Chapter 5
Industry 4.0 and the prospects for domestic automotive suppliers in Poland

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1. Introduction

Industry 4.0 is claimed to be one of the important triggers of smoother work organisation, significant modernisation and higher innovation performance. Industrial policy is currently being modernised in many countries (e.g. France, US, Japan and China) and aimed at the reorientation of national economies towards the requirements of the Fourth Industrial Revolution in order to maintain and restore workplaces or improve competitiveness and added value in the domestic sector (Roland Berger 2016). However, little is known about the role of Industry 4.0 in the potential upgrading of companies driven by the implementation of digital solutions (Szalavetz 2019). As the fourth industrial revolution now underway will dramatically change the way business is conducted, special attention should be paid to the impact of these new enabling technologies on domestic small and medium-sized enterprises (SMEs) and entrepreneurs, who constitute the major part of the local economy in several regions and form critical assets for their successful and sustainable development. The key question is whether the adoption of Industry 4.0 may provide opportunities for small and medium-sized enterprises and entrepreneurs to move up within global value chains (and avoiding stagnation).

Current radical advances in manufacturing technology are often described under the umbrella term ‘Industry 4.0’. The fourth industrial revolution relies on a combination of business and manufacturing processes which, due to the implementation of digital technologies, should allow the integration of all actors in a company’s value chain (Rojko 2017; Gracel and Łebkowski 2018). The following solutions and systems are usually classified as Industry 4.0:

a. cyber-physical systems;
b. various technologically advanced solutions, including:
   — smart analytics solutions;
   — smart decision-support solutions;
   — smart solutions in intra-plant logistics, production scheduling, product development and testing, etc.

Our research on the role of contemporary changes in the domestic sector and on digital transformation is focused on the Polish automotive industry, which holds a significant position in central and eastern Europe (CEE) in terms of its employment growth and overall potential. Part of the integrated periphery of the EU, Poland attracts numerous foreign companies involved in various global production networks. The
share of value-added created in foreign-owned companies has reached 90 per cent in the CEE automotive industry (Pavlínek 2017). Hence, it must be argued that, with low labour costs and a low share of work in value creation (Pavlínek 2018, 2020), the CEE automotive industry (and in Poland in particular) remains export dependent. The extent of domestic companies’ involvement in global production networks is relatively limited (Guzik et al. 2020).

We have investigated whether, and how, Industry 4.0 technologies are influencing the position of domestic suppliers (companies with a dominant share of Polish capital) within value chains in the automotive industry. In this chapter, we argue that a vicious circle exists in upgrading, illustrated by the various constraints being experienced by domestic suppliers. It is argued that positive attitudes towards the introduction of new technologies among managers of domestic automotive companies are rather the exception than the rule. To sum up, we argue that digital transformation facilitates neither the internationalisation of local SMEs or global value chain integration in Poland.

Our research is based both on primary and secondary data combined with a literature review of the position of the Polish automotive industry and the role of domestic suppliers within it. Fourteen interviews were conducted covering successful automotive suppliers (six interviews), ‘digital entrepreneurs’ – providers of Industry 3.0 and 4.0 solutions1 – (six interviews) and key public stakeholders (two interviews) representing institutions promoting the implementation of Industry 4.0 and managers of automotive clusters (see overview in Appendix). Automotive suppliers in the sample were selected on the basis of information obtained from, and the recommendations of, key personnel both among managers of automotive clusters and from IT & automation companies delivering Industry 4.0 solutions to the market. Data collection has been triangulated with a variety of secondary sources of information in order to enhance the reliability of our observations and conclusions.

This chapter consists of three main sections. The next section briefly discusses the Polish context and concentrates on the position of and current changes in the automotive sector in Poland, with a particular focus on the role of domestic suppliers. The main findings of the chapter can be found in section two and these are summarised in the last section.

2. Setting up the Polish context

2.1 Snapshot of the current state of the automotive industry in Poland

The automotive industry is the second largest manufacturing sector in Poland both in terms of production and exports. The role of this industry in Poland has been continually strengthening in the last three decades and, together with other CEE economies, the country has become one of the world’s fastest growing centres of the automotive industry,

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1. Industry 3.0 solutions include robotisation and the automatisation of manufacturing whereas Industry 4.0, as the next step, further entails the digitalisation of production processes.
second only to China. Currently, around 1,000 producers are active in Poland, with total employment exceeding 214 thousand, which makes Poland’s automotive industry the third largest in the EU after Germany and France. This development has been driven by massive foreign direct investment. More than 330 new automotive factories were built in Poland in the years 1989-2017, four-fifths of them by foreign investors (Domański and Gwosdz 2018). The country specialises particularly in components, parts and buses, while the dynamics of passenger car manufacturing substantially lag those of other CEE countries: Slovakia, Hungary and Czechia in particular.

