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Obstacles and Framework Conditions for Industry 4.0

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6.1 Introduction

- The degree to which Industry 4.0 applications are spread depends on size of enterprise. Large companies produce in high volumes, relatively capital intensively. Constant optimisation of highly automated production is a permanent element of process management. In SMEs the proportion of manual and hybrid activities is much higher. They produce rather for niche markets and often have a high degree of specialisation. In comparison with SMEs, large companies will realise much higher efficiency gains from the use of Industry 4.0 technologies.
- As the range of technological options increases small and medium-sized industrial enterprises will have to take advantage of developments towards networked production. Otherwise their international competitiveness could be threatened. The biggest challenges that small and medium-sized enterprises have to meet in this context are the development of an appropriate strategy, a cost–benefit analysis of the relevant technologies and lack of data security and uniform standards.

6.2 Lack of a Digital Strategy alongside Resource Scarcity

- The availability of consistent data is an important condition on the way to Industry 4.0. Information must be consistently available both vertically and horizontally along the value creation chain.
- One talks in this context of, on one hand, vertical integration, in the sense of the integration of various IT systems into a seamless solution. Compatibility will thus be achieved between the various IT applications, processes and data of the company's functional areas, such as procurement, production and sales. Horizontal integration, on the other hand, is the integration of various process stages between which there are flows of materials, energy and information.
- One example of this is an Enterprise Resource Planning (ERP) system, which takes care of material related, scheduling and capacity planning of order processing and is linked to a Manufacturing Enterprise System (MES) in the company's software architecture. This takes care of short-term, detailed planning and control of individual production orders. Based on such coordination between the various levels of the hierarchy by means of complementary IT solutions efficiency is boosted and throughput times are shortened.

