Management and Production Engineering Review
Volume 11 • Number 3 • September 2020 • pp. 4–13
DOI: 10.24425/mper.2020.134927

MADE IN AUSTRIA 2019 – SURVEY RESULTS OF THE FIRST INDUSTRY PANEL ON PRODUCTION WORK IN AUSTRIA

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Received: 13 January 2020
Accepted: 7 May 2020

Abstract
In order to assess the challenges and needs of Austrian companies with respect to current business and technological developments, a regular well-researched compilation of empirical data of the Austrian manufacturing industry is necessary. Hence, a panel of 104 decision-makers (owners, CEOs, managing directors and plant managers) from leading Austrian industrial companies was assembled in form of an "industry panel" to investigate current issues of production work in Austria by means of a survey.
In order to allow for a longitudinal study, it is planned to survey the same group of people every year; hence the instrument of an annual panel-survey was chosen. To date the panel consists of 104 leaders from different Austrian or international companies with at least one factory location in Austria. The panel was assembled first in 2018/2019 and the administered survey contained 23 questions. The actual questions comprise topics that concern the current economic situation and future expectations, operational issues with respect to delivery time, product variability and demand fluctuations, as well as questions relating to innovation, automation and the application of current technological developments (i.e. assistance systems, machine learning, etc.) in manufacturing. This paper presents the survey results and conclusions of the 2019 panel on production work in Austria.

Keywords
Austrian manufacturing sector, survey, production work, industry panel.

Introduction

Production work is a key economic factor for Austria's prosperity. With a share of 22% of gross domestic product (GDP) [1], production of material goods makes a significant contribution to economic success. Production has traditionally been a priority in Austria and current developments with restrictions to free trade show the importance of manufacturing for Austria and Europe. It is evident, that a solid industrial manufacturing base renders economies more robust against sectoral economic fluctuations.

Manufacturing in Central Europe faces numerous challenges, such as high labour costs and constantly increasing regulatory requirements. Hardly any other sector is more severely affected by the consequences of globalization. Businesses frequently struggle to keep up with global competition and the resulting demands in terms of price, availability, flexibility, quality and agility are a constant challenge. Hence, lean structures need to be created and maintained and complex supply chains must be mastered. Moreover, digitization and automation threaten established business models but also open up new opportunities for value creation and provide the chance to reclaim manufacturing in high-wage countries.

One of the key success factors in Central Europe are well-trained and highly motivated workers. At the same time, the shortage of skilled labour is a severe problem for companies. Hence, automation, robotics and worker assistance systems are of increased interest among manufacturing companies.

Goal of the study

In 2018/19 the industrial panel "Made in Austria: Production work in Austria" was surveyed for the first time, comprising 104 participants. The aim of this study is to provide a regular and scientifically sound depiction of the present situation of production work in Austria and gauge future expectations in the area of production work within the Austrian industry, in order to better support their innovation activities. Of particular interest are general economic and organisational challenges and the areas that can be summarised with the term 'Industry 4.0'. Those issues have previously been researched by singular studies concerning production work [2] or repetitive studies targeting the modernization of production [3] where production work was one of several topics.

The presented study is the first repetitive study focussed entirely on production work. The target group of the study are owners, managing directors and plant and production managers of manufacturing companies, who had to answer 23 questions regarding

- their company
- the general market environment
- their competitiveness
- the use of robotics and assistance systems.

In order to derive conclusions about medium- and long-term developments (longitudinal study), it is pertinent to survey the same group of people every year. Hence, about 20 questions will be the same every year to allow such a longitudinal study and 3–5 questions will change in order to detect new trends and developments. The questions were chosen in order to gain insight into the issues and problems manufacturing companies face and the results

- serve as input for research and teaching,
- highlight the opportunities offered by Industry 4.0, digitization and automation,
- have an opinion-forming effect and
- provide decision-makers with first-hand data.

Overall, 104 representatives from 102 different top Austrian companies took part in the panel survey. The difference in the number of respondents and the number of companies stems from several replies of the same company. 60% of the interviewed managers work directly in production or production-related areas.

Macroeconomic outlook

As in most industrial countries, for several decades the manufacturing sector declined in the share of Austria's GDP. In 2018, the share of tangible goods production in Austria's GDP was 22.0%, while the average for the EU amounted to 19.5%. In a comparison of European countries, Austria is located between Switzerland (20.5%) and Germany (25.8%) and significantly above the EU average [1].

In recent years, it became evident that a strong industrial sector is essential for competitiveness and innovative strength. Since the last economic crisis, future-oriented production has increasingly attracted the attention of economists, politicians and the broader public. A trend dubbed 'Industry 4.0' and 'Industrial Internet of Things', represents a wave of modernisation in manufacturing [5, 6]. Digitisation and automation and the use of network-technologies in manufacturing and assembly have the potential to secure existing production sites in high-wage countries and even attract new production sites. This is important for Austria and on a broader scale for the whole of Europe. Although the panel only measures the Austrian situation, it can provide a gauge for many manufacturing-oriented European countries.