The Polish automotive industry is positioned in the spatial division of labour as an integrated semi- periphery (Guzik et al. 2020; Pavlínek 2012, 2017, 2018, 2020; Krzywdziński 2018). Poland (along with other CEE countries) still performs a dual role, and low value-added and labour intensive products still constitute a substantial part of total output (one-third, according to estimates by Guzik et al. 2020). Gradual industrial upgrading is underway; however, the scope of functional upgrading is relatively limited, especially in comparison with the role of the country in production. Thus, the dependence on foreign firms and the secondary role of indigenous producers (discussed in greater detail later in this chapter) is a significant weakness.

2.2 The role and position of domestic suppliers

There are 280 companies with dominant Polish capital in the broadly-defined automotive sector in Poland (Table 1) and they bring together one-fifth of all employment in the automotive industry in the country. Less than seven per cent of them can be regarded as big companies in terms of employment or revenue (above 250 employees or €50m in revenue). Medium companies represent the core segment of the industry, while small companies are also numerous (Table 1).

Table 1 Automotive companies in Poland with predominantly domestic capital, by size

<table>
<thead>
<tr>
<th>Company size (number of employees)</th>
<th>No. of companies</th>
<th>Employment in thousand</th>
<th>Company size (revenue) in €m (As of 2017)</th>
<th>Total revenues EUR millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 and more</td>
<td>3</td>
<td>5,800</td>
<td>100 and more</td>
<td>2,560.0</td>
</tr>
<tr>
<td>500-999</td>
<td>9</td>
<td>5,628</td>
<td>50-99.9</td>
<td>969.4</td>
</tr>
<tr>
<td>250-499</td>
<td>21</td>
<td>7,198</td>
<td>10-49.9</td>
<td>1,565.5</td>
</tr>
<tr>
<td>50-249</td>
<td>149</td>
<td>20,136</td>
<td>5-9.9</td>
<td>378.4</td>
</tr>
<tr>
<td>10-49</td>
<td>56</td>
<td>1,795</td>
<td>Less than 5</td>
<td>191.2</td>
</tr>
<tr>
<td>No data</td>
<td>42</td>
<td>–</td>
<td>No data</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td>280</td>
<td>40,557</td>
<td>Total</td>
<td>5,664.5</td>
</tr>
</tbody>
</table>

Source: authors’ research

2. Dynamic growth and its implications have been widely documented and discussed in the research literature; see, among others: Domański et al. (2013); Domański et al. (2018); Drahokoupil (2009); Jürgens and Krzywdziński (2009); Krzywdziński (2018); Nölke and Vliegenthart (2009); Pavlínek (2012, 2017, 2018, 2020); Pavlínek and Ženka (2016) and Szalavets (2012).
Domestic suppliers represent all segments of component production, with the largest number being in the manufacture of plastic parts, metal and stamped parts, technological elements and electric components. Three-quarters of domestic producers are, predominantly, tier two suppliers. About 30 per cent deliver at least part of their production directly to OEMs, though only eleven per cent are predominantly tier one suppliers; production in the rest is focused more on tier two suppliers or for the aftermarket. Design competence is most common among tier one suppliers (25 per cent of plants) but very rare among lower-tier producers which are, in the main, subcontractors.

Although there is a clear growth of, and fast learning among, domestic tier one and tier two component producers, which are capable of providing high product quality and reliability of delivery, there is only limited progress in design competence among domestic companies. Only twenty-nine plants have competencies within product design (according to the requirements of IATF 16949). A relatively new trend is the emergence of independent start-ups, offering design and R&D services (for example Cadway Automotive in Rzeszów, CADM Automotive in Kraków and ctrlCAD in Katowice).

The analysis conducted in this research study and also in previous papers (see Domański and Gwosdz 2009; Pavlinek et al. 2009; Guzik et al. 2020) confirm that there is an ongoing development of companies that are participating in the automotive supply chain (reflected in growing revenue, increases in the range of products, development of tooling shops and construction departments and significant activity in obtaining EU funds). This has resulted in some companies becoming product specialists.

A recent phenomenon, which started after 2010 and gained momentum in 2015-2017, is the international expansion of Polish companies. This ‘going international’ trend (whether through greenfield investments or mergers and acquisitions) is associated primarily with the opening of a window of opportunity for Polish companies, which turned out to be the 2008-2009 crisis in the industry (Domański et al. 2013). None of the Polish producers expanded to core (western European) markets before 2010 and, in the early 2000s, only one Polish manufacturer – Groclin – decided to locate its activities outside the country, with the dominant motive being cost reduction. The motivations of companies that began international expansion during the last ten years are fundamentally different from considerations made prior to the crisis – cost-driven expansion has not been a particularly relevant factor in any of our investigated cases. Instead, it has been about the diversification of operations in the entire group (acquisitions made by Boryszew); expansion within the main activity by entering new markets (Wielton, Alumetal, Izoblok, Sanok Rubber); or following customer strategy (greenfield investments by Boryszew and Sanok Rubber). It must be stressed here that most of the Polish companies which have internationalised had previously achieved a significant position in the domestic market, be it in the automotive industry or in other business segments. In this sense, their growth can be significantly interpreted as a staged development in the internationalisation model (IP model, also called ‘Uppsala model’) (Johanson and Vahlne, 1977). The only exception is Izoblok, a Chorzów-based company whose mode of development can better be described by the concept ‘born global’ (Knight and Cavusgil 2004; Madsen and Servais 1997).
The share of manual operations is still significant in the plants owned by leading Polish manufacturers. As one of our key public stakeholders remarked, they ‘are currently in the phase of a difficult leap from Industry 2.0 to 4.0’. Strategies in these companies mostly aim at the comprehensive implementation of automation and robotisation (Industry 3.0), especially in the new production departments of companies launched both in Poland and abroad; however, up to now none of them have clearly declared in their strategy the desire to show strong leadership towards Industry 4.0.

