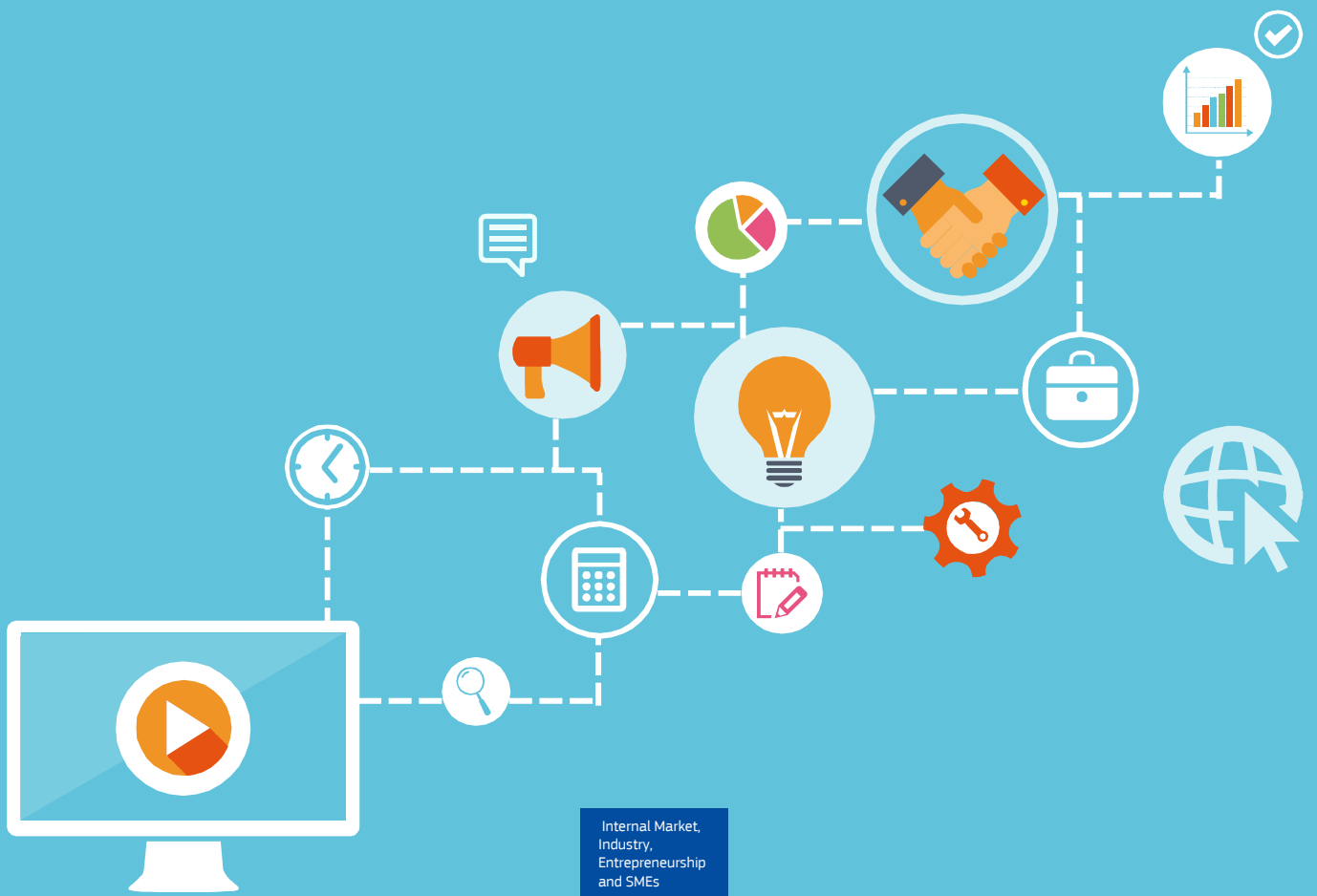




Digital Transformation Monitor

Germany: Industrie 4.0

January 2017





Germany: Industrie 4.0

Fact box for Germany's Industrie 4.0 policy initiative

 Policy Lever(s)	Publicly-backed and steered initiative that is implemented through stakeholder dialogue
 Funding Model	Mixing public funding with private financial and in-kind contributions; offering between a two to one or five to one ratio between private to public investment
 Target audience(s)	Manufacturers/producers, SMEs and policy-makers
 Impact & Focus Areas	Digital innovation and ICT market; transformation of business models and product/service delivery
 Key drivers	Idea development by research actors, reform experience in production and pro-active unions
 Key barriers	Competition among leading ICT players and shop-floor-level involvement
 Implementation strategy	Comprehensive research agenda and I40 platform as a network foundation for digital transformation
 Results achieved	Reducing industry segregation, transforming research agenda into practice, developing reference architecture and launch of platform with 150 members
 Budget	EUR 200 million from BMBF and BMWI that is complemented by financial and in-kind contributions from industry
 Uniqueness factor	Rapid transformation from research agenda into mainstream practice and platform constitute the largest and most diverse I40 network globally
 Value-added for policy-makers	A strategic initiative for consolidating technological leadership in mechanical engineering and for helping policy-makers to push forward I40 at all levels
 Expected Impact	Provide a consistent and reliable framework for developing Germany's competitive position in manufacturing through recommendations and actions

Source: Digital Transformation Monitor

A strategic initiative for pushing forward digital transformation

“Industrie 4.0” (Industry 4.0 (I40)) is a national strategic initiative from the German government through the Ministry of Education and Research (BMBF) and the Ministry for Economic Affairs and Energy (BMWi). It aims to drive digital manufacturing forward by increasing digitisation and the interconnection of products, value chains and business models. It also aims to support research, the networking of industry partners and standardisation.

I40 is pursued over a 10-15-year period and is based on the German government’s High Tech 2020 Strategy. The initiative was launched in 2011 by the Communication Promoters Group of the Industry-Science Research Alliance (FU) that was convened and organised by BMBF and adopted through the High-Tech Strategy 2020 Action Plan. I40 has become institutionalised with the Platform Industrie 4.0 (Platform I40) that now serves as a central point of contact for policy-makers. BMBF and BMWI have jointly allocated €200 million in funding.

Stakeholders consider I40 as a strategic measure to consolidate German technological leadership in mechanical engineering. I40 has managed to limit segregation among industry sectors, to swiftly move research into mainstream practice in a fairly short period, and to scale-up nationally to become one of the largest industry networks of its kind.

Forward-looking, some key challenges concern reaching out to SMEs and adapting management and shop-floor organisation at firm-level in support of the actual I40 implementation.

