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SUMMARY

Industry 4.0 and Advanced Manufacturing are topics of high international relevance. They are currently the subject of intensive debate both in the academic literature and in the practical context of what has become known as the 4th industrial revolution. They are highly dependent on the availability of an adequate digital infrastructure and well-functioning logistics systems and they have a number of repercussions for cities and regions.

Very little work has yet been done regarding the interrelations between Industry 4.0/Advanced Manufacturing and urban development. Consequently, this acatech POSITION PAPER addresses a new field of academic and practical interest, especially as it also adopts an international development cooperation perspective. The study was carried out in close cooperation with the Indian National Academy of Engineering (INAE).

The position paper is based on a number of expert studies on Advanced Manufacturing, logistics and urban development which have recently been published by acatech (Müller, Herzog, 2015), as well as on the project manager's and main authors' own research, e.g. in India. The results of a joint GIZ, acatech and INAE symposium held in India have also been incorporated into the report.

In the report, reference is made to the German Digital Agenda 2014–2017, the GIZ “Quality of Growth” concept, the GIZ/ICLEI discussion paper on the “Green Urban Economy” and the BMZ document “Managing urbanization – towards sustainable cities”. The discussion on the National Platform City of the Future (NPZ: Nationale Plattform Zukunftsstadt) in Germany was also taken into consideration. On the Indian side, the National Manufacturing Plan, the 12th 5 Year Plan 2012–2017 and the 100 Cities Program of the National Government were among the subjects discussed.

The following results can be highlighted:

- Industry 4.0 is a relevant topic for German development cooperation. It has the potential to support all dimensions of qualitative growth as defined by German development cooperation. Furthermore, it can help to promote a green urban economy and has the potential to make an essential contribution to sustainable urban development.
- The potential of Industry 4.0 regarding the implementation of the new post-2015 international development agenda based on the Sustainable Development Goals (SDGs) defined by the United Nations should be carefully explored and included in the international debate. In the context of the topic discussed here, Goals No. 8., 9. and 11.¹ which are related to economic growth, to resilient infrastructure and sustainable industrialization as well as to sustainable urban development, are of special interest here (UN 2014).
- Industry 4.0 has significant potential to positively impact economic development and to contribute to the sustainable development of cities in developing countries and emerging economies. However, the success of its potential benefits is also dependent on the appropriate economic and urban framework conditions being in place. If they are not in place, less positive or even negative impacts of Industry 4.0 on urban development, such as increased noise levels due to 24 hours transportation and commuter movements, changed logistics requirements due to smaller storage units, etc., may prevail. It is especially important for these framework conditions to be addressed by the BMZ and German development cooperation.
- India is a suitable partner for further action, especially in terms of generating Industry 4.0 and urban development good practice examples and working towards improving the framework conditions for successfully preparing the country for further development. The specific

¹ Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

interest of the Indian industry in Advanced Manufacturing and Industry 4.0 concepts, the extremely difficult, however, improving framework conditions for logistics, as well as severe bottlenecks concerning sustainable and inclusive urban development, and increasingly important demands for a more flexible and locally based urban and regional planning system, play a role here.

Based on these results, the following four recommendations can be made:

- **Carry out an International Industry 4.0 Screening Study:** The study should be global in scope and should identify countries and urban regions relevant to the interface between Industry 4.0 and urban development. The survey should draw on the experience of German industry. Germany's National Academy of Science and Engineering (acatech) could act as a partner and perform a liaison role, owing to its strong links with German industry (through its Senate) and also its strong working relationships with other engineering academies around the world. GIZ, KfW and DEG should also participate and contribute their international experience. The survey could complement an international benchmarking study which is currently under preparation by acatech, although this study focuses on international competitiveness and does not specifically address urban development issues and international development cooperation. Besides analyzing the state of Industry 4.0 as such, its potential positive and negative effects on urban development under different framework conditions should be scrutinized.
- **Develop an Industry 4.0 Readiness Assessment Toolbox:** The toolbox should facilitate informed national and local decision-making. Industry 4.0 will not be a feasible or successful option for development everywhere in the world or even in different parts of the same country. At present, little is known about the supporting framework conditions relating to quality of growth,

