



Ministry of Industry and Trade



United Nations Development Programme

# INDUSTRY 4.0 READINESS

## OF INDUSTRY ENTERPRISES IN VIET NAM

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HA NOI 2/2019

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# LIST OF ABBREVIATIONS AND ACRONYMS

CAD	Computer Aided Design
CAF	Centre for Analysis and Forecast
DEPOCEN	Development and Policies Research Centre
ERP	Enterprise Resource Planning
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
IoT	Internet of Things
IR4.0	Fourth Industrial Revolution
IT	Information Technology
MDC	Machine Data Collection
MOIT	Ministry of Industry and Trade
PDA	Production Data Acquisition
R&D	Research and Development
RFID	Radio Frequency Identification
SCM	Supply Chain Management
SMEs	Small- and Medium-sized Enterprises
SOE	State-owned Enterprise
UNDP	United Nations Development Programme
VASS	Viet Nam Academy of Social Sciences
VDMA	Verband Deutscher Maschinen und Anlagenbau – (German Mechanical Engineering Industry Association)
VND	Viet Nam Dong
VSIC	Viet Nam Standard Industrial Classification

# ACKNOWLEDGMENTS

This study was conducted by two groups of experts commissioned by the United Nations Development Programme (UNDP) and the Ministry of Industry and Trade (MOIT, Science and technology Department) - the Centre for Analysis and Forecast (CAF, Viet Nam Academy of Social Sciences, VASS) and Joint Stock Consultancy Firm EPRO - under the supervision and overall quality assurance of UNDP and MOIT. The UNDP commissioned expert group was responsible for the development of survey methodology and questionnaire (based on the method of Verband Deutscher Maschinen-und Anlagenbau (VDMA), which MOIT and UNDP agreed to select for the application in this study), processing and analysis of survey data, conducting in-depth interviews and writing report. The MOIT commissioned expert group managed data collection, processing and creating a raw database, participating in data analysis and report writing.

The CAF expert group included Dr. Thang Nguyen (team leader), Ms. Tran Ngo Minh Tam, Ms. Nguyen Thu Huong and Ms. Nguyen Thi Van Ha. Its report utilized inputs from Dr. Nguyen Ngoc Anh (Development and Policies Research Centre, DEPOCEN), Ms. Nguyen Thi Thanh Ha, Ms. Vu Thi Van Ngoc (CAF) as well as data analyses from the MOIT expert group. This latter expert group included Ms. Tang Thi Hong Loan, Mr. Pham Minh Cong and Ms. Trinh Khanh Hoa. This final report was prepared by Mr. Nguyen Tien Phong (UNDP) through consolidating the two above-mentioned independent reports of the two expert groups and using some results of UNDP forthcoming studies on “financing sustainable development” and “productivity and competitiveness”.

Notably, the research teams received valuable comments and effective support from Science and Technology Department, MOIT. Finally, the corporations and enterprises that committed time to fill out questionnaires and share information during in-depth interviews as part of the research process are also warmly acknowledged.

# SUMMARY

Along with acceleration of the digital revolution, the link between the real world and the digital space - the Fourth Industrial Revolution (IR4.0) - is solidifying more deeply on a global scale and bringing about significant changes to all facets of socio-economic life.

Viet Nam is certainly not outside this trend. During the past two years, awareness of IR4.0's impacts on the economy has grown in Viet Nam. As a result, strengthening Vietnamese enterprises' capacity to access IR4.0 has become an important policy target. However, a comprehensive evaluation to determine IR4.0 readiness of enterprises in Viet Nam had yet to be conducted. As such, this study provides the first evidence of IR4.0 readiness of industrial enterprises in Viet Nam, informed by a survey of 2,659 industrial enterprises in the country.

## KEY FINDINGS

Regarding **IR4.0 readiness in general**, analysis results show the majority of industrial enterprises in Viet Nam (85%) remain "outsiders" vis-à-vis the Fourth Industrial Revolution (IR4.0) and a small share (13%) are at "beginner" level. The few remaining enterprises are at "intermediate" or "experienced" level. It is noted that as the IR4.0 just started, the high proportion of enterprises that are not ready can also be observed in Germany – the country with much higher development level compared to Viet Nam: the VDMA 2015 report of the survey on IR4.0 readiness shows that the share of enterprises that are at "outsider" level in engineering and manufacturing subsectors were at 38,9% and 58,2% respectively.

Analysis of **IR4.0 readiness in each pillar** (six pillars used by this report to measure readiness levels: *Strategy and Organization*, *Smart Factory*, *Smart Operations*, *Smart Products*, *Data-driven Services* and *Employees*) exhibited similar trend of the overall IR4.0 readiness, excepts in two pillars of *Employees* and *Smart Operations*. It is encouraging to note that in these two pillars enterprises have rather high readiness level. In *Employees* pillar: 89% of enterprises at "beginner" level or higher (46% "beginner", 41% "intermediate" and a few enterprises at the two highest levels of "expert" and "top performer". In the *Smart Operations* pillar, with more than 87% of enterprises at "beginner" level or higher, the share of enterprises at "intermediate" level and above was relatively high (more than 60%).