Barriers to the growth of domestic producers in the (semi)periphery to becoming European/global suppliers are stronger now than they were ten to twenty years ago. This is due to: consolidation among the major automotive suppliers; the need to be present in various regional markets (Asia, America, Europe); the growing complexity of supply networks; and greater design requirements. The vicious circle which limits the functional upgrading of domestic suppliers is driven thus: the lack of design competencies constrains profitability which, in turn, reduces investment and development capabilities. A small scale of production alongside a low level of R&D competence has made it impossible to meet OEM expectations – including among the capital and organisational abilities to follow new client projects. Furthermore, small-scale production and the lack of design competencies (and, therefore, prospects for contracts for new projects with higher profit margins) enables the harvest only of ‘transfer projects’, hindering the possibility to upgrade within value chains. Only a few Polish companies have managed to break out of this vicious circle. It must also be stressed that some local companies are quite satisfied with their tier two position, perceiving promotion to tier one status not as an upgrade in their position in global value chains but rather a substantial risk to the company’s existence [Interview COMP-08].

Where can the opportunities for domestic automotive firms be found? Four main areas can be underlined in this regard:

— hybridisation: the involvement of non-automotive segments, or integration with other sectors. Several Polish companies (especially those producing plastics and metal components) combine deliveries to the auto industry with production for home appliances, electronics and construction industries;

— niche products: the ability of Polish companies to acquire competitive advantage has, after the 2008-2009 crisis, been directly related to the cost benefits and greater flexibility achieved from meeting specific customer requirements. This results from the establishment of market niches in the earlier period, above all in labour intensive segments (various products ranging from trailers or semi-trailers for special purposes, construction and protective components made of plastics and aluminium to demanding and technologically-sophisticated production services);

— developing close cooperation with other SMEs, either directly or via cluster initiatives enabling full-service supply thanks to the complementary capabilities of other network participants. This innovative strategy as far as Polish territory is concerned has been promoted by the members of the Polish Automotive Cluster
(PGM), with the members of the cluster recently initiating the establishment of a ‘PGM’ joint commercial brand;

— the aftermarket.

3. Effects and scale of Industry 4.0 in Poland

Major interest in Industry 4.0 solutions in Poland has been expressed by foreign-owned companies. A survey conducted on a large sample of manufacturing companies by Astor in 2017 (ASTOR 2018) shows that a growing number of companies have also started activities aimed at recognising the possibilities of transformation into Industry 4.0. However, the Astor research revealed that only seven per cent of factories had started or partially implemented any Industry 4.0 technologies or solutions (mainly in the form of Manufacturing Execution Systems). Moreover, not only the level of digitalisation but also the level of automation remains low. Hence, companies have first to face up to the third industrial revolution: in 2017, some fourteen per cent of manufacturing plants had still not entered Industry 3.0 (ASTOR 2018). Interest in the automation of manufacturing (Industry 3.0) stems from the decreased cost of technologies but, according to Astor, the *leitmotif* is pressure from customers to reduce costs and shortages of highly-skilled employees. The initial trigger (observed especially in SMEs) is related to price negotiations that do not end up in a deal due to high prices. This is endangering the position of Polish SMEs in supply chains (ASTOR 2018).

Interviews with managers of automotive companies confirm the above data. ‘Many automotive companies are still far from automation. Half automation – we are here. This is a big threat to companies with Polish capital. In order to exist, it is necessary to automate. Some companies do not know how to do it or why they are doing it. They look at it, as they did ten years ago, and then it did not make financial sense because labour costs were cheap. And I have the impression that many companies are still there. In the end, this is an investment and a risk. The problem is that some have overlooked the period when it was necessary to get into automation. Companies must go in this direction and, if they do not go, they will fail. But automation is a change, a challenge for organisation’ [Interview COMP-07].

In interviews conducted among our automotive companies, suppliers of Industry 4.0 solutions and key public stakeholders, three strategies for domestic automotive companies regarding digitalisation have been revealed.

