacity or agency to act; 2) power over – to exert control over others 3) power through – ideological forms of power that may reproduce dominant knowledge systems accepted as social truths (Spencer, 2014). With this in mind, alternative viewpoints promoting a conscious choice of the empowerment approach must be communicated, and questions asked on how insights from research can be used to promote health in vulnerable groups. Those in our society that can afford gym memberships, a personal trainer, and a massage therapist when needed can “buy health”. This is not the case for a growing group of people in Sweden. The growing trend for health consumerism, with an implicit message similar to the proverb ‘every man is the smith of his own fortune’ is in dire need of examination. However, Sweden is known for not singling out those in need, but instead including everyone; for example, all schoolchildren are offered lunch at school, and all families receive child support – barnbidrag – not only the

ones in greatest need. By tackling material and social injustice with policy on all levels – governmental, public and private institutions, workplaces and the community – health and well-being will be improved and other social problems are reduced. Political involvement allows the health sector to improve health outcomes in other sectors by multiple stakeholders sharing responsibility. The united action of civil society, for-profit companies, and governmental, and local agencies is an area of improvement and equally in need of further research.

KEEPING OUR CHILDREN AND YOUNG ADULTS HEALTHY

According to the United Nations, millions of young people in Europe are unemployed or not in education, which is of great concern. The connection between education and public health is well-known, and health is also known to affect academic achievement (Backman et al., 2012). The arguments to focus on health literacy in the field of education have increased in recent years (Kostenius et al., 2017). Health literacy is about people's knowledge, motivation and ability to access, understand, appraise and use health information. It also entails action competencies to make judgements and make decisions to maintain or improve their own and others' health and quality of life.

The Swedish National Agency for Education states that schoolchildren's well-being and development should be a focus in schools, and health and lifestyle issues are to be addressed. In the recent guidelines for school healthcare staff in Sweden, the National Board of Health and Welfare, together with The Swedish National Agency for Education, propose that staff contribute to health by promoting school development and to eliminate obstacles for individual students' learning. However, learning in the health area has a history of being on the periphery, lacking in coherence, and having low importance in the hierarchy of school subjects (Aira et al., 2014). Therefore, multidisciplinary practice and research should aim to identify common denominators in the fields of health and education. Considering the competence from professions, such as health educators, health coaches - hälsovägledare, occupational therapists and physical therapists in school and research connected to these professions might help to promote WHO's Health promoting schools in Sweden. In Finland the national school curriculum has been developed to include mandatory health education to increase health literacy of children and young adults (Aira et al., 2014). An increasingly large group of young people in Sweden are not in school or the labor market which need our attention (Lögberg et al., 2018).

In Scotland, the Getting it right for every child policy puts the rights and well-being of children and young people at the heart of services that support them. Investigating the collaborative nature of the work needed within and between education, social work, and child and adolescent psychiatry, and sharing across agencies is necessary and relevant for both research and practice. There are opportunities to give young people a voice and agency, thereby promoting health by various methods, including games, photos, dance, music, and art. The health-promoting effect of being out in nature and using arts (e.g., music and dance) is well-known. Projects using different kinds of art forms have been successfully realized in Sweden. However, there seems to be a need for further research on the long-term implementation of such efforts.

YOUNG AND OLD – A HEALTH JOURNEY ACROSS AGES

Approximately 2 billion people in the world will be over 60-years-old in 2050. Old age can bring physical, psychological, and social changes, increasing the risk of disease and ill-health. Children typically live longer than their parents, but if the trend of ill-health in children and young adults continues, this will no longer be the case. However, the elderly in Sweden are healthier for longer, and most healthcare support is needed in the later part of life. The Director-General of the WHO, Margret Chan, expressed the following regarding implementation of agenda Health 2020, “Maximizing health through all stages of life is a fundamental right for all and not a privilege for a few”. There’s nothing controversial in this statement as equal opportunities for a healthy life is a common goal worldwide. However, how we view health throughout our lifespan can make or break our efforts. Recognizing how aspects from different ages throughout life is affecting health and well-being in the present call for a holistic view of life stages (Sjöblom et al., 2016). However, today human life is commonly viewed with borders compartmentalizing life and healthcare into ages; child healthcare, occupational healthcare, and elderly healthcare. This has consequences for how we talk about health and organize healthcare. The risk of falling “in between” these compartments and the transfer of information and knowledge between them is not successfully administrated. Another concern is referred to as “ageism”, where people past retirement age are looked upon as a homogenous group. However, age continues to be associated with an increased need for care and health care, but there are other competing images of the elderly as active consumers and as active actors on the labor market.