Apart from the relatively high readiness level of enterprises in these two pillars, *Smart Products* is the pillar where the surveyed enterprises achieved the lowest readiness level, with 93% assessed at "outsider" level (3% at "beginner"), followed by the share of "outsiders" (and "beginners") having reached 83% (17%) in *Strategy and Organization*, 67% (33%) in *Data-driven Services* and 65% (35%) in *Smart Factory* pillars, respectively. It is noteworthy that a few enterprises reached "experienced" or "expert" levels in these pillars. Similar to the overall IR4.0 readiness level, the high proportion of enterprises at "outsider" level in pillars was also observed in Germany: though 60% enterprises were aware of IR4.0, 75% enterprises (most of them are SMEs) did not have IR4.0 Strategy in 2015.

Regarding **factors related to IR4.0 readiness levels of enterprises**, the size, ownership and nature of industry make significant differences. In particular, the greater the enterprise's size, the higher the participation rate in IR4.0. State-owned enterprises (SOEs) have the highest participation rate in IR4.0 followed by foreign-invested enterprises, while non-State enterprises have the lowest participation rate. Differences in types of ownership can stem from characteristics associated with an enterprise: SOEs have higher average levels of capital, size, technological



capability, industry's degree of concentration and use of advanced technologies. Of the 17 priority subsectors, oil and gas as well as electronic products have the highest IR4.0 readiness levels, followed by electricity-gas-water, motor vehicle manufacturing and chemicals. The metal product manufacturing, textiles, leather and footwear subsectors – major exporters in the industry sector – have the lowest readiness levels.

Analysis of results regarding factors related to readiness levels for each different pillar showed similar outcomes for *Smart Operations* and *Employees*. In these two areas, enterprises' readiness did not increase in tandem with firm size or type of ownership. While subsectors with high readiness levels in these two pillars were metal product manufacturing, ship-boat-train building and electrical equipment, in the remaining pillars the subsectors with the highest readiness levels were electronic products and electricity-gas-water.

Regarding application of **typical IR4.0 technologies**, similar to other countries and including developed ones, in Viet Nam advanced IR4.0 technologies are still in limited use in industrial enterprises. The two most popular IR4.0 technologies, cloud computing and modes of machine connections with equipment/products, are only applied by one-in-10 enterprises. Enterprises applying other technologies, especially additive manufacturing (3D printing) and data analytics and management (big data), were negligible. Overall, the share of enterprises applying advanced technologies tended to increase with firm size, more prominent in oil and gas, metal product manufacturing, electrical equipment and electronic products.

## IMPRESSIONS AND RESPONSES OF ENTERPRISES TO IR4.0

Approximately four-fifths of enterprises had no plans to implement significant adjustments in the context of IR4.0, including more than one-third who reported not knowing how to respond. In fact, the rate of responses "Do not know how to respond" and "Plan only negligible changes" decreased as a firm's size increased, and was lowest in the SOE group and highest in the domestic private firm group. While one-in-five enterprises anticipated making changes, the majority had yet to identify a specific area for adjustment. The field most selected by enterprises for adjustment was equipment and plant premises (6% of enterprises), considered to have an important role in the survival and growth of enterprises. Similar to other fields, though assessed as less important than equipment and plant premises, adjustments to information technology (IT) were next favoured (5%) by enterprise planning for change. With these selections, more than half of enterprises were confident they could cope with changes induced by IR4.0, while just below 30% thought they could cope if supported.

## POLICY IMPLICATIONS

This study was conducted against the backdrop of some key economic characteristics of Viet Nam, including: (i) the private sector remaining relatively small and undeveloped, (ii) micro, small and medium-sized enterprises (SMEs) making up a large and growing proportion in the economy, (iii) a large share of employees work in the informal sector and (iv) an industrial base developing with low labour productivity, added value and enterprise competitiveness. With the study's findings on the relationship between labour force and capital sizes as well as levels of industry concentration and technology, the readiness level of enterprises has important policy implications: *efforts to enhance the readiness level of enterprises for IR4.0 must be an inseparable part of industry policy and development of domestic enterprises, reform of SOEs and FDI attraction.*

Effort is required to help *all domestic enterprises of different types of ownership* (particularly medium-sized, small and micro enterprises) grow in scale and levels of capital equipment, increase the concentration index and apply advanced technologies, improve R&D capabilities and conduct skills training for workers. Priority must be given to multi-disciplinary solutions, the "whole of

government" approach (cross-sectoral), to build a "creative network" with participation from all stakeholders (government, enterprises and investors) in applying IR4.0 technologies with high spillover effects. This is necessary to support the important goals of industrial development, labour productivity and competitiveness as well as the competitiveness and connectivity of Viet Nam enterprises in domestic and global value chains.

Reform of SOEs must focus on: (i) application of IR4.0 technologies to promote the relative strengths of SOEs to raise labour productivity and competitiveness and (ii) create linkages between SOEs and domestic private enterprises to increase the spillover effect and SOEs' ability to enhance IR4.0 readiness.