For the Austrian industry, the past few years can be characterised by a fairly rapid recovery from the economic crisis in 2008–2010 and a constant upward trend ever since. The turnover of the Austrian industry is currently 21% above 2010 and 4.2% above the EU average for 2017 [7]. Hence, the question regarding the current global business situation, is a valuable assessment of the present economic sentiment.

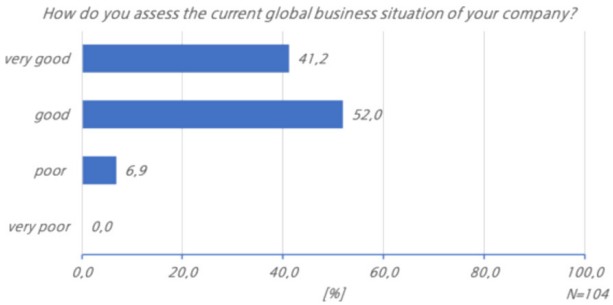

Fig. 1. Outlook on present worldwide state of business.

In the survey, 93.1% of participants rated their current global business situation as positive or very positive; only 6.9% of company representatives appraised it as negative. Thus, the vast majority of respondents were convinced at the time of the survey that the global economy would remain stable and positive in terms of tangible goods production.

The optimistic mood shows an ample investments in research and development (R&D) and innovative communication and production technology. Thus, a continued positive development in the manufacturing of tangible assets is expected. In view of global economic challenges (i.e. trade conflicts, protection-

ist tendencies, Brexit) strengthening an innovation-friendly industrial base remains an essential lever for an internationally competitive manufacturing sector.

The competitiveness of a location is closely linked to its economic development. The objective or even just a subjective assessment of the competitiveness of a country or region is a key decision criterion for awarding contracts to specific plants and broader for decisions regarding investments and location. Managers' opinions with respect to competitiveness are important criteria. Hence, the panel was surveyed regarding the competitiveness of their Austrian production sites (Fig. 2) and the development of competitiveness over the last five years (Fig. 3).

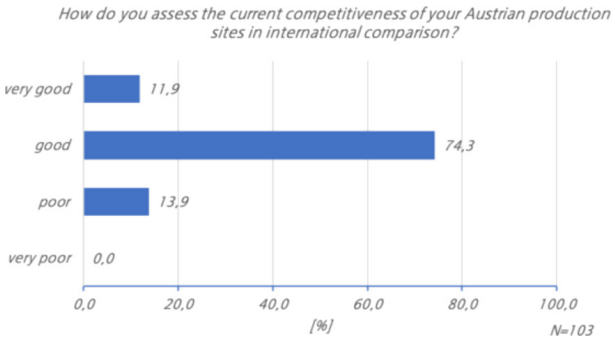

Fig. 2. Competitiveness of Austrian production locations.

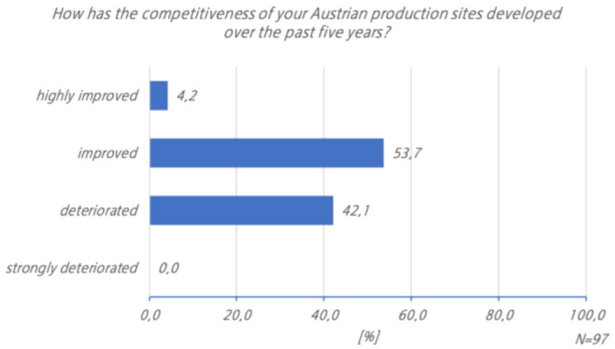

Fig. 3. Development of competitiveness of Austrian production sites.

Competitiveness of Austrian production sites is judged good by almost 75% of the respondents, while about an equal share assessed competitiveness as very good or poor. The factors employee education, good infrastructure and social balance are seen positively in Austria, while high ancillary wage costs, complex approval procedures and availability of qualified labour are assessed as negative [8].

Concerning the development of competitiveness over the last five years, about 58% see an improvement or strong improvement while approximately 42% perceive a deterioration (Fig. 3).

The results coincide with other studies that rate Austria's competitiveness as a stable leading midfield position worldwide. In the World Economic Forum's Global Competitiveness Report [8], Austria ranked 22nd in 2018 and 21st the previous year. Yet 42% of the panel's participants stated a deterioration in competitiveness of Austrian locations in the last 5 years, which are cause for concern for location policy.

High variance and shorter delivery times

'Lot size 1' at the cost of mass production - what has long been considered an impossible goal for lean enthusiasts and industry 4.0 apologists is becoming a benchmark for successful manufacturing. 'Lot size 1' is the ultimate goal in lean manufacturing enabling highly flexible production, increased personalization while minimizing work in progress. 'Lot size 1' is still a major challenge for many industries, but generally lot sizes are decreasing, which requires companies to adapt their business processes. This trend is driven by strongly networked (global) value creation networks and cyclic economic fluctuations. In this realm the main drivers of flexibility are:

- ever new, rapidly developed products and product variants,
- the reduction of delivery times accepted by customers,

and as a consequence:

- an almost complete lack of finished goods inventories,
- high demands on the temporal and spatial flexibility of the entire service provision.