Viewing health with a life-course focus gained attention in the Andorra Statement in the Context of Health 2020, defining the life-course approach as increasing the effectiveness of interventions throughout a person's life. This focuses on a healthy start to life and targets the needs of people at critical periods throughout their lifetime. It promotes timely investments with a high rate of return for public health and the economy by addressing the causes, rather than the consequences, of ill-health. The life-course approach included collecting and using data and evidence from national surveys and scientific research and long-term visions and national and international policy documents. The healthcare sector has led and coordinated most initiatives, and intersectional action has been reported as a fundamental component of all the successful life-course case projects and activities. One of the key messages was to build up societal structures that link health workers, schools, families, and communities to supporting a life-course approach, along with ensuring the existence of a network of services that best respond to population needs. There are some challenges with a life-course approach, and first and foremost it is to share a common agenda for health and then be able to connect organizations for effective flow of information.

One might consider health records as a person's "health passport" throughout life, which is in line with the empowerment aspect of health promotion and would strengthen the patient-centered care movement. Such a "health passport" might promote health in the future with the notion of an empowering structure of health care records, which have been launched in Sweden, allowing individuals to be able to read their medical records on a web-based solution. However, there continues to be some distance still to cover to meet The Swedish government's ambition and Norrbotten's commission to be a leader in the implementation of the UN Agenda 2030 for Sustainable Development. The agenda presents the intention to ensure healthy living and promote well-being, requiring looking beyond organizations and professions. To get away from "health is not my table", there's a need to turn to the settings approach to develop a common agenda for health-in-all-professions. Health promotion demands coordinated action by all concerned; governments, health and other social and economic sectors, nongovernmental and voluntary organizations, local authorities, industry, and the media. Within the life-course approach lies an opportunity for intergenerational exchange, not only to identify each generation's needs, desires, and goals in life, but also to give different groups in society a "voice" (Sjöblom et al., 2016). In-

tergenerational sharing between young and old has been induced by the rapid technological development and can be used in other areas as well. Possible methods and arenas for interactive shared learning spaces making use of life experiences from different age groups to promote health are in need of research.

LIVING IN AN (UN)HEALTHY DIGITAL WORLD

In Sweden, computers, mobile phones, and social media are part of people's everyday life, and there are some negative health challenges in the wake of the technological revolution. Health risks include having low levels of connectedness in relationships, loneliness, sleeping problems, depression, and stress – most people can relate to having had “technique headaches”. Hours spent in front of a screen has increased and, although online communication can offer opportunities, for example, relationship forming, friendship quality, and sexual self-exploration, on the other hand, this brings risks including cyber-bullying and unwanted sexual solicitation. At the same time, there are many e-health opportunities to be found within the digital world, many of which are outlined in Vision eHealth 2025. The Swedish government and the Swedish Association of Local Authorities and Regions support the efforts to make use of the possibilities of digitization in social services and healthcare. This vision will make Sweden the best in the world at the use of digitization and e-health to help people achieve good and equal health and well-being, as well as to develop and strengthen their resources for increased independence and participation in society.

The Swedish eHealth Agency suggest that e-health is about using digital tools and sharing information digitally to achieve and maintain a good level of health. Maybe it is time to widen the meaning of the *e* in e-health – instead of *e* solely as a sign of using electronic processes, perhaps the *e* should stand for equality and empowerment. This is in line with health promotion described by the WHO and will focus on enabling people to increase control over, and to improve, their health. Additionally, this *e* focus on increasing equality by ensuring equal opportunities and resources to enable all people to achieve their fullest health potential.

Digital driven services for public service provision has been used to reach remote areas, and virtual healthcare encounters are increasingly replacing real-life meetings. Health guidance, coaching, and education can be available on demand via smart devices, and social media creates opportunities to promote health and well-being. Students have identified digital solutions such as mobile phones, serious games and gamification

as health promoting tools (Lindqvist et al., 2015; Kostenius et al., 2018; Lindqvist et al., 2018). Another opportunity is using social media in health education in the classroom, enabling the health educators to cater to the millennial generation that has grown up using the internet and social media platforms (Kostenius et al., 2017). Internet is found to be a tool for togetherness in everyday occupations among older adults (Nyman & Isaksson, 2015). Also, there are digital solutions to increase self-empowerment in older adults (Wiklund-Axelsson et al., 2013). However, questions of safety and ethical considerations on the Internet illuminates interesting knowledge gaps. Additionally, there are important differences between real life and virtual meetings. Today we measure heart rate, calories, and steps with an implicit focus on these as important values. Meaning and purpose in life, the experience of awe and wonder, inner peace, and hopefulness are not as easily measured. Interesting research questions surface about measuring aspects of health in contrast to what are important values and activities for a healthy and satisfying life.