UNDP forthcoming studies on "*financing sustainable development*" and "*productivity and competitiveness*", considering FDI as an important sources of technology transfer and increasing IR4.0 readiness level for domestic firms, recommend the shift of focus in attracting FDI from quantity to quality. The studies suggest gradually application of (i) international technology standards to attract FDI, (ii) requirements for increased linkages with, and technology transfers to, domestic companies, (iii) more stringent standards on efficient energy use and environmental safety and (iv) strengthening institutional capacity and more rigorous review systems, thorough appraisals and approvals of FDI projects to ensure compliance with such standards.

To increase the industry sector's IR4.0 readiness, the study found that while the readiness score for the *Strategy and Organization* pillar of the entire industry sector and each subsector was low, many enterprises were formulating strategies to restructure labour forces, applying technical standardization throughout production chains, linking management operations in some units, adopting enterprise resource planning and management models (ERP), supply chain management (SCM) applications and enhancing the collection and exchanges of information on production processes and products. The research team recommends the industry sector, VSIC two-digit subsectors and within which enterprises, must upgrade to a IR4.0 strategy to elevate the management linkages to inter-connect all units. In addition, support for investment in technology renovation should be prioritized (upgrades, application of technologies with high spillover effects, relative simplicity and low costs, such as applying cloud technology and digitalization).

In respect to the *Smart Products* pillar, enterprises must focus on equipping the manufacturing process and especially products (suitable for integrating IT for product data) with IT features to collect and analyze data necessary for optimizing the manufacturing process and product development, sales and after-sales services.

Regarding the *Smart Factory* pillar, enterprises at "outsider" or "beginner" levels in this area should collect and process data to increase efficiency in planning and monitoring, adjustment and optimization of enterprise' production and business processes. At the same time, it is necessary to apply solutions to connect infrastructure, machinery and equipment with IT systems to automate procedures to fine-tune processes in a timely and flexible manner.

With the *Data-driven Services* pillar, enterprises at "outsider" or "beginner" levels must start applying data-driven services or integrating them with improved customer utilities. The group of "experienced" enterprises should digitize the integration of services and enhance utilities of customers.

For areas where enterprises have attained higher readiness levels, such as the *Smart Operations* and *Employees* pillars, improvements at a higher level can help increase the readiness level for these areas. In *Smart Operations*, enterprises should foster integration of systems with outside and automated control procedures. The readiness level for *Employees* will be improved if enterprises place due emphasis on equipping employees with necessary skills for aspects related

to IR4.0 readiness, achieved not only by efforts from each enterprise - but also implemented through linkages with “*top performer*” companies. “*Top performer*” companies may assign experts to deliver support or provide internships and practice opportunities for enterprises at lower readiness levels and with government support (organization of joint trainings, standards setting, lesson plans) at sector and industry levels.

However, it should be noted that: (i) the readiness level to *connect equipment with devices/systems/products* can only be elevated with investments in technology renovation by 47% of enterprises in the sector, requiring large investment that usually entails high risks and (ii) not all enterprises would need to meet all IR4.0 readiness requirements (measurements used in the survey). Depending on IR4.0’s impacts on their production and business processes, enterprises could determine suitable participation levels in each pillar/dimensions (indicators) and/or select advanced technologies with low costs and wide applicability, such as cloud technology<sup>1</sup>. To arrive at such a selection, as proposed by international experts at the ‘IR4.0 Summit’ organized by the Party’s Central Economic Commission and the Government of Viet Nam in July 2018, there should be further studies on the challenges, impacts and opportunities for each subsector/enterprise to provide the basis for formulation of action plans for each subsector/enterprise and government policy to help enterprises and subsectors minimize negative impacts, leverage opportunities and meet challenges brought about by IR4.0, so enterprises/subsectors grow faster and more sustainably.

Finally, “measures” and their use to assess readiness levels (pillars, dimensions of each pillar, weights and scoring methods) adopted and adapted from the VDMA (Verband Deutscher Maschinen und Anlagenbau - German Mechanical Engineering Industry Association) method and applied in this study must be “calibrated” for future similar surveys/studies. The dimensions of each pillar and questionnaires should be developed through several rounds of consultations with experts and enterprises of different subsectors, with weights developed based on evidence-based studies. As IR4.0 impacts are felt by all sectors and in different ways, meeting IR4.0 requirements necessitates increased linkages between sectors and future enterprise-focussed surveys/assessments should be conducted in all sectors of the economy.

*Specific policy recommendations by enterprises participating in the in-depth interviews (which form an integral part of the survey) included:*

#### INFRASTRUCTURE:

- Improve telecommunications infrastructure: Several shortcomings remain apparent, as the speed of internet connections in Viet Nam is sub-optimal and cable breakages on international telecommunications routes severely affect enterprises applying technologies and working with foreign partners. Especially with the proliferation of services and transactions of enterprises applying cloud computing technology, the dependence of enterprises on internet connections is greater than ever.
- Network and data security: The government should have more stringent and punitive sanctions against hackers acting in the territory of Viet Nam. Enterprises face increased threats of attacks from hackers in country and abroad, while the law does not have specific

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<sup>1</sup> For enterprises at the “beginner” level or higher, there should be mechanisms to encourage the adoption of pilot models to develop and implement strategy for linking and managing the operations of the product value chain, and for enterprises at “intermediate” level or above, it is necessary to consider developing and piloting roll-out of Internet of Things technology.

measures to protect rights nor has it adequate sanctions against unauthorized data infringements.