First is the most common sceptical attitude which relies on the passive observation of new solutions. Many Polish companies agree it is necessary to enter the fourth industrial revolution but, for now, they have decided not to implement Industry 4.0 solutions. This is due to several organisational (managerial), financial, intellectual and technological barriers (Table 2).
When Polish managers or owners recognise that, during the implementation of Industry 4.0, there is a need not only to change the technological solution but also to rebuild the whole company in terms of its management, they resign from this path. This obstacle is related to the limited competencies of chief engineers and the fear of exchanges with staff. The following quotation summarises it well: ‘You have to look at this in the concept of habits; these engineers have always acted in such a way – why should they change it?’ [Interview ORG-09]. As another respondent claimed: ‘Polish SMEs have not gone mentally through the development stage – to measure the process and to improve it’ [Interview COMP-01]. Meanwhile, in other departments of the company, especially those in which financial analysis is being carried out, there is increasing wage pressure and a belief that something must be done about introducing automation and digitalisation.

Secondly, the current stream of EU funding is focused on supporting R&D activities, not purely on the implementation of digitalisation or automation itself. Hence, medium-sized companies are gradually implementing Industry 4.0 solutions and technologies after carrying out R&D activities. The introduction of new solutions is being done on a step-by-step basis and so the implementation of Industry 4.0 is not holistic. Such a strategy may even be based simply on a desire to distinguish one’s companies from other suppliers and for higher prestige among western customers (Table 3).

Thirdly, a long-term corporate strategy aimed at full automation and transition to a higher level in the value-added chain ought to be a necessity for many firms. However, radical implementation (a total redesign of manufacturing processes and management) of Industry 4.0 is uncommon and very rarely takes place even in newly-constructed factories. One of the interviewees summed this up by arguing that digitalisation and Industry 4.0 have become slogans and symbols for the introduction of new technologies. ‘But everyone draws from these solutions what they need. Not everyone needs a fully automated factory’ [Interview COMP-06].

Table 2  
Main challenges to implementing Industry 4.0 in companies with domestic capital in Poland

<table>
<thead>
<tr>
<th>Domain</th>
<th>Main barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>- Low level of openness to cooperation</td>
</tr>
<tr>
<td></td>
<td>- Low level of project and process management</td>
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<tr>
<td></td>
<td>- Low level of use of IT tools among managers</td>
</tr>
<tr>
<td>Human and social capital</td>
<td>- Low social capital; lack of mutual trust between entrepreneurs, and sometimes even mutual hostility; unwillingness to cooperate; lack of courage in undertaking risky investments</td>
</tr>
<tr>
<td></td>
<td>- Shortage of young automotive specialists; ageing practitioners</td>
</tr>
<tr>
<td></td>
<td>- Outwards migration of outstanding specialists</td>
</tr>
<tr>
<td>Technology</td>
<td>- Too weak involvement of R&amp;D units for cooperation with the SME sector</td>
</tr>
<tr>
<td>Financial</td>
<td>- Low availability of funds for research and implementation of innovation in automotive companies</td>
</tr>
<tr>
<td></td>
<td>- Low and falling profitability of companies (seven per cent in 2012 to less than four per cent in 2018)</td>
</tr>
<tr>
<td></td>
<td>- Difficult access to external financing for companies in the SME sector</td>
</tr>
</tbody>
</table>

Source: Interviews with managers and key public stakeholders
Polish automotive companies which may be classified as tier two suppliers are still far away from Industry 4.0 and even 3.0. It is not yet sure whether the profile of domestic suppliers is suitable for Industry 4.0 solutions. Indeed, no domestic automotive suppliers has gone wholesale into Industry 4.0. To sum up, there is only a limited chance for the whole automotive industry to enter the digital age of manufacturing. At the current stage, we can talk rather more about implementation pilots for Industry 4.0 in firms with predominantly Polish capital. The main method is to implement solutions in small steps – a systematic implementation of individual solutions in existing production lines [Interview COMP-10]. Our research shows that companies are especially eager to implement methods and technologies in the area of predictive maintenance.

An overview of existing pilot schemes in selected Polish automotive companies is provided in Table 3.

<table>
<thead>
<tr>
<th>Motivation behind implementation</th>
<th>Main technology applied</th>
<th>Results achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>A long-term strategy of the company aimed at full automation and transition to a higher level in the value-added chain</td>
<td>CPS data collection and analysis (PQS); fully automated gas-spring production line</td>
<td>1. Improvement in the production process and in product quality (greater stability of quality) 2. Reducing the number of employees and increasing their skill level 3. Lower quantity of waste</td>
</tr>
<tr>
<td>The will to distinguish the company among other suppliers; raising the prestige of the company among customers in the west; increasing production capacity; ensuring replicable quality in a demanding technological process</td>
<td>Fully automated and robotised welding line; CPS data collection and analysis</td>
<td>1. Greater process control and optimisation of the product’s manufacturing cost 2. Greater comfort of service work, increasing the skills of the team 3. Authenticating the very high product quality in the eyes of customers</td>
</tr>
<tr>
<td>Implemented as an experiment, the secondary motive was the reduction of labour costs</td>
<td>Fully automated processing line for thermoplastic materials; IT unit for the central management of injection moulding processes; advanced quality control systems (AQc); CPS data collection and analysis</td>
<td>1. Obtaining the replicability of the production cycle 2. Adherence to a time operation regime 3. Technological production stability 4. Saving on losses, malfunctions and defects 5. Good information flow (facilitating responses to complaints)</td>
</tr>
</tbody>
</table>