In the survey, both flexibility drivers (increased product variance and reduced delivery times) were clearly identified; i.e. 96% of the experts surveyed stated an increase in product variants at their Austrian production sites over the last 5 years (75% growth/ 21% strong growth in product variants; see Fig. 4).

This development is expected to continue in the future. The pressure to launch new products and the need to react to short-term changes in customer requirements in a flexible fashion have a variety-increasing effect. Triggered by the need for individualized products, "mass customization" is evolving into "mass personalization" resulting in even shorter product life cycles. In addition to life cycles, delivery times are also subject to constant shortening, which were surveyed as well (Fig. 5).

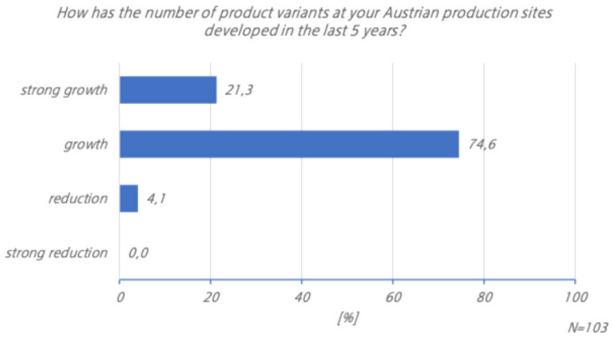

Fig. 4. Development of the number of product variants

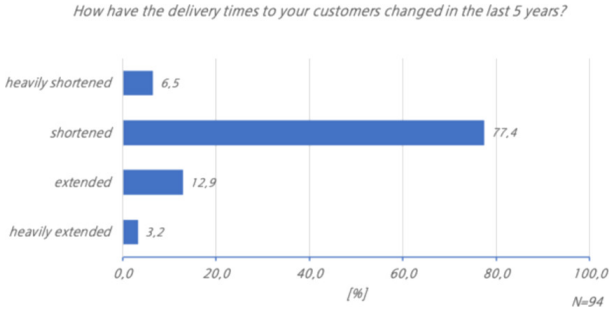

Fig. 5. Development of delivery times.

Approximately 84% of panel participants confirmed that delivery times have shortened or have greatly shortened within the last 5 years. This trend will continue, since companies that can deliver products quickly and instantly react to fluctuations in demand have a clear competitive advantage.

Those developments lead to high fluctuations in personnel capacity requirements. This trend is likely to intensify due to market dynamics, shorter order and delivery times and customer-specific production. A measure for this effect is the fluctuation range of the personnel-side capacity requirements, gauged by the frequency at which the planned values for personnel planning (in employee hours) must be adjusted to actual capacity requirements. The survey showed a focus on monthly adjustments (ca. 58%) and only around 34% of the companies adjust personnel-related capacity requirement fluctuations in production from week to week. Only about 9% of respondents reported fluctuations on a day-to-day basis (see Fig. 6).

In order to cover these fluctuations, there are numerous flexibility instruments. The targeted use of these instruments allows a preferably overlap-free coverage of capacity demand and supply. Currently, companies are increasingly relying on flextime wage records and annual working time models. Employees work when they are needed and are deployed more flexibly. In return, this flexibility is designed to be as plannable as possible and coordinated with the individual employees' flexibility requirements. In the competition for talent, the aim is to make work more flexible overall and to reconcile the needs of companies with those of employees.

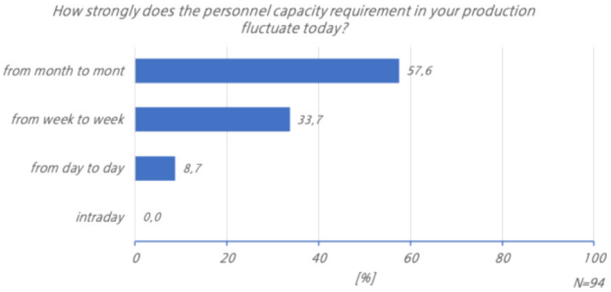

Fig. 6. Fluctuations in personnel capacity requirements.

Functioning labour relations at Austrian production sites

Prerequisite for flexible personnel deployment in terms of time, space and content are trust and cooperation between employers and employees. Austria usually performs particularly well in the categories of stability and reconciliation of interests between employers and employees. Hence, the panel was also surveyed with regard to cooperation with employee representatives (Fig. 7).