- Infrastructure such as electricity and water: These utilities must be upgraded in the age of IR4.0.
- Upgrading the Data Centre of Viet Nam Road Administration (Ministry of Transport) is recommended due to overloading. Meanwhile, the centre constitutes an important digital platform as this database management system can solve numerous problems, such as extracting necessary data and information for the traffic management agencies and tax management departments.

#### ACCESS TO FINANCE:

- Improve disbursement procedures: Most enterprises claimed incentive packages for preferential credit and financial support from government were ineffective. The main reason cited was difficult disbursement procedures that discouraged capable and qualified enterprises from approaching financing sources as opportunity costs were too high compared to preferential benefits received.
- Enterprises recommended a tax incentive policy for the import of high-tech machinery for production.
- A concessional lending policy for enterprises investing in IR4.0 technologies was recommended, as large investments usually entailed high risks.

#### HUMAN RESOURCE DEVELOPMENT:

- Policies are necessary to train students with skills and knowledge based on technology from schooling to easily access new machinery and technologies when entering the workforce. In addition, there should be a strategy for training students majoring in computer science, information technology, robotics engineering in line with the rapid progress of technology.
- Support access to information: Enterprises requested the government and research institutions, pioneering in the field of technology, organize seminars and training courses to improve knowledge about technologies and share business experiences of difficulties and challenges faced when applying IR4.0 technologies and how all enterprises can overcome such impediments. The government should also apply digital management to make information sharing more effective, rather than simply placing information on government and ministries' websites. It is also necessary to accelerate application of auto search engines to select relevant information for enterprises in the manner platforms such as Google and Facebook, conduct digital marketing. This will help automate the process of sharing information with enterprises, ensuring information is transferred to the right audience, especially SMEs with less resources for search and analysis of necessary information.
- Training courses, skills coaching: Most interviewed enterprises highly valued the capabilities of Vietnamese workers, but due to limitations in accessing high technology machinery and equipment, it is necessary to create conditions for experts, engineers and users of technology to be exposed to advanced technologies and participate in short-term, yet effective and practical training courses.
- There should be clear policy orientation to encourage and facilitate enterprises to penetrate more deeply into the global value chain: The government and State governing agencies should be more active in guiding and supporting enterprises to convert from low value processing to higher value enterprises, such as FOB exports.

#### OTHER RECOMMENDATIONS:

- A policy to promote and implement e-commerce activities for enterprises, especially in the field of intermediate goods and raw materials.
- It is advisable to build an e-commerce transaction platform for domestic and international enterprises operating in the territory of Viet Nam, capable of ensuring quality for sellers and buyers. For example, Alibaba supports Chinese enterprises reaching out to customers and partners globally.
- Thoroughly implement electronic administrative procedures (typically Customs and taxation), harmonize and integrate them with international electronic systems (such as international Customs systems).
- Standardization of international technical standards: Technical and environmental standards promulgated by the Ministry of Science and Technology differ from international technical standards, while enterprises are required to import machinery from abroad to support production. This requires efforts to reprogramme machinery, equipment and software.



## 1. INTRODUCTION

With the accelerated digital revolution, the connection between the physical world and cyber space has become increasingly powerful. With three main features: (i) high-speed internet (wired and 3G broadband, non-linear 4G), (ii) high-performance computing (mainframes, personal computers, tablets, smart phones and software) and (iii) sensors, cyber space is creating more value in economies (in terms of absolute value as well as percentage of GDP) by optimizing activities in the real world. This is the most fundamental feature of IR4.0, which is accelerating and changing the present structure of economies in general and of sectors and enterprises, in particular.

In the past two years, Vietnamese society's awareness of IR4.0 has significantly increased. The Government issued Directive No.16/CT-TTg (dated 4 May 2017) on enhancing access to IR4.0, which requires ministries and sectors to produce annual reports with updated assessments and levels of access to IR4.0 in Viet Nam, in general and Vietnamese enterprises, in particular. While there has been a great deal of discussion in recent years, a lack of in-depth analysis on the level of Vietnamese enterprises' access to IR4.0 based on evidence has been apparent.

To address such a need, this is one of the first evidence-based studies (implemented from January to July 2018) on the IR4.0 readiness of industry sector enterprises in Viet Nam. Its objective was to assess, through a sample survey of around 2,700 industrial enterprises in Viet Nam and in-depth interviews with 25 enterprises representing surveyed sectors, the current status as well as trends and general characteristics of IR4.0 readiness of industrial sector enterprises in Viet Nam. This study will also help the MOIT to: (i) make proposals to government on appropriate solutions and contributions to the Politburo's draft resolution on IR4.0 to help Vietnamese enterprises seize opportunities and overcome challenges associated with IR4.0 to enhance productivity, efficiency and competitiveness and (ii) gain initial forecasting information as a basis to roll-out monitoring and evaluation of future progress on industrial enterprises' readiness level for IR4.0.