Source: Interviews with managers and company data

3.1 The impact on human resources

The main factor accelerating the digitalisation of the Polish automotive supply industry is the current labour market situation, in particular the increase in labour costs [Interview COMP-09] and staff shortages. This was well summarised by one of the managers of a global automotive tier one company operating in Poland: ‘When it comes to Industry 4.0, the conditions in the labour market gave us this gift so we could engage in 4.0 solutions;’ while another remarked: ‘Industry 4.0 is a direction that we can not
avoid because of the human and economic factor (...) When there is a problem, we want to know where it is. We want to combine data about production’ [Interview COMP-08].

Introducing Industry 4.0 solutions in a company spurs substantial changes in its skills breakdown. As one of the managers we interviewed emphasised: ‘The company will increasingly rely on more skilled employee segments, like constructors as well as IT specialists’ [Interview COMP-12]. Another interviewee stressed: ‘Because we made a conscious decision systematically to increase the level of automation and robotisation, now we need engineers, not production workers/operators. The ideal situation would be if we did not have operators at all, only automatic lines and engineering staff’ [Interview COMP-07].

With the push to automate, there are expected to be limited job losses among production workers in companies introducing Industry 3.0 and 4.0 solutions. However, given the relatively low technology level among the majority of domestic suppliers, major job losses may emerge in the future as a result of company failures to survive in the competitive automotive market. Digitalisation will represent a serious threat to further competitiveness if technological change turns out to have a disruptive pace and range.

Industry 4.0 requires an interdisciplinary and interdepartmental approach, as well as a combination of knowledge and skills in several areas (Gracel and Łebkowski 2018). This combination manifests itself firstly in attitudes towards operational and managerial change. Our research reveals the existence of intellectual barriers at the managerial and company ownership levels, but also as regards engineers and production workers. At the highest management level, there is the problem of accepting innovative solutions due to high costs while there is, simultaneously, a lack of searching for comprehensive solutions. There are also, overall, reactive attitudes to changes in the labour market [Interview COMP-01]. At the mid-management level, the conservative approach to the training of engineers in Polish companies weakens the possibilities of using Industry 4.0 solutions (ASTOR 2017). At shopfloor level, new solutions increase the scope of processes that fall on a single employee, thereby increasing responsibility. The shortage of human resources and position mismatches are one of the major barriers to the development of Industry 4.0. The ability to learn, unlearn and relearn is relatively low in Poland.

As emphasised by respondents, there is a significant problem with finding larger groups of engineers with the required skills to handle larger projects. This gap may, partially, be filled by transfers from international companies. The second chance for Polish automotive companies seems to be the use of human resources from related industries. New areas of technical competence will gain in importance, such as the integration of IT systems control techniques and the integration of analytical methods in data clouds with local networks or cyber security. This will lead to the search for highly-skilled engineers in automation, robotics and software, production engineers, designers of automation systems and mechatronics, and designers from the virtual reality world or gaming.
3.2 Public policy response

The Strategy for Responsible Development, an instrument launched recently by the Polish government to manage the main development processes in Poland, identifies five development traps that Poland faces, including the ‘average product trap’. The authors of the plan highlight – among others – that R&D expenditure amounts to less than one per cent of Polish GDP. They also stress the slightly awkward findings that only thirteen per cent of SMEs innovate (compared to 31 per cent in the EU) while only five per cent of exports originate in high-tech sectors (https://www.miir.gov.pl/media/14873/Responsible_Development_Plan.pdf).

This section offers a short look at the current support instruments introduced by the Polish government which are aimed at accelerating and facilitating the transition of the Polish economy into Industry 4.0.

The main activity is the Platform for Future Industry (4.0) (Platforma Przemysłu Przyszłości) which started its operation at the start of 2019 as a foundation under the Council of Ministers. The role of the Platform for Future Industry (4.0) is to integrate and accelerate the transformation of the Polish economy towards Industry 4.0. The Platform’s project also encompasses the integration and coordination of activities for suppliers, research centres and various entrepreneurs, from both the public and the private sectors. Moreover, the Platform will help in the setting-up of a cross-linked business ecosystem (company network) and the coordination of Digital Innovation Hubs (DIH), and will also provide access to instruments and tools aimed at stimulating interaction between companies and research institutions (https://www.mpit.gov.pl; http://przemysl-40.pl).