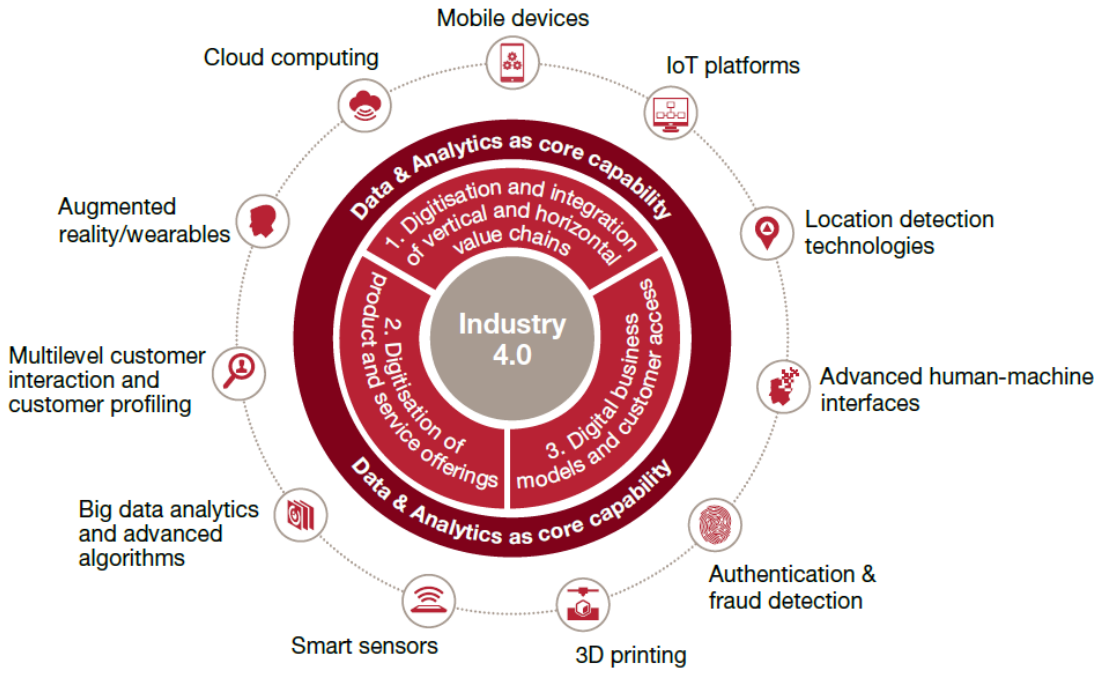

Fig.6.1 – Framework and contributing digital technologies

- The particular set of IT systems, machinery and processes at a given small or medium-sized enterprise tends to have been acquired over time; machines and equipment come from various manufacturers and are of different vintages.
- As a result, it is expensive to retrofit automation software to achieve compatibility. An even bigger challenge for many small and medium-sized enterprises is likely to be to bring about data flow to adjacent internal and external areas in order to enable the exchange of production data horizontally with suppliers and customers and vertically for sales, planning, services or controlling.
- For SMEs this challenge is particularly great because they have less resources and know-how than large companies. SMEs often do not have their own IT department, which means that the managers themselves have to assess the various Industry 4.0 technologies with regard to their technological maturity and business potential. These differences may also be the reason why small and mediumsized enterprises frequently encounter difficulties in selecting the right solution and complain of a lack of user transparency.
- The fact that the networking of production is viewed with some caution by the management of small and mediumsized enterprises is illustrated by the IT *Innovation Readiness Index* produced annually since 2013. This shows that the senior managements of manufacturing SMEs are more cautious about the issue of Industry 4.0 than production managers who were surveyed.
- This reserve on the part of business management is worrying to the extent that the implementation of Industry 4.0 is an extensive task that usually has to be substantially planned and initiated at this level. The task includes the restructuring of processes and company organisation at almost all levels, the adaptation of workers' qualifications and strategic considerations with regard to the development of new business models and the opening up of new markets.
- Without the motivation and involvement of management the dissemination of Industry 4.0 will be confined within narrow limits. The fact that four out of ten SMEs have no comprehensive strategy for implementing Industry 4.0, while among larger companies the proportion is only two out of ten shows that this shortcoming is characteristic of SMEs.

6.3 Lack of standards and poor data security

- ***Lack of standards***: The reservations of small and medium-sized enterprises with regard to switching to new Industry 4.0 technologies and moving forward with the integration of the various IT systems can also be attributed to the lack of standards and norms, but also to worries about unauthorised access to data.
- Although progress has been made in the development of standards –for example, by means of Open Platform Communications Unified Architecture – an international standard has not yet been implemented. This would be important for security of investment, however. Secure standards and norms are also a condition of achieving a high number of network partners and thus of unfolding the economic potential of Industry 4.0.
- At the moment, small and medium-sized enterprises often adapt to the standard of the large company of which they are a supplier. The lack of general standards makes it hard for small and medium-sized enterprises to join value creation networks with different standards and norms and thus narrows their room to manoeuvre.
- ***Poor data security***: Smart factories and supply chains are connected via Industrial Internet of Things (IoT) that makes use of IP addresses to connect and communicate within and outside the production line. Internet-connected devices without proper cyber security measures in place are

always vulnerable to unauthorised access by hackers. Fundamentally, these smart factories face the following challenges when it comes to cyber security:

- **Malware intrusions**: Though many industries use a basic firewall and antivirus, this approach is not enough for protecting an automation system from malware attacks. Intruders can leverage vulnerabilities to get into automation and production systems and turnaround the entire production cycle, creating a mess. It is better to use advanced level cyber security measures like Common Internet File System Integrity Monitoring. Such systems provide an additional layer of security and protection by alerting about unauthorised changes to system files essential for process automation.
- **Modifications to firmware**: Hackers nowadays are proficient in creating alternate versions of firmware which can be infused into an IoT system to create security loopholes or to crash the entire network. As an IoT network includes several devices with least protection, using this method to cripple the whole factory is becoming quite common.

- To deal with such a scenario, modern IT teams should scrutinise every firmware and driver update before installing it into the network. Also, using a user-centric restriction & access system, disabling USB ports on critical systems and restricting unauthorised network access is a good way to avoid such kind of a cyber security issue.
- There is a greater need for making industry 4.0 compliant with acceptable cyber security standards. Using standard approaches to cyber security is not enough in a network with several hundred devices and systems. A multi-layered approach should be adopted that includes implementation of a reference architecture for digital transformation of an industry.