This study's IR4.0 readiness assessment includes three aspects:

- Readiness level of enterprises to access IR4.0
- Factors related to readiness level of enterprises to access IR4.0
- Perceptions of enterprises on the impact of IR4.0 and their responses.

## 2. METHOD TO ASSESS IR4.0 READINESS OF ENTERPRISES

### 2.1. VDMA METHOD

To assess IR4.0 readiness of enterprises in the industry sector, this study used the method developed by the German Mechanical Engineering Industry Association (Verband Deutscher Maschinen- und Anlagenbau - VDMA)<sup>2</sup>. This evaluation method ("the VDMA method") can be summarized as follows<sup>3</sup>: Overall, the model evaluates enterprises' level of participation in IR4.0 based on six pillars:

- **Strategy and Organization:** Measuring the strategic vision of an enterprise accessing IR4.0 in the following dimensions: B1 Degree of strategy implementation, B2 Completeness of strategic performance measurement indicators, B3 Investments (for technological innovation) and B4 Innovation management.
- **Smart Factory:** Measuring the level of digitization and automated production on the physical-cyber space system platform of an enterprise in the following dimensions: C1 Control, connectivity features of equipment, C2 Level of meeting connectivity needs of equipment, C3 Digital modeling for management, C4 Method of data collection, C5 Purposes of data usage and C6 Level of coverage of information technology system (C6 was not used in the Viet Nam survey).
- **Smart Operations:** Measuring the ability of processes and products to be digitalized and controlled through information technology systems in the following dimensions: D1 Information sharing, D2 Automation, D3 Autonomous processes, D4 Information technology security and D5 Cloud computing technology usage.
- **Smart Products:** Measuring the ability to control products by information technology and enable the connection of products to high-tech systems in the value chain in the following dimensions: E1 Data analytics in usage phase (data feed ability of product by information technology) and E2 IT add-on functionalities (using data of products).
- **Data-driven Services:** Measuring the ability to provide services to connect products, processes and customers in the following dimensions: F1 Services integrating data on production and product usage, F2 Contribution of data-driven services usage in sales revenue (this dimension was not applied in the Viet Nam survey) and F3 Data-driven services (data usage level collected).
- **Employees:** Measuring the quality of personnel in the following dimensions: G1 Employee skill sets and G2 (the ways of) skill acquisition (not used in this survey).

Figure 2-1 presents an overview of the VDMA method model that assesses an enterprise's level of participation in IR4.0, with the six pillars and 18 dimensions earlier described. These pillars and dimensions (as well as scoring and rankings outlined below) used by VDMA to assess an enterprise's

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<sup>2</sup> The German Mechanical Engineering Industry Association (VDMA) is headquartered in Frankfurt, Germany, and represents about 3,200 members, making it the largest professional association in Europe. The association represents the interests of average mechanic companies to policy and social planners, as well as to enterprises, the scientific community, public authorities and media.

<sup>3</sup> This section is based primarily on the German Mechanical Engineering Industry Association's 2015 report (Source: VDMA. 2015. "Industrie 4.0 Readiness - The Readiness for the Fourth Industrial Revolution", <https://www.industrie40-readiness.de/?lang=en>).

level of participation in IR4.0, were developed through VDMA consultations with representatives from German enterprises joining the association through seminars and discussions.

**FIGURE 2-1: MODEL OF VDMA METHOD TO EVALUATE ENTERPRISES' READINESS TO PARTICIPATE IN IR4.0**



**SOURCE: VDMA (2015)**

These six pillars and 18 dimensions are used to develop a method for enterprises to self-assess/grade and to rank their readiness/participation in IR4.0<sup>4</sup>.

- Evaluating (scoring) the readiness level/participation of an enterprise in each dimension (e.g., B1, B2 or D1, D2, etc., as stated above): (i) Based on responses to questions about each dimension (in each pillar), scores will (with a value from 0-5) be assigned to a readiness level of an enterprise in that dimension. A value of 0 will be assigned to the readiness level of an enterprise in the dimension if there is no answer/no information, and/or the enterprise has not done anything or very little to prepare or implement activities related to that dimension. Value 5 (highest) will be assigned to the readiness level of an enterprise if it has successfully implemented activities in that dimension and (ii) a readiness score for IR4.0 is determined by the scores of the pillars according to the formula:

Readiness score (A) = 25.4% \* B + 14.3% \* C + 10.2% \* D + 18.5% \* E + 13.7% \* F + 17.9% \* G, where B, C, G are readiness scores of the pillars, which have a value equal to the lowest score<sup>5</sup> among those in corresponding dimensions (e.g., B = B1 if B1 has the

<sup>4</sup> Details of the minimum criteria an enterprise must meet to determine whether it has completed each level, as well as the scoring and ranking are given in Appendix 1.

