

WHITE PAPER

Making Industry 4.0 Real - using the acatech I4.0 Maturity Index

A systematic methodology for manufacturing enterprises to assess current readiness and strategize their Industry 4.0 journey





Executive Summary

As technology permeates into the physical world, every element of the value chain can actively contribute to business. Industry 4.0 aims at the convergence of the physical world and digital, creating the world of cyber-physical systems and associated processes to realize immense business value. Detailed industry research and the study from Infosys along with the Institute for Industrial Management (FIR) at RWTH Aachen shows, while companies fully appreciate the phenomenal business benefits Industry 4.0 can bring, they are still seeking guidance and a structured approach to assess their readiness and to strategize their Industry 4.0 journey systematically. This paper presents a preview of the acatech I4.0 Maturity Index that will enable companies to assess their readiness and define the appropriate next steps to realize the full potential of Industry 4.0

Unlike other frameworks, the Industry 4.0 Maturity Index outlined here covers the interplay between enterprise IT, control systems, the lifecycle of facilities and products, and relevant IT and business properties, so companies can holistically examine their readiness for Industry 4.0 to then formulate a comprehensive strategy. Leading research institutions and industry leaders have collaborated to articulate the Maturity Index which provides a systematic approach to assess and assist Industry 4.0 adoption. Also, developing this approach along with acatech, who first came up with the term Industry 4.0, provides a perfect opportunity for the industry to take advantage of this positive development.

Industry 4.0: On your marks, get ready...

While many are still struggling to understand what Industry 4.0 implementation really means to them, in broader terms, Industry 4.0 promises real-time-capability, intelligent horizontal and vertical interconnectivity of humans, machines, objects and ICT systems for management of complex systems in near real time.¹ Industry 4.0 will therefore have a huge impact on manufacturing organizations across the world and is rightly being referred to as the fourth industrial revolution.²

There are multiple strategic initiatives to support organizations successfully manage this huge digital transformation which is currently underway in the manufacturing industry. Also there are ongoing surveys, research and pilot projects trying to establish and tap the full potential of this transformation. However, the early results are inconclusive. Therefore, companies are still struggling or are far-behind their goals in the implementation of a holistic Industry 4.0 approach.

One of the recent developments is the coming together of leading organizations – the Industrial Internet Consortium (IIC) and the Platform Industry 4.0 – announcing to work together to formulate requirements for standardization, to promote interoperability and reduce fragmentation. However, for now, much of the future course of the Industrial Internet remains uncharted, making future-proof decisions and investments difficult.

According to a recent survey, while more than 50% of the companies based in Germany, Japan, and the U.S. expect Industry 4.0 to increase their competitiveness, less than 30 % have an overall Industry 4.0 strategy and even fewer follow a roadmap.³ Currently, companies in Germany are investing only 15% in Industry 4.0 implementation. However, the number of companies planning further investments is set to increase over next five years.⁴ Another study revealed that though only 15% of the companies have “systematically implemented” Industry 4.0 concepts to manage asset efficiency, 48% of them want to become Industry 4.0-enabled asset efficient by 2020.⁵

Looking at these results in more detail, reveals more specific barriers towards a better implementation of Industry 4.0: inherent organizational structure, security concerns and unresolved issues in terms of data ownership, and lack of skilled staff.

To begin with a systematic approach, it is vital to understand the current maturity and define the path a company has to undertake to achieve the next level of maturity. The development of such an approach for producing companies is within the scope of this acatech initiative. In a first step, the Maturity Index is presented for the production process and defines the following six maturity levels. These six levels of Industry 4.0 form the basis for an in-depth analysis of the current challenge in defining the right transformation strategy. This framework therefore describes the approach to assess and measure the efforts of implementing Industry 4.0 and therefore an increase in efficiency and business opportunities for the company.