ARCTIC PERSPECTIVES OF HEALTH – TOO COLD OR “COOL”?

The residents of the Arctic and subarctic regions are facing many unprecedented combinations of rapid changes involving environmental processes, cultural developments, economic changes, industrial developments, and political changes, which all affect health and well-being. The growing pressure on the Arctic due to climate change, industrial expansion, and demand for natural resources (e.g., ore, gas, and oil) calls for the responsible development of the Arctic region with peoples' health in mind. Additionally, these changes open new possibilities to develop attractive, healthy, and sustainable communities for people and companies in the northern arctic and subarctic regions of the world. The snow and ice can create an attractive outdoor environment, providing activities to promote physical, mental, and social health and well-being, for example, winter biking and kicking – sparka – on ice roads. Municipalities in Norrbotten have also expressed the need for a planning manual enabling urban planners to develop outdoor environments with the help of citizens' experiences to promote health in cold climates. By challenging the urban planning process with a health-promoting aspect resulted in an idea for a green-blue-white plan. This plan combines the central areas of the city's green (leisure) areas, blue (water) areas, and white (snow and ice) areas during the long winter – keeping in mind the needs and wishes of the citizens (Nilsson & Kostenius, 2016). Interesting areas of further research are methods for citizen's participation in urban planning in the Arctic and subarctic regions to ensure health promoting aspects in the cold climates (Chapman et al., 2017).

Environmental challenges due to global warming affect people's lives. Environmental migrants – people who need to leave their home country due to environmental changes – are likely to increase in the future. With a possible increase in refugees, asylum seekers, and migrants coming up north to the Arctic region, issues of health inequalities are undeniable and challenge society as a whole. Increased migration might, on the one hand, curb the declining population in Norrbotten and the northern areas of the Arctic but, on the other hand, increase the need for successful integration of migrants affecting people's health. There are opportunities and at the same time challenges to help this group want to remain in the north, to settle down to live a good life, and contributing to the labor force in the development of the Arctic region. Health is being created and lived by people within the settings of their everyday life; where they learn, work, play and love. However, the arctic mindset (with focus on self-efficacy) creates existential questions affecting health.

Feelings of being on the periphery, not belonging, and low self-worth – being left out in the cold – in contrast with a mindset of living on top of the world and being “cool” is a field of tension where interesting research questions can be formulated in connection to health and well-being. Social innovations are desirable to meet social challenges and enhance capacity to act (Lindberg & Hylander, 2017). This will be necessary when faced with future migration to improve collaboration between local actors and better use of resources to promote health, as well as enhancing the way living in the Arctic is experienced – from feeling too cold to being “cool”. This can be further developed through, for example, the Living Lab method – a citizen-centric approach to innovation (Bergvall-Kåreborn & Ståhlbröst, 2009). The core principals of Living Lab include building trust for good cross-border collaboration to strengthen creativity and innovation (continuity), an open user-driven innovation process to gather many perspectives (openness), and generating results that are valid in real-life situations (realism). Also, the engagement of users is fundamental in Living Lab to motivate and empower the users to engage in these processes (empowerment) and, the ability to detect, aggregate, and analyze spontaneous users' reactions and ideas over time (spontaneity). Forming an Arctic Living Lab to contribute with social innovations promoting health with a “cool” northern perspective calls for multidisciplinary research interlacing health with areas, such as education, architecture, work science, nature, art, and digitalization.

HEALTH - FUTURE PATHWAYS AND IMPLICATIONS

Choosing health in the future can be a challenge if it's put in opposition to prioritizing disease prevention, rehabilitation, and care of the severely ill. Injustice and inequality challenges are so vast in our society that resources are insufficient. However, minimizing pain and suffering for as many as possible is a clear argument for health promotion. During my years in the field of health science with a focus on health promotion, the areas discussed in the text above have grown into topics of interest over some time. Challenges in need of new perspectives have been identified, and LTU can take the lead. The references at the end in this report are examples of interesting research to further build upon. It is with great appreciation to all colleagues who have contributed with their research and discussed directions for future health research. These discussions in research groups and in national and international research networks convinced me that directions for future health need to take place in an interdisciplinary field, where tensions and synergies compete. For research to be useful, there must be a close connection to stakeholders in order to identify societal needs and opportunities, which is important to keep in mind in the following areas:

Closing the health gap – We are well-informed about vulnerable groups where health inequalities are more frequent, for example in migrants, LG-BTQ persons, people with disabilities, and those with insecure finances. It is important to bear in mind that individual, organizational, and population health promotion efforts are fundamentally different, and each is required. Population approaches have been shown to change health norms, which benefits the most deprived. Even though individual approaches have succeeded to some extent, protection of the most vulnerable groups has been limited. The over-reliance on individuals' abilities to make lifestyle changes in combination with the increased consumer focus on a growing health market where "buying health" is an option for some, but not all, risks widening the health gap. Turning "buying health" into "saving health" through incentives like Health Impact Bonds might be a way to not only argue for health promotion but for re-thinking health and sustainable economic investments. This needs to be critically examined to inform practice in the development of health investments to narrow the health gap of inequalities.

Promoting health literacy – To acknowledge research on the connection between health and learning, health education should be prioritized. Health education has traditionally been offered in the maternal and childcare settings, with an unfulfilled intention to continue into the educational

system. Examining experiences in Finland and Scotland in their national efforts for health promotion can be fruitful. With health education as a single subject or integrated into existing subjects in compulsory education raises questions concerning health in the school curriculum and level of health competence in professions in school. Considering professions such as health educators, health coaches - hälsovägledare, occupational therapists and physical therapists in school may be a way to echo the WHO's health promoting schools in Sweden. Additionally, health literacy efforts and research going beyond the educational arena to include young people who are not in school or the labor market is crucial.

Health through the life-course – Unpacking health differently will involve going from compartmentalized by age to viewing health through the life-course, as a journey, thus challenging how health care is organized in Sweden. Using a “health passport” from birth to old age not only increases the need for technical systems to be compatible and safe but professionals cooperating skills to strengthen public health. Further research on illuminating and theorizing intergenerational sharing and learning as dimensions of significance for health and well-being may aid the life-course perspective. There are already some cross-disciplinary projects where people have been met in a collaborative design to develop devices and services by facilitating the creation of new knowledge with an end-user process in mind. Further research is needed on how the participatory aspect can be developed with an intergenerational ambition to overrule age boundaries bringing together young and old. Research methods and arenas for interactive shared learning spaces are needed to make use of life experiences from different age groups to promote health.

Health promoting technology – Although technology can bring health risks and challenges, it can also be a useful tool to promote health. The possibilities are endless; games for health education, health counseling robots, and 24-h health services. However, technology typically decreases the face-to-face encounters between people, which may affect health and well-being. There is a need for a curious examination of changes in interpersonal relationships in the wake of the digitalized everyday life and the problems associated with encounters moving from physical places to places on the Internet. Also, there is need for taking a second look at the measuring agenda in the field of health technology. Today we measure heart rate, calories, and steps with an implicit focus on these as important values. Meaning and purpose in life, the experience of awe and wonder, inner peace, and hopefulness are not as easily measured. Technology needs to be further explored in research with a focus on in-

terpersonal relationships or lack thereof and existential issues to further the health-promoting aspects. Moreover, what would happen if we let the e in eHealth stand for equality and empowerment?

The “cool” northern perspective – The work continues in the search for innovative ideas on how challenges like the cold, the dark, and long distances can be turned into health-promoting tools. Great strides have been made since the first World Health Conference was held in Sweden 20-years-ago and in the recent Joint Arctic Agenda, which involves five northern universities that share resources and create synergies in education, research, and innovation. However, living in the north goes far beyond challenges and opportunities associated with climate. The arctic mindset raises existential questions affecting individual and public health. Also, a co-ownership is needed surpassing collaboration between universities, including the engagement together with municipalities and citizens in this region. Might social innovations created in an Arctic Living Lab contribute towards promoting health with a “cool” northern perspective?