<sup>5</sup> Assigning the lowest score value among the scores of dimensions in the pillar as being the point of the whole pillar shows the complementary attachment of dimensions in a pillar. For example, a

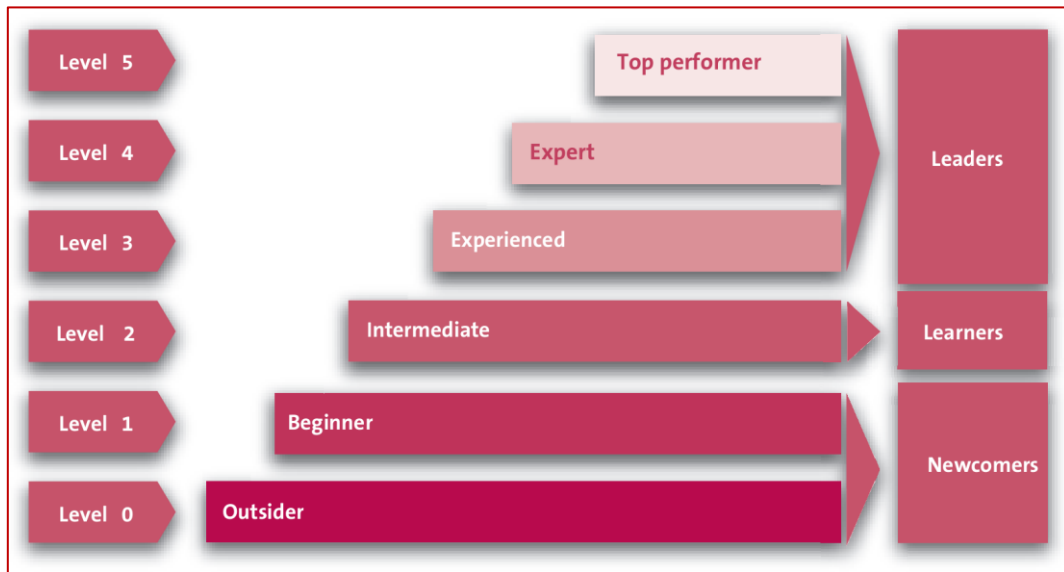
lowest value among B1, B2 and B3), and the percentages (25.4%, 14.3%) are the weight assigned to each pillar (*Strategy and Organization* is assigned the weight of 25.4%, *Smart Factory* 14.3%, *Smart Operations* 10.2%, *Smart Products* 18.5%, *Data-driven Services* 13.7% and *Employees* 17.9%). These weights are determined based on the empirical studies of VDMA conducted for 289 enterprises of the German engineering industry by 2015.

- Rating readiness level/level of participation of an enterprise in IR4.0: Is classified into six levels (from 0 to 5) with the scores calculated as above. It is specifically described in Figure 2-2:

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business may have a high score on 'strategy', but a low score on 'investment' or 'innovation management' that demonstrates although a strategy does exist/is good, but nothing/little was done, the readiness level of the business regarding this pillar is not high. However, this method of assigning scores may give rise to errors, such as those related to latency of investment over the time of strategy development and timing of the evaluation.

FIGURE 0-1: SIX READINESS LEVELS OF AN ENTERPRISE IN IR4.0



**SOURCE: VDMA 2015**

At level 0 is a group of enterprises that are assessed as “outsiders” – enterprises that have not done anything or very little in preparation for the implementation of IR4.0-related activities. Level 5 features the “top performer” enterprises, those that have successfully implemented IR4.0 activities, fully deployed a targeted vision and have an entire value chain integrated with real-time technology, allowing interactions between value chain stages.

The six readiness levels are divided into three groups enabling a summary of results in a more general level and create a more conducive condition to draw conclusions about the level of progress, and identify requirements/conditions and specific required actions based on the implementation levels (Figure 2-2). As such, the: (i) *Newcomers* group (readiness level 0-1) includes “outsider” and “beginner” enterprises, (ii) *Learners* group (readiness level 2) includes “intermediate” enterprises, which have made the first steps in deployment of IR4.0 and (iii) *Leaders* group (readiness level 3 and above) includes “experienced”, “expert” and “top performer” enterprises that have made sufficient strides in IR4.0 deployment and are at a much more developed level than other enterprise groups.

## 2.2. APPLICATION OF VDMA METHOD IN SURVEY TO EVALUATE IR4.0 READINESS OF ENTERPRISES IN SUBSECTORS UNDER MOIT ADMINISTRATION

The VDMA method was developed and applied for the *self*-assessment of enterprise readiness levels in the manufacturing industry, especially the mechanical engineering industry in Germany. The areas and especially the requirements for each area were designed to categorize firms in Germany: (i) operating in the manufacturing industry, particularly the mechanical engineering industry (an industry of high precision with high levels of automation) and (ii) generally have high levels of development and IR4.0 readiness levels.