Andrzej Soldaty, President of the Management Board of the Platform for Future Industry (4.0) foundation, argues that the government’s involvement in the implementation of Industry 4.0 extends to measurable effects in the area of the better use of resources and the better use of market opportunities. In his opinion, ‘Not entering the 4.0 level and not becoming competitive poses a great threat to the whole economy,’ while the role of the Platform for Future Industry (4.0) should be to raise the competitiveness of enterprises by supporting digital transformation. The Platform’s aim is to support development in four areas: market; business environment; technology; and people. Soldaty distinguishes two main roles of the Platform: the first is in creating and recommending, based on developments in knowledge and skills, but also in providing formal and legal solutions and financial resources; the second is to enable ‘coopetition’ – to encourage competition and cooperation among enterprises by building networks and establishing thoughts, concepts and common goals in order to raise the level of advancement.

Assistance in carrying out changes in enterprises will be delivered by regional initiatives named Competence Centres (Centra Kompetencji) whose role is to offer developed support instruments, such as workshops and training, and other comprehensive services for enterprises. Furthermore, the Centres will be responsible for cooperation between research institutions, technology providers, engineering companies and business
partners. In 2018, three regional Competence Centres were opened in the Mazowieckie, Wielkopolskie and Śląskie regions (https://www.mpit.gov.pl). In addition, the Ministry of Entrepreneurship and Technology, together with the three Universities of Technology – Silesian, Warsaw and Poznań – prepared in 2018 a pilot project named the ‘Incubator of Industry Leaders 4.0’ (Inkubator Liderów Przemysłu 4.0). The main aim of the project is to train staff in the Competence Centres and in the Platform for Future Industry (4.0).

In 2017, a Sectoral Programme of Scientific Research and Development (INNOMOTO) was launched by the National Centre for Research and Development and the Polish Chamber of the Automotive Industry. INNOMOTO supports the implementation of large R&D projects and aims to increase the number of innovative solutions. The co-financing of projects can help entrepreneurs create new, or expand existing, R&D departments as well as develop innovative technologies and products. In 2017 and 2018, 57 projects were co-financed by INNOMOTO to a total amount in excess of PLN 326m (https://www.ncbr.gov.pl; http://innomoto.com.pl).

One of the tools of innovation policy formation has been the revision of the tax law in Poland, which took place in the second half of 2017. The purchase cost of industrial robots and 3D printers can now be written off more efficiently. The government hopes that new incentives will encourage companies, small and medium-sized enterprises in particular, to invest in new technologies and solutions.

The main weakness of the tools and solutions implemented by the government is the lack of the necessary flexibility in the case of R&D activities. The specificity of innovative projects often forces changes in the direction of research during the process, but programmes do not take into account the complexity of implementing the solution and the frequent need for cooperation. Representatives of companies in our survey emphasise that, in the case of projects financed from public funds, it is very difficult to change the project assumptions during the process and call for greater trust – ‘Entrepreneurs should be given more flexibility and the right to make mistakes as this is what searching for innovative and effective solutions is about’ [Interview ORG-01].

However, there are promising results among some innovative support programmes aimed at accelerating cooperation between innovative startups and big companies in more mature industries. These have been introduced by the Polish Agency for Entrepreneurship Development (PARP) in partnership with technological parks (i.e. the PARP KPT ScaleUp accelerator). With the low level of industry 4.0 implementation in Polish companies, technology parks become an essential channel for transferring state-of-the-art solutions. It is hard to assume that incubators and technology parks will be a central pillar for introducing Industry 4.0 solutions among Polish producers, but they can be an important element in the upgrading of Polish industry. Know-how in the area of particular unsolved problems is critical to the success of initiatives along with support for global expansion.

Another example of good practice could be clusters (e.g. Automotive Silesia, the East Automotive Alliance). The role of a cluster is to support cooperation, spread knowledge
and provide the opportunity to attract potential suppliers. A representative of one of our organisations [Interview ORG-01] pointed out that (especially foreign) executives increasingly expect companies to have a range of competences – from design through to the ability to make a prototype and to develop an implementation-ready solution. In this context, cooperation between companies is crucial because most local firms are too small to carry out this kind of imperative alone.

4. Conclusion – the thorny road to Industry 4.0?

Polish automotive suppliers, especially SME companies, are at the very beginning of the path leading to the implementation of Industry 4.0 solutions. There is a growing awareness among owners and managers, but few companies have yet started to taste the waters and, for now, the thorough implementation of smart manufacturing in the automotive industry is limited to large foreign-owned plants.