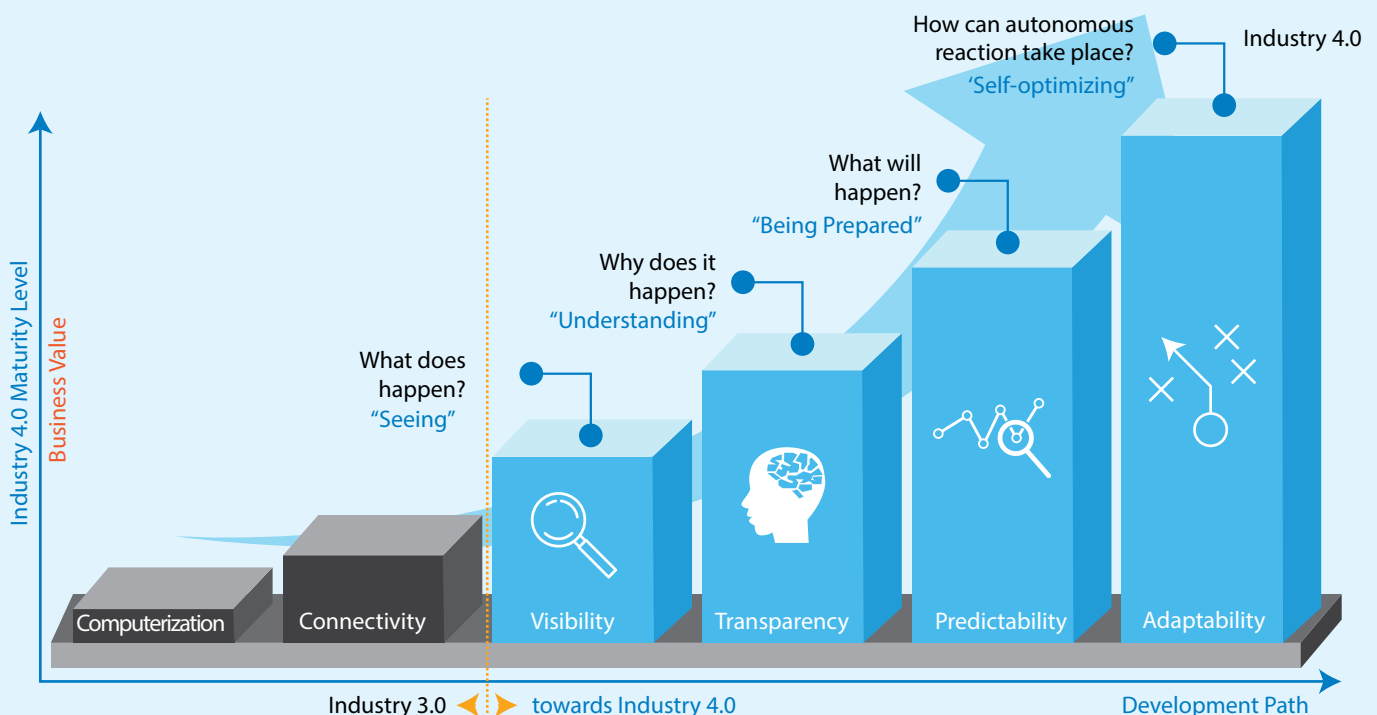


Figure 1: Six maturity levels on the path to Industry 4.0

At the same time Industry 4.0 involves a companywide transformation, and therefore it is important not to focus only on the technical side in the production management and operations IT, but also include the main processes within the organization.

The Industry 4.0 Maturity Index

To gain a deeper insight into their current state of Industry 4.0 implementation, the Industry 4.0 Maturity Index offers a comprehensive methodology using which companies can evaluate their progress, identify specific goals and develop suitable measures to achieve them. In contrary to previously proposed approaches^{8,9}, the Industry 4.0 Maturity Index is holistic and multidimensional.

It defines the following four key perspectives to evaluate Industry 4.0 readiness of an organization: Resources, information systems, organization structure, and organization culture.

Resources in the context of Industry 4.0 include the operational, physical as well as the immaterial resources that are engaged in a production process. **Information systems** include all processes for the collection, organization, storage and communication of information for an effective and efficient implementation of Industry 4.0. The **organizational structure** describes any corporate structure, alignments and regulations to explain how Industry 4.0 activities of task allocation, communication, coordination and supervision are directed toward the achievement of organizational objectives. An organization can be structured in different ways, depending on its objectives. And **culture** basically explains the organization's culture for Industry 4.0 implementation as an opportunity to create a new workplace and industry environment. It is crucial to employ design models that enables responsibility, autonomy, flexibility and a 'culture of innovation'.