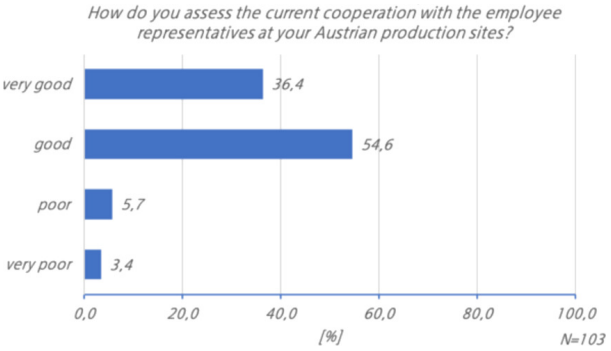

Fig. 7. Cooperation with employee representatives.

The 'good' cooperation is reflected in the results; a large majority of 91% of the experts surveyed consider the cooperation with employee representatives to be 'good' or 'very good'. Further analysis revealed that small and medium-sized enterprises (SME) rated the question of cooperation negatively (26.2%) than large companies (3.4%).

Innovation in Austria

Austria has a fairly good position for innovative production. Its central geographical location within

the European Union and its proximity to suppliers in Eastern and Southern Europe are advantageous. Its differentiated technical and scientific educational offerings (universities and universities of applied sciences, technical colleges, apprenticeships) ensure the education and training of qualified personnel. Further, Austria and more specifically Vienna is a very attractive place for international experts to live. However, Austrian businesses criticize strict market regulations and high bureaucratic hurdles. In Europe disruptive technologies seem to take longer to reach market maturity and entrepreneurs with radical innovation ideas are often attracted to places where these hurdles are smaller and access to venture capital is easier. This is clearly shown in Austria's corporate landscape, where established companies in traditional sectors compete on an international level, while the number of highly innovative breakthrough products and services is relatively small. In times of disruptive innovations, it is important not only to work on existing technology, but also to break new ground. A measure for innovation in the operational context is the share of turnover for research and development (research quota), which is shown in Fig. 8 in comparison to selected European countries.

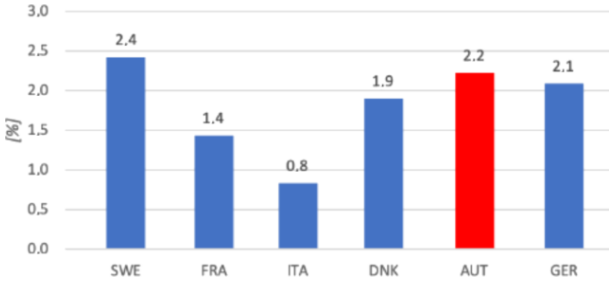

Fig. 8. Expenditures for R&D in % of GDP in 2017 [9].

Within the EU, after Sweden (2.42%) Austrian enterprises, with 2.22% of GDP, spend the most on research and development. In comparison, the EU average is 1.36%. Among the industry panel, the average research quota is ca. 5%, more than twice the Austrian average. This demonstrates the relevance of manufacturing companies for an innovative economy.

Another key figure that illustrates the high dynamics in the companies surveyed is the share of new products (less than 3 years old) in sales (Fig. 9).

In this case, the average value in the sample was 29%, more than twice the average value of all Austrian companies (Statistik Austria: 12.6% [10]). The differences between the individual sectors are clear in comparison to the sector data from 2016. The highest share of turnover by innovations was accounted for by the economic sectors [10]:

- data processing equipment, electronic and optical products, electrical equipment (42%),
- motor vehicles and parts (37.8%),
- mechanical engineering (27.8%).

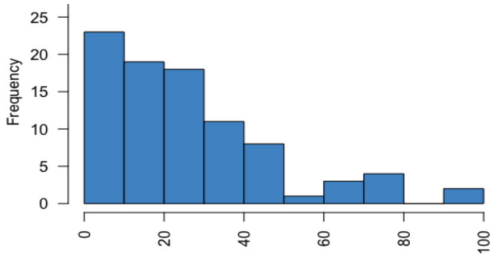

Fig. 9. Share of new products and services in revenue.

Innovation is also a matter of leadership and attitude. A very interesting question is the assessment of panel participants with regard to the innovativeness of their companies and employees (Fig. 10).

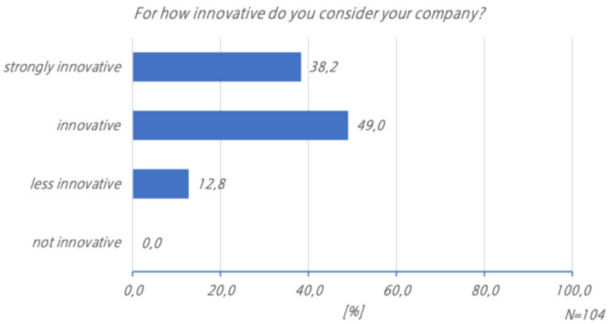

Fig. 10. Perception of own company on innovativeness

More than 87% of participants rated their company, i.e. the existing structures and processes, as 'innovative' or 'very innovative' and only 13% as 'less innovative'. No company was classified as 'not innovative'. With respect to the attitude of employees the survey shows a positive picture of technical innovations and process innovations (Fig. 11).