Therefore, when applying the VDMA method in a *sample survey* to determine the *main trends* and characteristics of readiness levels of industrial enterprises in Viet Nam, it should be noted there are three differences between the application of the VDMA method in Germany and to this survey in Viet Nam.



Firstly, the surveyed enterprises in Viet Nam operate in 17 subsectors, much broader than the mechanical manufacturing industry. Specifically, some advanced IR4.0 technologies, such as data analytics and management (big data) and additive manufacturing (3D printing) technologies, are considered suitable and are used in the mechanical industry, but 3D printing may not be suitable (and not widely used) in food processing, chemicals or beverage.

Secondly, the surveyed enterprises in Viet Nam have much lower levels of development and readiness, as areas and requirements for each according to the VDMA method may not be fully suitable for enterprises in Viet Nam. Scoring for classifying readiness levels according to the VDMA method may be more appropriate in terms of "differentiation" in Germany (where enterprises can be distributed more broadly/equally on the VDMA scale of IR4.0 readiness: in the Germany's engineering subsector 38.9% enterprises were at "outsider" level, 37.6% - "beginner", 17.9% - "intermediate", 4.6% - "experience", 1% - "expert" và 0% "top level", source: VDMA 2015) than in Viet Nam (where enterprises are mainly clustered in low readiness level groups according to the VDMA classification scale: 85% at "outsider" and 13% - "beginner"). Therefore, the very low scores by Vietnamese industrial enterprises against some requirements in areas does not always indicate no or limited action to improve access to IR4.0. In some cases, business characteristics of enterprises in some subsectors (as mentioned earlier) do not require enterprises to have access or use such technologies (or technologies yet to be widely used in some subsectors) now or in the future (although it is unclear if such technologies will indeed be widely by subsectors). However, if the technologies are essential and have been used extensively (replacing 3.0 technologies) in subsectors, such as mechanical engineering, the low score is an appropriate indicator of readiness level.

Thirdly, this was a sample survey to assess the current status and general trends regarding IR4.0 readiness levels of industrial enterprises in Viet Nam (while the VDMA method is designed for enterprises to self-assess readiness levels). As a result, the scoring, ranking and analysis of survey results at enterprise level are not statistically significant and cannot be used for comparison between enterprises (as only a small number of enterprises participated in the survey). The analysis of survey results is aimed to assess the current state, trends and characteristics at sector and industry levels (for subsectors with two-digit codes, according to Viet Nam Standard Industrial Classification - VSIC).

In order to address these differences and increase the relevance of the VDMA method to this survey in Viet Nam, the research team made a number of adjustments, including: (i) addition of several questions, for example, on which technologies a business used (cloud computing, 3D printing) as typical IR4.0 technologies, which are fundamental and can be applied broadly in many subsectors other than the mechanical engineering industry, to provide broader sector coverage and to take into account technological capabilities/readiness of industrial enterprises in Viet Nam, (ii) detailed sampling design for the survey and (iii) adjustment of scoring method as described below<sup>6</sup>.

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<sup>6</sup> Due to time constraints and limited international experience of the methodology for assessing readiness for I4.0, these modifications were rather modest. In the future, the pillars, dimensions, specific questions and scoring method should be developed on the basis of results of consultations with representatives of enterprises, industry specialists and in particular weights should be determined on the basis of empirical research.

## 2.2.1. QUANTITATIVE QUESTIONNAIRE OF SURVEY IN VIET NAM

The questionnaire of the sample survey was developed based on the VDMA questionnaire (see Appendix 2). However, there were differences (see comparison of differences between the two questionnaires in Appendix 2) to better suit conditions in Viet Nam.

## 2.2.2. SAMPLE SELECTION

The sampling frame of this survey was constructed from 68,000 industrial enterprises in the General Statistics Office's 2017 Enterprise Census. Some 14,666 enterprises were randomly selected to be sent questionnaires (with a target of at least 2,000 responses for the entire industry sector and 138 samples per two-digit subsector to ensure 95% confidence in accordance with the sampling design per Appendix 3), sub-divided using the following two criteria:

Firstly, according to VSIC, the industry sector comprised two primary subsectors - "Mining and Quarrying" and "Manufacturing" - comprised of 29 secondary subsectors with the (two-digit) secondary subsector codes ranging from 05 to 33. This survey focused on research of 17 manufacturing subsectors (VSIC codes 06, 10, 11, 13, 14, 15, 17, 20, 22, 24, 25, 26, 27, 28, 29, 30, 35) and remaining subsectors (other industries). As oil and gas has a small number of enterprises, to ensure their representation, all firms in the sampling frame were selected for survey and analysis. The manufacturing subsectors' names were abbreviated according to characteristics of the industry sector and are summarized in Table 2-1. The proposed abbreviations are the most specific subsector names in each industry group.