To determine Industry 4.0 maturity, each of these perspectives is evaluated based on six dimensions that indicate increasing Industry 4.0 maturity levels. The six proposed dimensions of Industry 4.0 maturity form the basis for an in-depth analysis of the current challenge in the formulation of the right transformation strategy.

In the first stage, "computerization", information and communication technologies (ICT) take up the manual production and support activities in the factory leading to automation or computer-integrated manufacturing (CIM).

On the second level, "connectivity" is implemented in a structured hierarchical manner with defined functionalities. But this is limited to enterprise integration "within company" supply chains, connectivity and automation.

These two levels are the characteristics of previous industrial revolutions driven by rapid advances in computerization and connectivity through to the exponential increase in computing power. The next four are more innovative stages and are defined as "visibility", "transparency", "predictability" and "adaptability" and are inclined to the benefits achieved. None of these stages can be skipped, as they serve each other and one builds upon the other.

An organization with real time data collection capability can have the visibility of its production systems in real-time. A 'digital shadow' is implemented at this stage that has all the relevant information with adequate quality and in real-time for the decision-making purpose. Visibility enables production managers to make information-based decisions rather than experience-based decisions.

Having acquired all relevant information enables the company to reach the next stage of Industry 4.0: transparency. Companies that have transparency understand why past and current events have happened or are happening in the complex systems that have evolved. Decisions are not based on past impacts of choices and historical data. At this level, it is no longer about measuring specific KPIs rather it is about understanding everything to create complete transparency of the manufacturing processes in real-time across production facilities.

The next step to transparency, is “predictability” that enables manufacturers to start focusing more on how they are actually seeing the information, basically starting to analyze the results. Therefore, methods of data analytics such as complex event processing are required to analyze data and event patterns in real-time in big data streams. Event patterns then are

stored and categorized systematically for future analysis. The often used term big data is not precise enough, since only filtered, combined and enriched information are useful. The result is rather smart data and in comparison to big data enriched and context sensitive to gain knowledge about future events. Those are derived from predictions based on the comprehensive understanding of the system dynamics within the company. Requirements are case-based reasoning algorithms as well as the capability to design and assess trigger-event scenarios and their probabilities.

The sixth and last step on the path to Industry 4.0 maturity is “adaptability”. Adaptability is extreme level of connectivity and automation of the system (e. g., the production system) to react automatically on changing exogenous conditions. Those exogenous conditions need not be the ones that occurred in

the past, but the system is trained to self-adapt and adjust to completely new circumstances. Therefore, a deep understanding of all interdependencies within the system and all of its influences is critical.

The Industry 4.0 maturity of a company lies within its structure. Therefore, the already described six levels of maturity are reflected within the four perspectives (see Figure 3). To realize the holistic nature of the maturity index, one company can only reach a certain level when all of its four perspectives have reached the specific level. For example, even though information systems are capable of predictability, the organizational structure must allow the execution of derived decisions with suitable resources. Similarly, a production system that is not able to take measurements derived from predictions into action hinders the success of the implemented solution.