REFERENCES

- Aira, T., Välimaa, R., Paakari, L., Villberg, J. & Kannas, L. (2014) Finnish pupils perceptions of health education as a school subject. *Global Health Promotion*, 21(3) 6-18.
- Backman, Y., Alerby, E., Bergmark, U., Gardelli, Å., Hertting, K., Kostenius, C. & Öhrling, K. (2012) Improvement of school environment from a student perspective - Tensions and opportunities. *Education Inquiry*, 3(1)19-35.
- Bergvall-Kåreborn, B. & Ståhlbröst, A. (2009) Living Lab - An Open and Citizen-Centric Approach for Innovation. *International Journal of Innovation and Regional Development*, 1(4)356-370.
- Chapman, D., Nilsson, K., Larsson, A. & Rizzo, a. (2017) Climatic barriers to soft-mobility in winter: Luleå, Sweden as case study. *Sustainable Cities and Society*, 35, 574-580.
- Ghaye, T., Melander-Wikman, A., Kisare, M., Chambers, P., Bergmark, U., Kostenius, C. & Lillyman, S. (2008), "Participatory and appreciative action and reflection (PAAR) – democratizing reflective practices", *Reflective Practice*, 9 (4)361-397.
- Haglund, B.J.A. & Tillgren, P. (2016) Från Ottawa Charter till Shanghai Statement – en 30 årig resa i hälsofrämjande arbete, *Socialmedicinsk Tidskrift*, 93(2)128-137.
- Hertting, K. & Karlefors, I. (2013) Sport as a Context for Integration: Newly Arrived Immigrant Children in Sweden Drawing Sporting Experiences. *International Journal of Humanities and Social Science*, 3(18) 35-43.
- Kostenius, C., Bergmark, U. & Hertting, K. (2017) Health Literacy in an age of technology – schoolchildren's experiences and ideas. *International Journal of Health Promotion and Education*. DOI: 10.1080/14635240.2017.1369891
- Kostenius, C., Hallberg, J. & Lindqvist, A-K. (2018) Gamification of health education - Schoolchildren's participation in the development of a serious game to promote health and learning. *Health Education*.
- Lindberg, M. & Hylander, J. (2017) Boundary dimensions of social innovation: negotiating conflicts and compatibilities when developing a national agenda. *The European Journal of Social Science Research*, 30(2)168-181, DOI:10.1080/13511610.2016.1204534

Lindqvist, A-K., Kostenius, C. & Gard, G. (2014). "Peers, parents and phones" Swedish adolescents and health promotion. *Journal of Qualitative Studies of Health and Well-being*, 10, 27397 <http://dx.doi.org/10.3402/qhw.v10.27397>

Lindqvist, A., Castelli, D., Hallberg, J. & Rutberg, S. (2018) The Praise and Price of Pokémon GO -Exploring children's and parents' experiences playing Pokémon Go. *JMIR Serious Games*, 6(1):e1 doi:10.2196/games.8979

Lögberg, U., Nilsson, B. & Kostenius, C. (2018) "Thinking about the future, what's gonna happen?" - How young people in Sweden who neither work nor study perceive life experiences in relation to health and well-being. *International Journal of Qualitative Studies on Health and Well-being*, 13(1)1422662, DOI: 10.1080/17482631.2017.1422662

Melder, C. & Kostenius, C. (2016) Existential health – developing and evaluating methods for successful health promotion in a secularized context. Poster presentation vid 22nd World Conference on Health Promotion, 22-26 maj, Curitiba, Brazil.

Nilsson, L. K. & Kostenius, C. (2016) Hälsa på hal is - Gränsöverskridande byggd miljö för god hälsa i kallt klimat [Health on thin ice – transboundary built environment for good health in cold climate]. *PLAN*, 70(3)18-23.

Nyman, A. & Isaksson, G. (2015) Togetherness in another way: Internet as a tool for togetherness in everyday occupations among older adults. *Scandinavian Journal of Occupational Therapy*, 22(5)387-393. ISSN 1103-8128, E-ISSN 1651-2014.

Sjöblom, M., Öhrling, K., Prellwitz, M. & Kostenius, C. (2016) Health through the lifespan - the phenomenon of the inner child reflected in events during childhood experienced by older persons. *International Journal of Qualitative Studies on Health and Well-being*, 11,31486 - <http://dx.org/10.3402/qhw.v11.31486>

Wiklund-Axelsson, S-A., Melander-Wikman, A. Näslund, A. & Nyberg, L. (2013) Older people's health-related ICT-use in Sweden, *Gerontechnology*, 12(1)36-43. ISSN 1569-1101.

ADDRESSING **SOCIETAL CHALLENGES**

We live in a world disrupted. To some of us, it almost feels like it is spinning out of control. In this current rapidly changing and turbulent society, the changes and challenges are indeed many. This book provides synthesis, integration and reflection upon some key societal challenges of our times: Climate and environment, Digitalization, Future work, Health, and how to improve Learning outcomes in the Swedish school system. The book is grounded in the present but essentially future oriented, and seeks to fuel the debate concerning future research investments, vision and profile for our university.