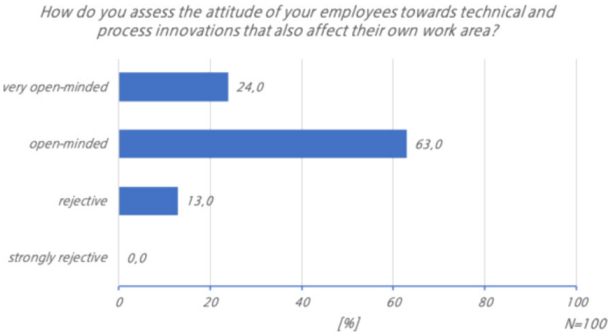

Fig. 11. Perceived attitude of employees towards technical and process innovations.

Only 13% of the respondents stated they felt 'rejective' about the attitude of their company's em-

ployees to technological innovation. In contrast, 87% of the surveyed experts quoted that the employees are 'open-minded' or 'very open-minded'. This shows that in the surveyed companies employees are aware of the central importance of innovation in maintaining competitiveness. In this respect, it is interesting to determine if there is a connection between the research quota of a company and the assessment of the participants with regard to the attitude of employees towards innovation. The hypothesis is, that there is a positive correlation between a company's expenditure on R&D and its self-perception. In both cases a correlation was confirmed (Fig. 12).

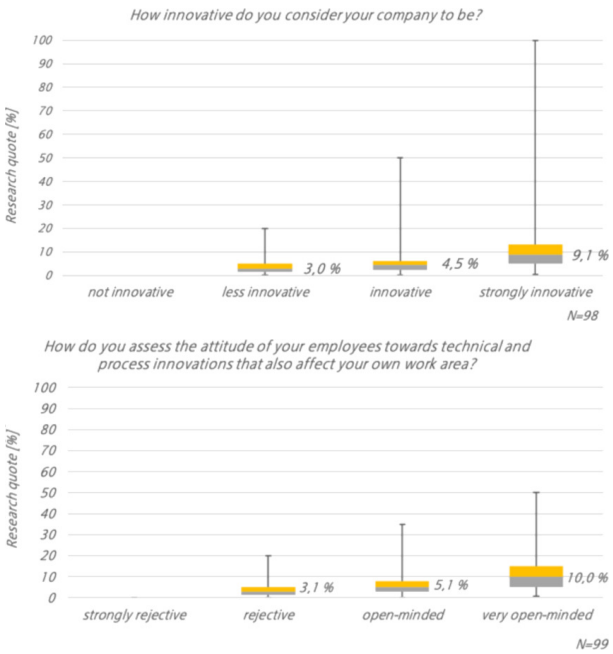

Fig. 12. Perceived attitude of employees towards technological innovation

Accordingly, the perceived attitude of employees of companies with a higher research quota is more open to innovations and is an indication of a higher level of innovation awareness in those organisations.

Production work remains important-despite increasing automation

In recent years, digitization and automation have led to fears about "empty factory buildings" and job losses. For this reason, the panel was also asked about the importance of human labour in production (Fig. 13). 45% responded with 'great significance' and almost 50% acknowledge that human work continues to be of 'significance' in their manufacturing operations. This is an indication that, at least in the medium-term, human labour will continue to play a major role in manufacturing.

Fig. 13. Importance of human work in manufacturing.

With regard to the expected development of the number of employees over the next 5 years, the estimates differ (Fig. 14).

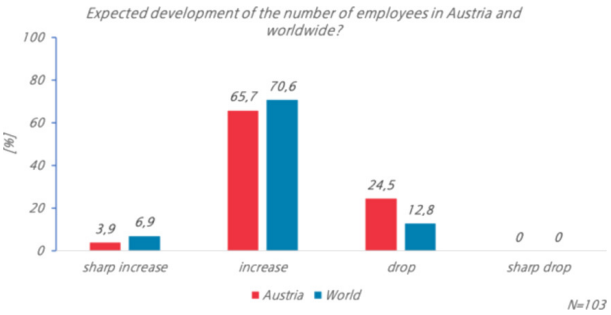

Fig. 14. Expected development of the number of employees in Austria and worldwide.

While over 77% expect an increase in the number of employees worldwide, for the Austrian locations it is almost 8% lower. Although the positive business situation will lead to an increase of employment in Austria, stronger growth can be expected in foreign locations. This might be influenced by the continuing shortage of skilled workers in Austria.

Further, the companies were asked about the expected development of the number of employees in Austrian locations in general-purpose areas and in comparison in production-related areas and directly in production. Figure 15 compares the results.

A majority of the participants see an increase in the number of employees and growth is projected to be somewhat higher in general-purpose jobs than production and production-related areas. This is also reflected in the group that expects a decline of jobs, which is more than twice as high in production and production-related areas than general purpose jobs. This is not surprising, as automation is mostly

occurring in production and production-related areas. Overall, a healthy growth in employment can be assumed. In summary, it is expected that the demand for employees in the companies surveyed will increase in the future, albeit somewhat weaker at the Austrian locations; especially in production and production-related areas.