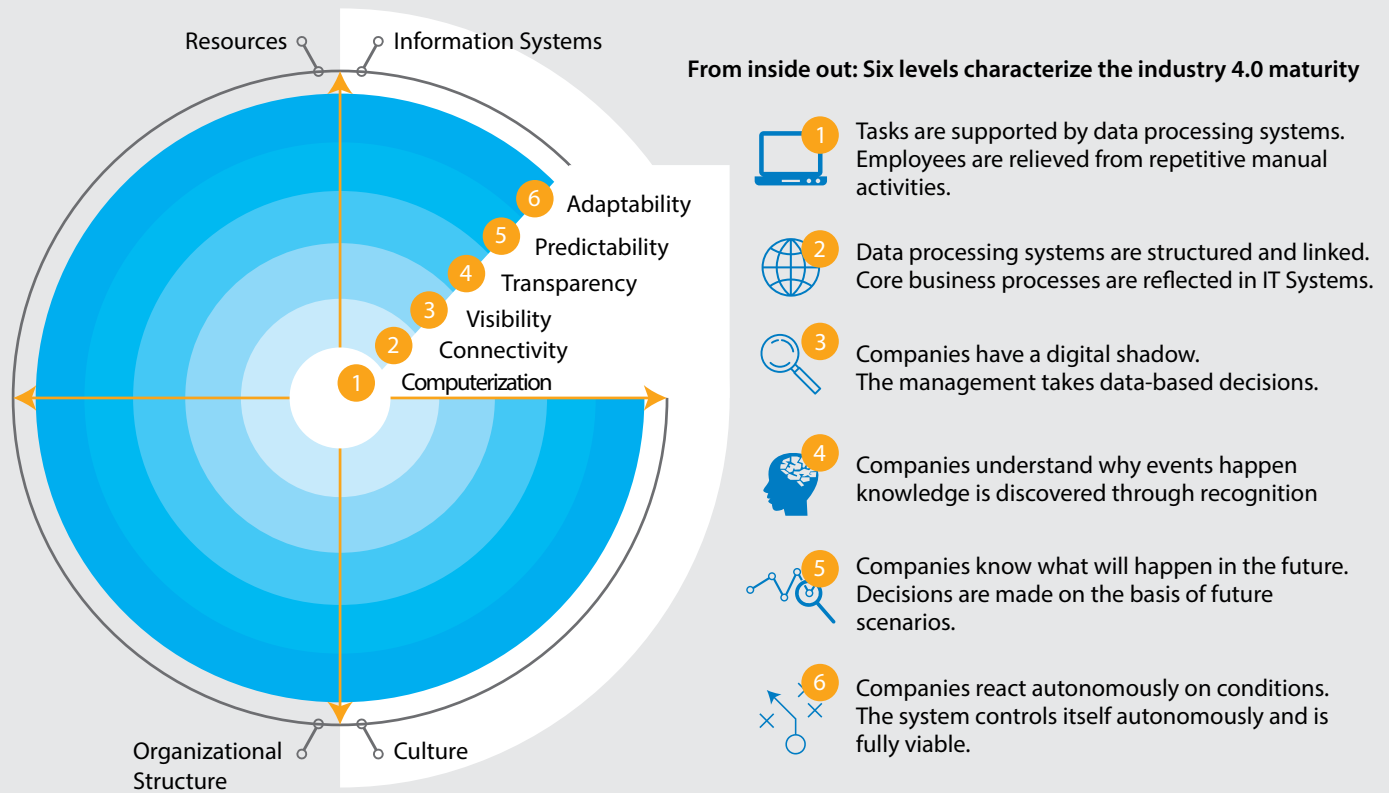


Figure 2: Perspectives on a company's structure and the six dimensions to evaluate Industry 4.0 maturity within each perspective

Conclusion

Building on a global study conducted by Infosys and Industrial Management (FIR) at the RWT Aachen University study, the acatech Industrie 4.0 Maturity Index provides a unique multidimensional assessment that covers not only production and logistics but also includes engineering, service, sales and marketing as well as safety and security to provide a holistic assessment.

This index is developed in a scientific consortium, led by acatech with Infosys and FIR @ RWTH Aachen as the founding partners, along with the leading scientific and industry partners. The research institutions who are part of the consortium include: Industrial Management (FIR) at the RWT Aachen University, Darmstadt University, Paderborn University, Fraunhofer IML, and the DFKI Saarbücken. (<http://www.acatech.de/de/projekte/projekte/industrie-40-maturity-index.html>)

The framework would define specific capabilities needed leverage the benefits of

Industry 4.0 and will support companies to evaluate their own progress, identify specific actions, and derive suitable measures to achieve their strategic goals.

Quote Prof. Dr. Henning Kagermann:

"Research shows that companies are looking for guidance and a systematic method to assess their current Industrie 4.0 level of implementation. This model provides a sound methodology and underscores acatech's goal to promote future technology by facilitating the cooperation between the sciences and business."

Quote Former Infosys CEO & MD, Dr. Vishal Sikka

"As software permeates deeper into the physical world, smaller and smaller physical pieces of the value chain can actively contribute to digital business processes. Infosys is a founding member of consortium because companies need a comprehensive, holistic model to accelerate innovation and the adoption of Industry 4.0"



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