Digitalisation presents key opportunities

Approx. 15 million jobs in Germany are directly or indirectly linked to the production of goods, meaning that new digital evolutions in industry offer key opportunities for companies.¹ As a leading supplier of industrial equipment at the global-level, the digital restructuring of industry offers plenty of opportunities to boost international competitiveness of German production and better conditions for job creation.

The government launched its High-Tech Strategy in 2006 to coordinate research and innovation actions aiming to preserve competitiveness and to drive forward technological innovation. In July 2010, the High-Tech Strategy 2020 was announced to facilitate Germany’s position as a leading provider of technology, science and innovation in e.g. climate, mobility, health and security.

As part of the government’s Action Plan High-Tech Strategy 2020 from March 2012, ten “Future Projects”, including I40, were developed to support the High-Tech Strategy. In the CDU-CSU-SPD government’s coalition agreement for the legislative period of 2013 onwards, I40 was deemed as vital in ensuring technological leadership.

I40 and the increasing digitalisation through smart factories and IoTS is placed high on the Government’s Digital Agenda, with the digital economy and digital workplaces among the agenda’s focus areas.

Objectives in support of CPS and IoTS

The I40 strategy aims to ensure an industry fit for future manufacturing in Germany. It supports the integration of cyber physical systems (CPS) and Internet of Things and Services (IoTS) with an eye to enhance productivity, efficiency and flexibility of production processes and thus economic growth.

The objective of the I40 platform is primarily to secure and develop Germany’s leading position in industrial manufacturing and to promote digital structural change and a framework to achieve it. It further aims to develop a consistent overall understanding of Industry 4.0 through dialogue with stakeholders, to draw up recommendations for action and to demonstrate how industrial manufacturing can be digitised.

“We must (...) deal quickly with the fusion of the online world and the world of industrial production. In Germany, we call it Industrie 4.0.” – Angela Merkel, German Chancellor

Policy levers for Germany’s Industrie 4.0



Source: Digital Transformation Monitor

Combining top-down, public steering with stakeholder collaboration

I40's policy levers include an agenda-setting, visionary and top-down steering role for the government through the BMBF and BMWI ministries and in the form of strategies and funding. However, emphasis has been given to build up collaboration and partnerships. Idea development and practical implementation is largely carried out by industry, science and social partners e.g. through the National Academy of Science and Engineering (Acatech) and the I40 Platform, but in collaboration with policy-makers.

The main emphasis of the initiative is on technology deployment and structural change of industry by promoting IoTS and CPS in industry processes – with comparatively less emphasis on digital skills. In addition, while the funding model is based on public sources, targeting research, partnership-building, competence centres and test-beds, industry contributions are also complementary sources.