Fig. 15. Comparison of labour demand at Austrian locations structured according to areas.

Robots on the rise

The view of robots in production increasingly changes from machines working exclusively behind protective fences to direct interaction with workers. In general, production work increasingly takes place in direct cooperation between people and automated machines and equipment. This machinery is represented by physical assistance systems such as cobots (robots capable of collaboration) and exoskeletons, and increasingly by digital assistance systems and applications from the field of artificial intelligence (AI). As a consequence, an ever- increasing number of systems are monitored, maintained and serviced by fewer people [11]. To meet the increasing requirements, the use of worker assistance systems and supporting technologies (e.g. IT-supported data analysis/big data, AI, etc.) is growing. In order to illustrate the level of penetration of manufacturing with selected technologies, the panel asked questions on the use of various assistance systems (Fig. 16).

A comparable measure for the use of robots in companies is the so-called robot density, indicated in robots per 10,000 employees. The panel's arithmetic mean of the degree of automation is 240 robots per 10,000 employees – notably higher than the Austrian average of 167 robots per 10,000 employees. Compared to Germany with 309 or South Korea, the world's leading country for automation, with 631 robots per 10,000 employees, the degree of automation is relatively low both at the Austrian and international locations of the panelists' companies. One explanation for the uneven distribution are industry differences, i.e., the production of car bodies has an extremely high degree of automation, due to large numbers of welding robots.

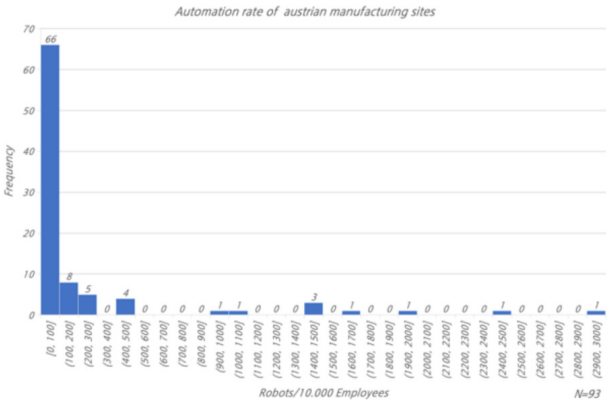

Fig. 16. Automation rate of Austrian manufacturing sites

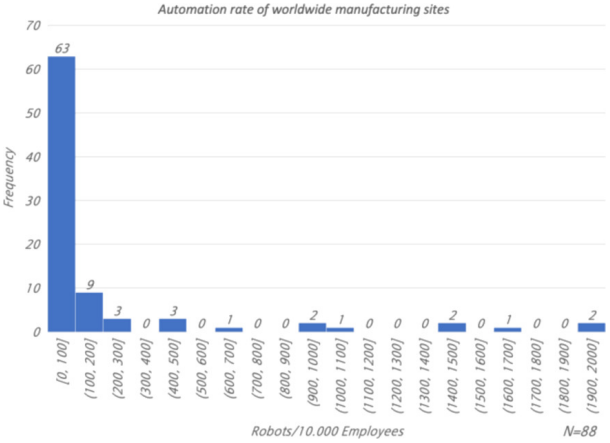

Fig. 17. Automation rate of worldwide manufacturing sites.

The panel survey examines the degree of automation at the participating companies and the use of lightweight robots.

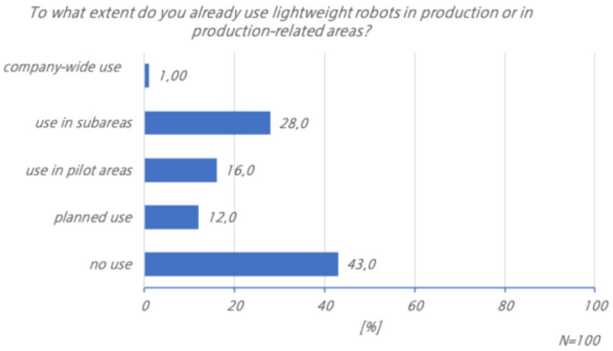

Fig. 18. Deployment of lightweight robots (cobots)

Particularly interesting are recent developments in lightweight robotics. Cost-effective lightweight

robots are frequently introduced in SME and take over monotonous manual or inherently stressful or strenuous tasks. But most notably they work with people in a more flexible and cooperative way. In this context, one also speaks of collaborative lightweight robots or "cobots". The strong interest in lightweight robots in the panel survey is remarkable, with 45% already using and a further 12% planning to use lightweight robots.

As expected, the comparison between SMEs and large enterprises revealed differences (Fig. 19).