At the moment, in automotive suppliers with predominantly Polish capital we can observe pilot implementations of Industry 4.0 solutions. The companies that are experimenting with these are mainly seeking a means of better serving their existing customers; very rarely are they embracing Industry 4.0 as a long-term strategy aimed at upgrading to a higher level in the value chain. Thus, the argument that digital transformation facilitates the independent internationalisation of local SMEs and their integration into global value chains cannot be confirmed at the current stage of development of the bulk of companies in the automotive industry in Poland. There are only a handful of companies that are consciously introducing a strategy of full implementation of Industry 4.0. However, a more adequate concept describing such companies would be ‘readiness for change towards 4.0;’ there is a strategy to reach 4.0 based on a high sense of advance (the implementation of comprehensive Industry 3.0 solutions), preparing staff and seeking the availability of capital. Even so, the vast majority of domestic suppliers are at the transition stage from Industry 2.0 to 3.0 solutions. A specific feature of Polish suppliers is still a significant amount of production by manual labour, especially in companies founded in the 1990s. Undoubtedly, the acceleration of the implementation of solutions in the field of automation and robotics production at the level currently observed in Polish industry will be a vehicle that will also accelerate the implementation of Industry 4.0. However, this will be an incremental upgrading because there are no mechanisms that allow leapfrogging. The interviews we conducted indicate that, at the current stage in the automotive industry in Poland, companies are mostly interested in Industry 4.0 solutions in the area of predictive maintenance.

The application of Industry 4.0 solutions in the coming years will not be a factor likely to improve significantly the position of Polish automotive suppliers in European production networks. In a perspective of a few years alone, neither will it have a negative impact on their functioning in the market. This is connected on the one hand with the inertia of industry (the duration of contracts already concluded) and, on the other, with the existence of cost and product niches in which local producers may remain competitive. However, if the technology gap continues, this will represent a serious threat to the competitiveness of these companies in the medium and long-term.
The main barriers to the development of Industry 4.0 are the underfunding of technological innovations; intellectual barriers among owners and managers; and a lack of skilled staff (both among production workers and among management). Moreover, the lack of cooperation between companies, research centres and government is having negative effects on the development of innovations (cf. Table 2). Our research also shows a deeper problem resulting from the characteristics of organisational culture and social capital in Poland. As one of the managers pointed out: ‘The plants operating in Poland are focused solely on production, not on data interpretation. Polish SMEs have not mentally reached the stage “Measure the process and improve it”’ [Interview COMP-01]. Another interviewee remarked: ‘We have an inadequate organisational culture in Poland. The basic barrier is low trust among companies and a low degree of cross-linkages’ [Interview COMP-01].

Support instruments introduced by the Polish government aimed at accelerating and facilitating the transition of the Polish economy into Industry 4.0 are of a very recent nature (the first actions were taken in 2018). Therefore, it is too early to draw a firm conclusion about the effects of the newly-implemented programmes. The public stakeholders we interviewed are also careful in their opinions, stressing that public support should not be overestimated in the whole process of speeding toward Industry 4.0 in Poland. Nevertheless, managers assess the activities of the Ministry of Enterprise and Technology as valuable, mainly in the field of providing support for education and staff training. What is considered by managers as particularly relevant and effective in terms of support is the possibility of experimenting and exploring new fields. Without public financial support, Polish companies could not afford this. There have been some promising results among some innovative support programmes aimed at accelerating cooperation between innovative startups and big companies in more mature industries which have been introduced by the Polish Agency for Entrepreneurship Development (PARP) in partnership with technological parks and Special Economic Zones. The major long-term positive effect of current policies may be found in networking activities among business companies, research centres, universities and other institutions.

Four main factors that have, or could have, an impact on accelerating the implementation of Industry 4.0 solutions in the Polish automotive industry have been identified. The most important, according to this survey, is the growing cost and decreasing availability of employees. Support offered by public authorities could become an important factor but, because the leading tool (the Platform for Future Industry 4.0) is at the implementation stage, it is difficult to indicate how effective it will be. It should be remembered that a large number of countries have implemented similar mechanisms, so it is difficult to predict ex ante the extent to which the activities of the Polish institutions will be effective. Given the structural features of Poland (low institutional social capital), one should be careful in forecasting that it will be a breakthrough factor. Another vehicle for the implementation of Industry 4.0 solutions might be customer policies, primarily among OEM and tier one companies towards their tier two and lower level suppliers. This path, however, is associated with the danger of increased dependence on the dominant partner.
The growth of Industry 4.0 in Poland may depend not only on the production companies themselves but also on the development of domestic companies specialising in the integration of automatic and digital solutions (‘digital entrepreneurs’). Technological changes related to Industry 4.0 seem to provide a window of opportunity for medium-sized Polish suppliers of tailor-made technological and software solutions. These are providers of comprehensive services in the field of industrial automation, PLC programming, robotics, SCADA visualisation systems, MES class systems, industrial informatics, data collection and archiving. Thus, we predict that the upgrading of companies with Polish capital will be more indirectly than directly related to the development of Industry 4.0 in the automotive industry. The large cluster of automotive companies in central Europe creates a market for domestic companies offering Industry 4.0 solutions which can build their competence on the basis of cost and responsiveness factors. The relatively large size of the domestic market facilitates the implementation of what are ground-breaking solutions for innovative SME companies.