Public funding from BMBF and BMWI

Funding of up to €200 million has been provided by the government, following BMBF and BMWI contributions. BMBF has given €120 million for research activities and calls for proposals targeting areas of IT systems for CPS, IoTS and I40.² BMBF has also provided funding for testbeds, aimed at SMEs in particular. BMWI has responsibility for funding I40's work on standardisation and regulation. It has also offered €80 million in research funding, for example through the "Autonomics for Industrie 4.0" and "Smart Service World" programmes.

Moreover, the public funding behind the operation of the I40 Platform stems mainly from BMWI. The platform however works on a voluntary basis. Only the main office behind the platform receives funding, while the rest of the participating stakeholders finance their own participation and time spent for example legal and technical activities.

Private financing and in-kind contributions

Industry financing is essential for the running of I40 and its platform. Overall, as part of the funding arrangement, industry partners provide in-kind and financial contributions for the research they participate in. SMEs can get up to 60 % in public financing, but typically they have a share of around 50%. Larger companies receive below 50 % in public funding according to EU funding rules.

SMEs would thus typically account for half of the project costs and larger companies for slightly more. In order to receive public funding in research projects, the project participants have to calculate a budget for the planned work. The ministries calculate if budgets and activities are realistic and they also follow up on the financing of the projects, in particular by assessing if the beneficiaries indeed did invest their share of the money.

There is no clear or accepted definition for which activities and research qualify as industry 4.0; the distinctions for what falls under industry 4.0's reach are somehow ambiguous. It is therefore considered difficult by BMBF and BMWI to compile data and quantify figures on how much money is spent by private sector sources. Neither do the ministries ask beneficiaries how much money is invested in I40 activities. An evaluation study has however provided some insights on the leverage effect of public to private finance in I40.³

Overall, there is some variance in the level of private investment return on public funding according to company-size. Smaller IT and technology companies typically provide a two to one ratio between private investment and public funding. For German medium-sized companies, corresponding to the German Mittelstand that covers companies with between 50 and 500 employees, the ratio is just below four to one between private and public financing.

This set of companies work mainly in the production field. However, the technology companies of the same size behave fairly similarly when it comes to the leverage ratio. The larger companies provide approx. a five to one ratio of private to public financing. They however take significantly longer to bring products or services to the market.

A platform for digitalising industry

An I40 research agenda was initially prepared seeking to foster research and innovation and to transfer scientific results into technology development.

The dynamic I40 platform was later developed in 2015 and is tasked to develop recommendations and advise policy-makers on I40 implementation, support the creation of knowledge, standards and examples, mobilise businesses and SMEs, disseminate understanding, promote global networking and ensure the practical operation of I40. The platform initiates, funds and supports research and company-led projects and test-beds and competence centres for the piloting of production systems.

At director-level, the platform is currently chaired by the Minister for Economic Affairs and Energy, Sigmar Gabriel, and the Minister for Education and Research, Johanna Wanka, and by industry, scientific and trade union directors. An industry-driven Steering board has the responsibility for strategy development.

While the Strategy group provides political guidance and agenda setting, the Secretariat and Project office ensure organisation and coordination. A Scientific Advisory Committee is advising on scientific and program-related matters; it has a fund from which it can support projects. Finally, five working groups ensure the thematic work on reference architecture and standardisation, research and innovation, security, legal framework and training.

Target audience – emphasising businesses, SMEs and politics

Aiming to enhance the digitisation of industrial processes and provide know-how for different target groups, I40 targets large corporations, entrepreneurs and in particular SMEs in industry sectors. Representatives from policy, research, social, industry and business domains cooperate to realise I40. FU worked on the initial concepts and launch of the I40 initiative.

On behalf of scientific and technological groups, Acatech provided office functions the initial work. The I40 platform was launched by Federal Association for Information Technology, Telecommunications and New Media (BITKOM), the German Engineering Federation (VDMA) and Electrical and Electronic Manufacturers' Association (ZVEI).

“Plattform Industrie 4.0 (...) has developed into one of the world's largest networks for the digitisation of industry. The platform is a highly sought-after partner (...)” –
Sigmar Gabriel, Federal Minister for Economic Affairs and Energy

Concepts and focus areas - CPS and IoTS enables value creation

The I40 initiative targets knowledge, financial and regulatory framework conditions for enhancing I40. The focus areas are pursued by seeking to integrate concepts such as CPS into manufacturing as well as IoTS into industrial processes, thereby bringing together information, resources and people. The endeavours are expected to improve value creation, work organisation, and downstream services.