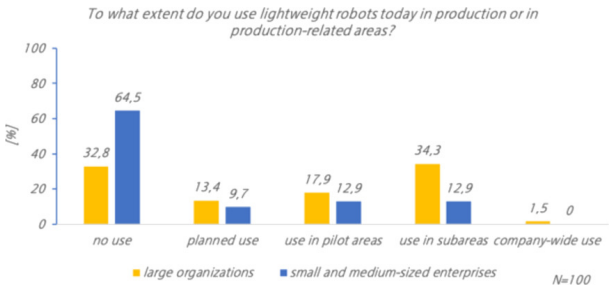

Fig. 19. Deployment of lightweight robots (cobots).

Two-thirds of the surveyed SME had no plans to deploy them; the figure for large companies is 35%, which indicates lively interest. Despite intensive advancements in collaborative robotics in recent years, there are still some problems with their practical application. The versatile applicability is a particular problem in certification for concrete use-cases. Moreover, the limited speed of movement, which is necessary for certification for collaboration, represents a challenge.

Although SMEs can benefit in particular from low costs and high flexibility, there is a certain reluctance to use this technology. For many firms the effort for planning and operation is too high and the resulting potential not promising enough. The question of how the situation will develop in the coming years is interesting. It can be assumed that smaller companies will recognize the competitive advantages of collaborative robotics in manufacturing.

Use of digital assistance systems

The use of digital assistance systems opens up new prospects in manufacturing. Digital assistance enables employees to focus on core competencies and to take on more complex tasks, while ergonomics, efficiency or quality can be improved. Specific examples for the application of digital assistance are the provision of information such as work instructions, process steps, sensor data or in-line measurements as well as additional information and learning material. Further, support and monitoring of quality-relevant processes as well as assistance with learning can be provided. The devices used range from displays, projection systems, data glasses to virtual reality environments.

The panel asked the participants about the current level of use of digital assistance systems in production and production-related areas (Fig. 20).

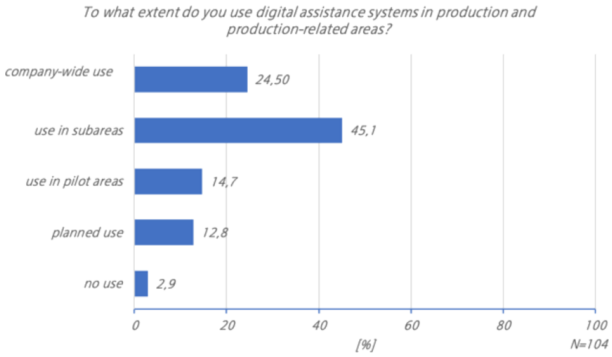

Fig. 20. Use of digital assistance systems in production and production-related areas.

The data shows that the use of digital assistance systems in production and production-related areas is already relatively widespread. Only 3% had no such systems in use, which illustrates that they are no longer an issue for just a small minority.

Concerning the use of digital assistance systems, company size plays an important role again (Fig. 21).

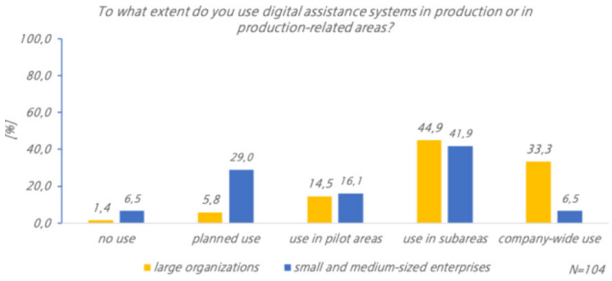

Fig. 21. Use of digital assistance systems in production and production-related areas with respect to company size.

While 29% of SMEs plan a future use of digital assistance systems, only 6% of large companies fall in this group since they already use such systems. Conversely, one-third of large enterprises reported a company-wide deployment, while SMEs report just 6.5%. In summary, SMEs plan to employ assistance systems in the future while larger enterprises already use them.

In view of a lack of skilled factory workers, digital assistance systems can play a decisive competi-

tive role. However, the use of assistance systems requires a sensitive approach, positive user perception and superior usability are important keys to success. Psychological and ergonomic aspects of system use are a central topic of their successful practical application, while low acceptance leads to reluctant use, rendering such investments inefficient.

Machine learning in production

Machine Learning, as a key technology of AI, enables IT systems to independently recognize patterns and generate new knowledge based on existing data. Production companies can use these technologies in areas such as risk management, quality, efficiency, condition monitoring, predictive maintenance and process management. Machine learning and its applications in the areas of image, speech and data evaluation are regarded as an essential future technology for automation and digitization [12]. In this respect, the current state of implementation was part of the survey (Fig. 22).