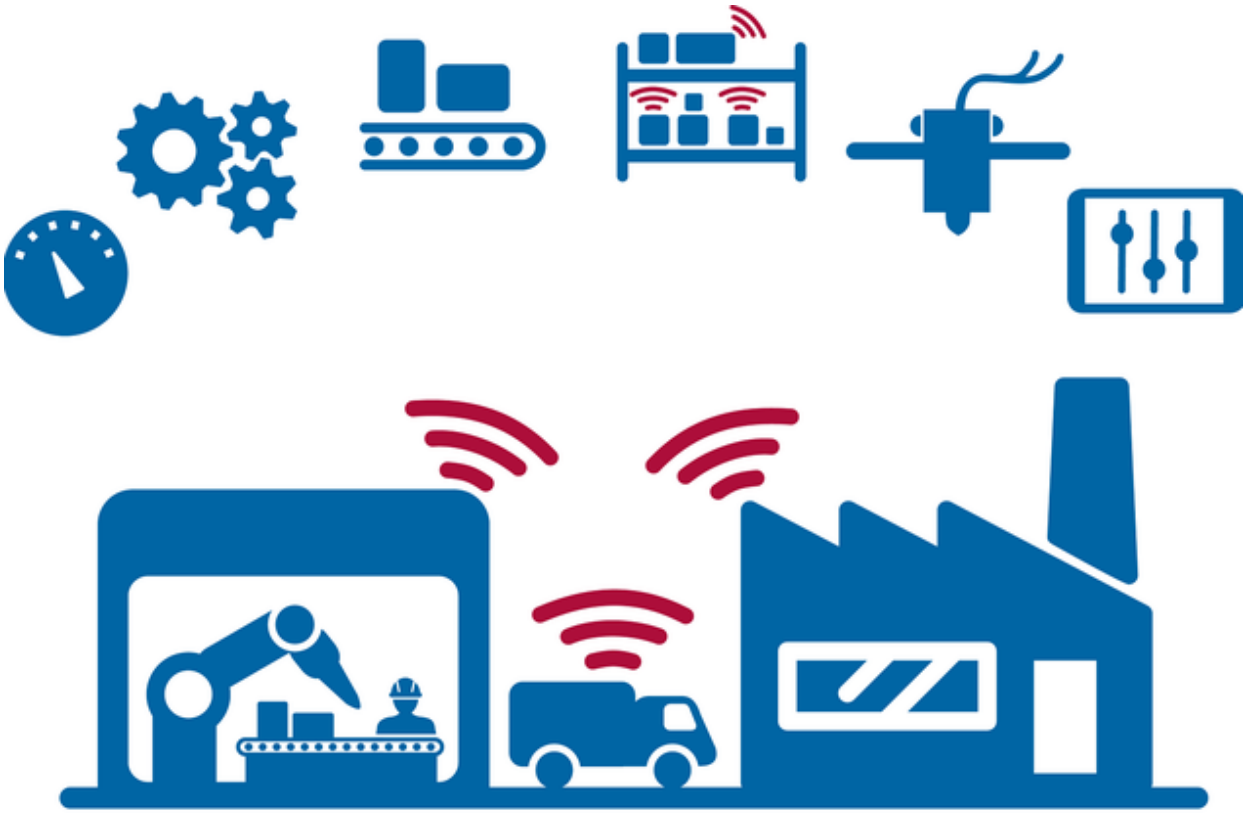

Fig.6.2 – Cyber Security requirement in Industry 4.0

6.4 Financing conditions

- The development and introduction of Industry 4.0 technologies may require substantial investment. Challenges to implement digital transformation tend to pivot around the issue of finance. Manufacturers need to work with a financier which understands the commercial benefits of Industry 4.0; and can make investments sustainable and cash-flow friendly. The financing techniques that enable sustainable digital transformation are becoming known as 'Finance 4.0'.
- Finance 4.0 can help manufacturers ensure they are early adopters of digital transformation and benefit from a strong competitive advantage, before other companies in their sector take the lead. These specialist Finance 4.0 tools include:

i. **Pay to Access/Use Equipment & Technology Finance:** Whether starting a pilot or accelerating implementation, most manufacturers are looking for financial tools to help them acquire a piece of technology, machinery or a system from OEMs without the need to use up their own capital. Early engagement with the right financing partner will enable manufacturers to size and specify the pilot without unnecessary financial constraints; and help build the business case with the freedom to access the 'best fit' technology. Financial solutions will usually be based on a range of options – finance lease, operating lease, rental or hire purchase arrangement.

ii. **Technology Upgrade and Update:** Integrated equipment and technology finance options to upgrade during the financing period offer protection against technological obsolescence.

iii. **Software Finance:** The journey to digital transformation necessarily means deploying combined hardware and software solutions which can deliver digital data streams of performance data that are the key to production optimization, predictive and remote maintenance, and more intelligent manufacturing. This is recognized by specialist financiers that can offer manufacturers integrated arrangements for financing requirements

iv. **Pay for Outcomes:** Savings or gains from access to the technology are used to fund monthly payments.

v. **Finance to assist transition from pilot to mainstream:** Financing arrangements are available that defer payment for a new system or scaled set up until it is reliably up and running.

vi. **Working Capital Solutions:** Manufacturers are under increasing pressure to manage cash flow. Added-value financing services offered in partnership with a specialist financier – usually based on some form of invoice finance – are available to help manage the cash flow challenges that success through digitalization brings.

6.5 Availability of Skilled Workers

- ***Skills*** for industrial 4.0 era is a phenomenon that will changed everything totally. This is a trend of automation and data exchange in manufacturing technology which include cyber-physical systems, Internet of Things (IoT), cloud computing and cognitive computing. Humans as workers must have the capabilities needed by industry as capital to enter the industrial market. Preparing workers to acquire different and new skills is a preventive effort. This can help raise employment rates.
- Sectors whose work is doing routine things may face challenges in keeping up with industry developments. Also, all workers must improve their skills to avoid changing by robot that industry needed cause it less cost, effective and efficient. In this revolution workers must have capability industry needed. Not only hard skills but also soft skills need.

There are four main skills that must be possessed in the face of the industrial revolution 4.0.

1. To have information, media and technology skills, in other terms, must be technology literate which means information, media and technology skills including media literacy, visual literacy, multicultural literacy, global awareness, and technology literacy.
2. To have learning and innovation skills that include creativity and curiosity, problem solving, and risk takers.
3. To be skilled in life and learning such as having a leadership and responsible spirit, having ethical and moral values, productivity and accountability, flexibility and adaptation, social and cross-cultural, initiative and self-direction.
4. To have effective communication skills such as being able to work in teams and collaborating, to have personal and social responsibilities, to communicate interactively, and to have a national and global orientation.

6.6 Comprehensive Broadband Infra-Structure

- Fast and more secure data connections are a basic condition for the realisation of Industry 4.0. Broadband provision is different in all countries, but it is a cause for concern that the International Telecommunication Unit (ITU) already defines a transfer rate of at least 2 MB per second as a broadband connection. This transmission rate is far from adequate for organising inter-company internet-based production or downstream services, such as the evaluation of real-time data.

Fig.6.3 – Industrial network connectivity

- Stable high-speed transmission paths over fibre optic cable are needed for that. Small and medium-sized enterprises, especially in production, are often located in rural areas, where there is virtually no fast fibre optic cable. The need for action to raise fibre optic coverage in a short time in order to unleash the potential of Industry 4.0 for the world, is correspondingly great. Although according to the government's plans extensive broadband coverage of over 50 MB per second is to be available by 2025, this is possible only by means of vectoring technology.
- At least on the basis of copper cables, this technology can be only an interim solution because the achievable transmission speeds will not be sufficient in the future and the vectoring effect in copper cable decreases with length.
- This is compounded at present by the fact that only one telecom provider can offer such a service. This threatens competition and thus more cost effective broadband provision. There is no medium-term alternative to expansion of fibre optic coverage, given the state of current technology. Otherwise smart factories are not feasible. The fibre optic network must therefore be expanded as a matter of urgency.