On the other hand, the massive size of the internal market reduces the pressure on companies to ‘go global’ and take on challenges abroad. Also, the relatively close headquarters-coordinated structures of foreign-owned subsidiaries hamper any moving-up in the newcomer value chain. The key to the upgrading of domestic companies is the engagement of Polish tech companies in developing digital solutions which would make many indigenous firms experience a ‘leapfrog effect’. However, according to some experts, ‘Due to the lack of expertise in automation and robotics in Poland, foreign suppliers will be able to profit more than others from the trend towards automation’ (https://industryeurope.com/polish-automation-gaining-momentum/).

Thus, we may conclude that, at the current stage of research, although the domestic market has significant limitations (low demand from local companies and limited decision-making competence among foreign subsidiaries), it does offer some important growth factors for digital entrepreneurs. This point was well summarised by one of our interviewees: ‘The level of global OEMs is beyond our reach at present. But between them and small companies there is a vast space for growth’ [Interview COMP-01].

Taking into account the preliminary conclusions resulting from this exploratory research among high-tech domestic companies which are providers of Industry 4.0 solutions, a promising research agenda is emerging which could aim, inter alia, at the identification of the growth factors appropriate to such companies and in-depth investigation of the conditions for the promotion of competence within European and global value-added chains. Future research might also explore the functioning of the ecosystem for high-tech domestic ‘digital entrepreneurs’; the main mechanisms and factors behind the upgrading of these companies; and the impact of regional and local features on their emergence and growth, in particular the extent to which geographic proximity – both to customers and to other high-flying domestic companies – is important for the development of such firms.
## Appendix

### List of interviewed companies and organisations

<table>
<thead>
<tr>
<th>Interview No</th>
<th>Type of company</th>
<th>Main activity/products</th>
<th>Turnover in PLN millions (M)*</th>
<th>Employment**</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP-01</td>
<td>Digital entrepreneur</td>
<td>Control and automation systems</td>
<td>PLN 10-20M  100 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-02</td>
<td>Digital entrepreneur</td>
<td>Provider of industrial automation and industry 4.0 solutions</td>
<td>PLN 10-20M  50 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-03</td>
<td>Digital entrepreneur</td>
<td>Provider of automation, IT solutions and industral robotics for different branch of industry, including automotive</td>
<td>PLN 50-100M 60 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-04</td>
<td>Automotive supplier Tier 1 / Tier 2</td>
<td>Design &amp; testing services for automotive industry, special machines-design and production, Conversion of vehicles from combustion engine to electric drive</td>
<td>PLN 50-100M 400 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-05</td>
<td>Digital entrepreneur</td>
<td>Design of vehicles, modules and parts for the transport industry (including automotive)</td>
<td>PLN 50-100M 250 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-06</td>
<td>Digital entrepreneur</td>
<td>Design and manufacturing of 3D scanners for the automotive industry</td>
<td>PLN 10-20M 50 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-07</td>
<td>Automotive supplier Tier 1</td>
<td>gas springs, ball joints and tie rods</td>
<td>PLN 10-50M 250 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-08</td>
<td>Automotive supplier Tier 2</td>
<td>plastic components for automotive, electrical engineering, home appliances and interior decoration industry</td>
<td>PLN 50-100M 150 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-09</td>
<td>Automotive supplier Tier 2</td>
<td>Stamped metal parts</td>
<td>PLN 100-200M 250 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-10</td>
<td>Digital entrepreneur</td>
<td>Factory automation and processing technologies, drive products, computerised numerical controllers</td>
<td>PLN 100-200M 250 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-11</td>
<td>Automotive supplier Tier 2</td>
<td>Rubber products, plymers and elastomers combined with metal and plastics for the automotive, household appliances and electrical engineering industries</td>
<td>PLN 5-10 M 50 employees</td>
<td></td>
</tr>
<tr>
<td>COMP-12</td>
<td>Automotive supplier Tier 1</td>
<td>Starter batteries</td>
<td>PLN 200-500M 200 employees</td>
<td></td>
</tr>
<tr>
<td>ORG-01</td>
<td>Business Organisation</td>
<td>Association of manufacturers of automotive parts and accessories.</td>
<td>Over 20 members (1-2 bln of revenues and 5000 employees in 2017 in total)</td>
<td></td>
</tr>
<tr>
<td>ORG-02</td>
<td>Business Organisation</td>
<td>Support for the ecosystem of high-tech companies: technology incubator and accelerator, certified Living Lab, providers of hardware, software and network infrastructure</td>
<td>PLN 10-50M 50 employees</td>
<td></td>
</tr>
</tbody>
</table>

* Euro (EUR) to Polish zloty (PLN) annual average exchange equalled 4,298 in 2019.
** Employment figures do not include agency or temporary workers.
References


Industry 4.0 and the prospects for domestic automotive suppliers in Poland


The barometer of the automotive parts production sector in Poland, research conducted by the SDCM and Frost & Sullivan Q1 2018. [Quoted in Automotive Sector in Poland 2019. Figures, Summaries, Analyses, SDCM, Warsaw; 2018 JETRO Survey on Business Conditions of Japanese Companies in Europe].

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