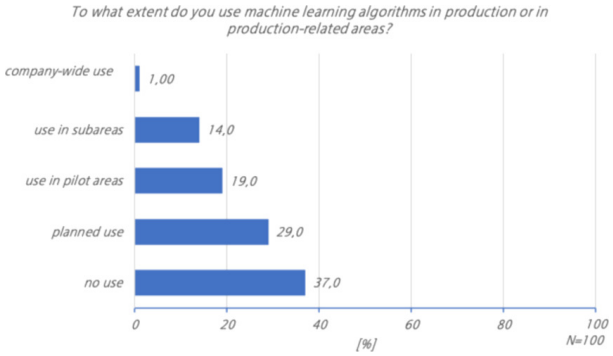

Fig. 22. Use of machine learning in production and production-related areas.

A large share of the experts stated that they had planned its use (29%) or already used machine learning in pilot areas (19% pilot areas, 14% sub-areas, 1% company-wide assignment). Due to its strong IT affinity and the complexity of the core processes, machine learning has not yet found its way into production across the board. In this respect, it is not surprising that significant differences are found between SMEs and large enterprises exist (Fig. 23).

While machine learning scored high on overall potential, its implementation is very specific and involves a considerable effort. Furthermore, expertise in this field is in great demand on the labour market and hence is expensive and usually only available in larger companies.

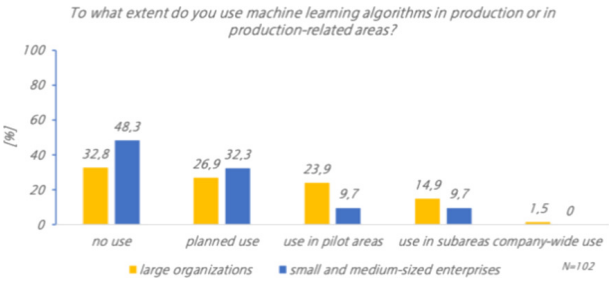

Fig. 23. Use of machine learning in production and production-related areas with respect to company size

Conclusion

The industrial panel "Made in Austria: Production work in Austria 2019" provides quantitative data on the subject of production work in the commercial and industrial production of tangible goods. The spectrum of companies surveyed in the panel ranges from start-ups and micro-enterprises to large international corporations and provides a representative picture of the Austrian corporate landscape in the field of production. The results show that the surveyed companies are optimistic about the future, especially in the light of the economic situation. The development is also positive with regard to jobs and employment and an increase in employment in the manufacturing sector is to be expected. Employment growth is anticipated to be stronger in general sectors and at international locations. Nevertheless, it should be emphasised that the competitiveness of Austrian production sites has deteriorated for more than 40% of the population, which is a clear warning signal.

Compared to the Austrian mean, the participating companies have a relatively high degree of automation (measured in robots/10,000 jobs), with certain companies and sectors standing out, while other companies are only just discovering the possibilities of robotics. Especially for the Austrian manufacturing industry, which is dominated by SMEs. The new technological developments in lightweight robotics offer excellent opportunities to secure or even expand the Austrian locations through flexible, collaborative robotics.

In the face of increased automation, the human factor continues to be of high importance. Despite the media excitement regarding substitution potential of human work through robotics, AI and automated systems, Austria's manufacturing companies continue to be a driving force behind jobs. In contrast, the current shortage of skilled workers is a dampening factor on growth that should not be underestimated and the issues of qualification and training are of high importance for many companies.

Innovation plays a central role for Austrian companies, which is reflected both in concretely measurable attributes (% share of products with an age <3 years) and in the subjective self-assessment of the innovativeness of companies and employees. The subjective assessments in particular show that they correlate positively with the research quota (expenditure on research and development).

Digitization and automation challenge employees and companies. While employees are often worried about job security and qualifications, companies are struggling with a shortage of skilled workers and the recruiting of new staff. A key to solving both problems lies in the training and further education of employees [2, 4].

Austria's manufacturing sector is in the process of advancing its technological base whereby unsurprisingly, larger companies are taking on a pioneering role. The topic of assistance systems is very current and many of the companies are already implementing or utilizing assistance systems, while the topic of machine learning is just arriving in industry is generating its first initial applications.

Overall, Austria's manufacturing sector has recognised the challenges posed by digitisation and automation and needs to take advantage of the technological opportunities to improve the competitiveness of Austria's production sites.

The results of this study are based on the industry panel that consists of 104 participants from 102 Austrian companies. Although it was always the intent to get a representative sample, there is a potential selection-bias insofar, that successful and innovative companies have a higher willingness to participate in such a panel, which might result in overly optimistic results. However, since it is the intent to steadily grow the number of panellists and actively broaden their spectrum with respect to industry and economic situation, this should become less problematic.

The annual survey of the Austrian manufacturing industry using a state of the art online tool allows for efficient data acquisition and will provide the decision makers with an up-to-date overview of the general mood of the sector but moreover with specific information with respect to the application of innovative technology like robotics and assistance systems.

The research presented in this paper is supported by the Austrian Research Promotion Agency (FFG) through the Austrian Ministry for Transport, Innovation and Technology (BMVIT)-endowed professorship "Human Centered Cyber Physical Production and Assembly Systems".

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