In a nutshell, I40 enables plenty of Industry 4.0 related opportunities, including: customer-specific design, flexibility through CPS-based networking; improved decision-making and early verification of design; adaptation of resource consumption; interactive collaboration of workers and systems; and improved work-life balance by flexible work models

A good starting position for I40 rollout

Having maintained a stable manufacturing labour force and know-how simultaneously with an ongoing upgrading of technology in industry processes, Germany had a good starting position for its I40 strategy. It can build on its experience from the 1990s – responding to the “Third Industrial Revolution” - with IT reform in industry and company re-organisation.

Similar to the 1990s, labour unions have been highly integrated in the dialogue and are supportive of technical integration and re-organisation of workplaces. The active role of scientific actors in shaping visions, tools and knowledge has also driven forward I40. Coupled to the benefits of new digital technologies and CPS, companies have displayed significant interest in engaging with research, prototyping and collaboration on I40 matters.

SWOT Matrix for Germany's Industrie 4.0

<p style="text-align: center;">Strength</p> <ul style="list-style-type: none"> Comprehensive framework with broad involvement of policy-makers, industry, science and social partners enables it to push forward I40 at all levels 	<p style="text-align: center;">Weaknesses</p> <ul style="list-style-type: none"> Ensuring actual deployment at shop-floor level, which will become increasingly relevant
<p style="text-align: center;">Opportunities</p> <ul style="list-style-type: none"> International cooperation opportunities and transferability of I40 platform 	<p style="text-align: center;">Threats</p> <ul style="list-style-type: none"> Balancing between different industrial and sectoral interests

Source: Digital Transformation Monitor

A dual strategy design drives I40

From a policy design perspective, a dual strategy was opted for combining a leading market strategy with a leading supplier strategy. The main is to become both, a leading supplier of smart manufacturing technologies as well as to develop new lead markets for CPS technologies and products. Initially, I40 was designed as a research agenda to coordinate research initiatives and promote conceptualisations.

The I40 network platform was later launched and its structured design builds bridges between industry, science, and policy-makers, facilitating coordination and cross-industry exchange of know-how and technological innovation. The design involves a steering role for BMBF and BMWI on the basis of formulated strategies and funding and a vital role for industry actors in driving the practical implementation.

In essence, I40 has been put in place through a cross-sectoral approach, implemented by a long-term and gradual process, combined with migration strategies that can deliver results immediately.⁴

The working group behind I40 – a driving force

The I40 implementation followed a number of steps. After being launched by FU in January 2011, I40 was adopted through the High-Tech Strategy 2020 Action Plan. Based on the High-Tech Strategy 2020, the I40 Working Group, chaired by Dr. Dais and Prof. Kagermann, and working under the coordination of Acatech, was created and funded by BMBF and tasked to formulate an implementation strategy.

The working group delivered its final report in April 2013, outlining actions for an I40 strategy and platform. Following the group’s work, the I40 Platform was set-up by BITKOM, VDMA and ZVEI and it became the implementation mechanism for I40 and coordination.

The I40 implementation have been supported by technology programmes, such as the “Smart Service World” and “Autonomics for I40”, launched to promote IoTS and the Cyber-Physical Production Systems project (2012) aiming to develop CPS modules for production systems.

Overcoming diverse goals and interests

Initially, the key challenge was to bring all stakeholders together. The different goals between companies and trade unions and among competing German industrial groups did initially restrict the platform’s influence in the wider manufacturing landscape. The government had first refrained from joining the platform, but eventually decided to participate and to enlarge the group to improve coordination, collaboration and uptake.

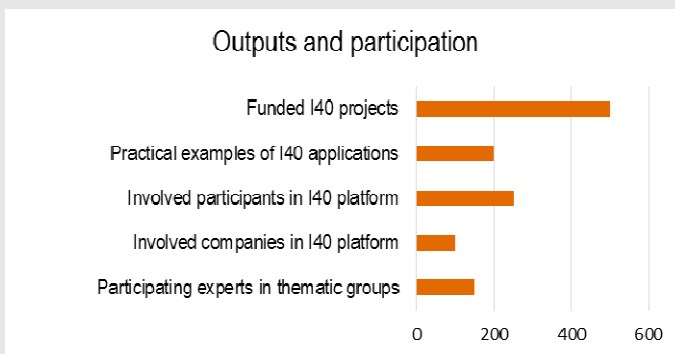
While business associations run the platform, BMWI and BMBF assumed an active role in developing the platform to what it is now, through political leadership and agenda-setting. Having emphasised the advancement of concepts and standards, I40 will need to increasingly address SMEs and the shop-floor level operationally, where much of the actual transformation occurs, in terms of successfully integrating new digital and industry processes and adapting work organisation.