economic development, employment and possible integration into international value networks and their impact. It is also not clear which factors are relevant to enabling Industry 4.0 to contribute to a green urban economy and sustainable urban development in each specific case. The toolbox should therefore serve as a guide to national and local administrations for carrying out (rapid) analyses. It should provide elements for an Industry 4.0-related SWOT analysis of the different countries, regions or urban areas. The toolbox should also contain a set of assessment tools regarding e.g. data communication facilities and ICT readiness, cluster analysis, competitiveness and resilience, infrastructure, labor market, general socio-economic characteristics, urban structures and planning instruments, governance and related policies and strategies. The Assessment Toolbox should encompass issues related to quality of growth, the green urban economy and sustainable urban development.

- **Re-examine urban development strategies – Integrate Industry 4.0 Concepts:** Industry 4.0 may facilitate more mixed urban development by bringing the factory back to town, even close to residential areas. This may promote the realization of the "compact city" and the "city of short distances". It is made possible because of two features of Industry 4.0: diminishing lot sizes and the promotion of environmentally-friendly integrated "urban production". However, such positive consequences of Industry 4.0 for urban development will not come about automatically. Numerous bottlenecks and necessary urban and regional framework conditions will need to be addressed, such as negative environmental impact, increase of noise levels due to extended logistics and commuter movement, etc.. Smart, modern planning will also play an important role. Re-examining existing urban development strategies as well as legal frameworks and urban planning systems is therefore indispensable in most countries. Strategically-oriented modern urban

planning practices that directly involve all the relevant stakeholders may help to deliver the potential urban and environmental dividends of Industry 4.0. The BMZ and GIZ should place special emphasis on improving the framework conditions in order to enable the potential benefits of Industry 4.0 to be fully realized. As far as India is concerned, an interesting link could be established with the 100 Smart Cities Program of the Indian Government. In anticipation of the extremely high urbanization rates expected in the coming decades, India is planning to develop 100 smart cities all over the country. Urban retrofits will form part of the program. German development cooperation could contribute its experience in this field and connect the initiative with the results of the NPZ (Nationale Plattform Zukunftsstadt) and the respective Strategic Research and Innovation Agenda of the German government presented in 2015.

- **Create Good Practice Examples – Leading the Way to Industry 4.0:** The good practice examples should facilitate joint learning from practical experience in different sectors and cities. There is a need and opportunity to promote Industry 4.0 in developing and emerging countries in order to keep up with developments in e.g. Germany, Europe, Japan, China and the USA. Joint initiatives could be undertaken in selected manufacturing sectors such as automotive, microelectronics, IT,

pharmaceuticals and food processing in order to explore the opportunities for Industry 4.0 technologies, consult industry with regard to appropriate technologies and their introduction, establish transfer projects and create good practice examples. The creation of international peer-to-peer networks between cities and other institutions could be a first step here to foster international exchange and joint action. As good practice examples cannot be established everywhere at the same time, one approach would be to start with one carefully chosen example agreed upon by all the relevant parties. It should include the most important aspect of Advanced Manufacturing: intelligent production controlling the production processes by Cyber-Physical Systems and incorporating the appropriate Industry 4.0 interfaces/standards between the business, production, and logistics levels, and it needs to include several tiers of suppliers, among them also MSMEs. India could be a suitable country for establishing a peer-to-peer network and good practice case. The good practice example should be geared towards facilitating Industry 4.0-based production and logistics processes among a small set of MSMEs and exploring and supporting the development of favorable framework conditions in a small or medium-sized Indian city. The good practice example should be accompanied by Industry 4.0 discussion fora and standards activities.