6.7 State Support

- ***State support*** in India for specific Industry 4.0 projects, requires very large amount of money and time period of five to seven years. The spectrum of supported technology is generally fairly broad.
- Nevertheless, the matic efforts can be identified, based on the amount of funding and the number of projects receiving support, in the research areas of autonomous systems, hardware development and assistance and visualisation systems.
- Software development also receives considerable support. However, according to the authors the focus of support in relation to software development should be shifted towards interoperable, open, sustainable and secure software platforms; for example, a platform for Industry 4.0 apps.
- Overall, the field of application of supported Industry 4.0 technologies lies in production and only to a lesser extent in auxiliary activities, such as logistics, maintenance and product development. Prospectively, these adjacent value creation processes should receive more support in order to boost microeconomic and macroeconomic use of Industry 4.0 across the board.
- Support programmes are directed largely towards small and medium-sized enterprises, although large companies are not excluded. Making an application requires detailed administrative knowledge, however. This and the cost of organising joint research projects is often too much for SMEs. Options for simplifying the application process should therefore be taken into advantage. Similarly, existing measures should be packaged and made more transparent. Finally, putting research results into practice, among other things by demonstrators and prototypes, is also recommended.
- Government has already put the competence centres for Industry 4.0. The different competence centres are supposed for Industry 4.0. Their main task will be, to submit information and consultation offerings and to support small and medium-sized enterprises in the implementation of new Industry 4.0 technologies.
- Close cooperation with the relevant chambers and associations is supposed to ensure regional access to information and to lower the threshold for companies to deal with the issue.
- Overall, government policy is on the right track to raise the awareness of small and medium-sized enterprises with regard to Industry 4.0 and, by means of the above mentioned measures, to provide the push towards implementation.

6.8 Legal Framework

- The data generated, stored, utilised and transferred in the course of automation, like the deployment of new application technologies or product liability, give rise to numerous legal issues. Although these emerging issues are not really new, they can be very complex. On top of that, adjustments required by law cannot be brought about as rapidly as new technological developments and procedures can be implemented. Legal uncertainties, furthermore, are compounded by the networking of small and medium-sized enterprises with foreign companies.
- Although legal uncertainty can often be substantially reduced by drafting contracts appropriately, the complexity of the issues to be regulated represents a barrier to investment for small and medium-sized enterprises, especially those without their own legal department. The legal challenges include the following aspects, among others:

6.8.1 Protection of corporate data

- Data exchange between companies makes it possible for third parties to obtain an insight into their business strategies. It must therefore be clarified to whom the generated data belong and who is entitled to use them. In cases in which the legal protection is insufficient from the company's standpoint individual contracts can be concluded. However, having to conclude a large number of contracts can be an unreasonable expense for individual companies.

6.8.2 Liability

- Who is liable for faulty products? Networked production means that the attribution of sources of error is not a simple matter without implementation of corresponding regulations on traceability procedures. Furthermore, it will have to be clarified contractually who is responsible for damages, and to what extent, when autonomous systems generate inaccurate data or data are accessed by unauthorised third parties.

6.8.3 Handling personal data

- In a smart factory, risks primarily arise when processing personal data relating to staff and customers. Every case of networking between humans and production and logistical systems may lead to personal data being acquired, processed and under certain circumstances transmitted together with other data. Not least when customised products are involved, for example, when data from the production or logistical control systems can be linked to a particular customer. The control of technical assistance systems can require the collection of personal data, whose protection and confidential use must be ensured.

6.9 References

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3) Character of Industrial 4.0 Skilled Workers, Ana A and Danny Meirawan, International Journal of Engineering & Technology.