Achieved results: I40 is now mainstream

The Boston Consulting Group expects productivity benefits to be around €90-150 billion over the next 5-10 years.⁵ Overall, I40 enables new ways of creating value, novel business models and helps SMEs to become temporary production networks with precise estimates on their contributions.

Being launched as a research agenda in 2011, I40 has moved into mainstream in terms of collaboration and deployment in a very short time-frame. While it’s still early days, the initiative has been successful in transferring research into practice, e.g. by supporting testbeds and a reference architecture (RAMI 4.0).⁶ BMWi has funded ten I40 competence centres, with five more to come.

Targeted and/or achieved results for Germany’s Industrie 4.0



Source: Digital Transformation Monitor

By facilitating partnerships and dialogue, I40 has also helped to avoid a segregation of industry domains and enabled integrative embedded systems. The I40 Platform is one of the largest and diverse I40 network globally helping stakeholders and policy-makers at drive forward I40 at all levels.

Achieving significant scale at national level and offering global transferability

I40 has since its launch already been significantly scaled up at the national-level through strategy development, structured stakeholder engagement, deployment etc. In terms of transferability, the platform could be considered as a model to follow for many countries, although national industry structures, specialisation and qualifications must be considered.

While Germany with the I40 policy initiative was first to tap into this new way of pursuing industrialisation, the industrial transformation is a global trend; many countries, such as the Netherlands, France and UK, have taken steps to support IoT and CPS in manufacturing.

The vital role of stakeholder engagement and political involvement

One key lesson learned concerns the need to enlarge the I40 platform model with more participants and give it a stronger political basis, in order to overcome competition among industry groups through collaboration on common norms and standards as well as the integration of industry domains. In this respect, data driven business models will become a major driving force of Industrie 4.0 in the future.

Another major factor behind the policy design relates to the importance of engaging stakeholders and the “Mittelstand”, i.e. SMEs, through targeted funding, test-beds, IOT-support and further qualification. The integration of SMEs into I40 and global value chains is vital, since they are less prepared for technological adjustment, due to a lack of specialist staff or unfamiliarity with new technology.⁷

References

- ¹<http://www.bmwi.de/EN/Topics/Economy/Industrial-policy/industrie-4-0.html>
- ²<https://www.bmbf.de/de/zukunftsprojekt-industrie-4-0-848.html>
- ³ Prognos AG (2014) *KMU-innovativ IKT: Chancen für Unternehmen - Förderung im Schwerpunkt „Softwaresysteme und Wissenstechnologien“*
- ⁴ FU and Acatech (2013) *Securing the future of Germany manufacturing industry – Recommendations for implementing the strategic initiative INDUSTRIE 4.0 – Final report*
- ⁵ Boston Consulting Group (2015) *Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries*
- ⁶ BMWi (2016) *Digitization of Industrie – Plattform Industrie 4.0, Progress Report - April 2016*
- ⁷ acatech (2016): *Industrie 4.0 in a Global Context. Strategies for Cooperating with International Partners.* Available on: http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Publikationen/Projektberichte/acatech_STU_engl_KF_Industry40_Global.pdf
- ⁸ Centre for Strategy and Evaluation Services LLP (CCES) (2016) *Industry 4.0 – Study for the ITRE Committee*



About the Digital Transformation Monitor

The Digital Transformation Monitor aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. The site provides a monitoring mechanism to examine key trends in digital transformation. It offers a unique insight into statistics and initiatives to support digital transformation, as well as reports on key industrial and technological opportunities, challenges and policy initiatives related to digital transformation.

Web page: <https://ec.europa.eu/growth/tools-databases/dem/>

This report was prepared for the European Commission, Directorate-General Internal Market, Industry, Entrepreneurship and SMEs; Directorate F: Innovation and Advanced Manufacturing; Unit F/3 KETs, Digital Manufacturing and Interoperability by the consortium composed of PwC, CARSA, IDATE and ESN, under the contract Digital Entrepreneurship Monitor (EASME/COSME/2014/004)

Authors: Demetrius Klitou, Johannes Conrads & Morten Rasmussen, CARSA and Laurent Probst & Bertrand Pedersen, PwC

DISCLAIMER – The information and views set out in this publication are those of the author(s) and should not be considered as the official opinions or statements of the European Commission. The Commission does not guarantee the accuracy of the data included in this publication. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which might be made of the information contained in this publication. © 2017 – European Union. All rights reserved.