*TABLE 2-1: ABBREVIATION OF SUBSECTORS UNDER VSIC 2*

No.	VSIC Code	Name by VSIC	Abbreviation
1	06	Extraction of crude petroleum and natural gas	Oil and gas
2	10	Manufacture of food products	Food processing
3	11	Manufacture of beverages	Beverages
4	13	Textiles	Textiles
5	14	Manufacture of wearing apparel	Garments
6	15	Manufacture of leather and related products	Leather and footwear
7	17	Manufacture of paper and paper products	Paper products
8	20	Manufacture of chemicals and chemical products	Chemicals
9	22	Manufacture of rubber and plastics products	Rubber and plastics
10	24	Manufacture of basic metals	Basic metals
11	25	Manufacture of fabricated metal products, except machinery and equipment	Fabricated metals
12	26	Manufacture of computer, electronic and optical products	Electronics
13	27	Manufacture of electrical equipment	Electrical equipment
14	28	Manufacture of machinery and equipment n.e.c	Machinery and equipment n.e.c

15	29	Manufacture of motor vehicles; trailers and semi-trailers	Motor vehicles
16	30	Manufacture of other transport equipment	Other transportation vehicles
17	35	Electricity, gas, steam and air conditioning supply	Electricity-gas-water
18		Remaining industries	Other industries

Secondly, in each industry, enterprises were categorized by size: small firms (less than 200 employees), medium-sized firms (200 to 299 employees) and large enterprises (more than 300 employees)<sup>7</sup> as some studies have shown significant differences in enterprises' involvement in IR4.0<sup>8</sup>. Given the majority of enterprises in Viet Nam are SMEs and to ensure representation of large enterprises in the sample, over-sampling was conducted for this SME group. The accompanying sampling weight was used for calculations for this group of enterprises for computational analysis to ensure results were unbiased. Details on sample selection are provided in Appendix 3.

### 2.2.3. SCORING AND RANKING OF ENTERPRISES ACCORDING TO IR4.0 READINESS

The research team tried, to a maximum extent, to apply the pillars, dimensions (appropriate for Viet Nam's industries) and VDMA's evaluation criteria for scoring and ranking firms by IR4.0 readiness. However, during implementation, the research team made some adjustments to suit actual conditions, specifically:

There was a difference in the VDMA survey questionnaire with that of the MOIT survey as mentioned above. For questions included in the VDMA survey, but not in Viet Nam's, they were not used for evaluation (in the VDMA survey, unanswered questions were ignored as having no information, treated as missing information). In contrast, for questions included in this survey and not in the VDMA questionnaire, collected information was not used to calculate the scores and rank enterprises, but was only used for analysis of factors as described in the second part of this report.

As the 2015 VDMA survey report did not provide a detailed scoring scale for each question (no scoring scheme) and only gave qualitative guidelines, the research team had to specify such guidelines to establish a more detailed scoring scale. In this process, the team strived to follow the qualitative guidelines on how to benchmark the readiness level of an enterprise in each dimension of VDMA.

As stated, the weights for the six areas developed by VDMA based on empirical research for 289 German manufacturing industry firms may not be entirely appropriate for Vietnamese firms due to large differences in technological capabilities between enterprises of the two countries. However, due to time constraints, empirical studies to determine the weights were not possible.

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<sup>7</sup> The sizes of large, medium and small enterprises are defined based on Decree 56/2009/ND-CP (for industrial and agricultural enterprises, "small- and medium-sized" equals 300 employees or less and "large" more than 300 employees, while for service enterprises "small and medium-sized" equals 100 workers and less and "large" is more than 100 employees). However, in the analysis of differences in readiness levels by size, the research team also looked and analyzed the size of firms at different levels.

<sup>8</sup> Source: VDMA, 2015. "Industrie 4.0 Readiness - Readiness for Participation in the Fourth Industrial Revolution".

Hence, the research team used these weights for computation of aggregate results and provided results based on calculations without weights (unweighted average) for comparison.

The scoring method for enterprises' IR4.0 readiness level was also based on VDMA methodology described earlier, while the scoring of a readiness level of an industry (or sector) was computed using the following formula:

$$A(\text{industry, sector}) = \frac{\sum A(i) * P(i)}{\sum P(i)}$$

Where: A (i) is the readiness level of an enterprise in the under valuation, P (i) is the sampling weight calculated for the enterprise to determine the share of firms of an industry in calculations, which is represented by sampled enterprises.

The ranking of enterprises based on the scores is described in Table 2-2.

**TABLE 2-2: RANKING OF READINESS FOR IR4.0**

Group	Level	Score	Readiness Level	Response Activities
Newcomers	0	0-1	Outsider	No proper preparation
	1	1-2	Beginner	Very little preparation
Learners	2	2-3	Intermediate	Have basic preparation
Leaders	3	3-4	Experienced	Have good preparation
	4	4-5	Expert	Have considerable preparation
	5	5	Top Performer	Have absolute preparation

The *Newcomers* group (readiness level 0-1) includes "outsider" (scores 0-1) and "beginner" enterprises (scores 1-2), the *Learners* group (readiness level 2) includes "intermediate" enterprises (scores 2-3) and the *Leaders* group (readiness level 3 or above) includes "experienced" (scores 3-4), "expert" (scores from 4 to less than 5) and "top performer" (score of 5) enterprises.

### 2.3. QUALITATIVE SURVEY

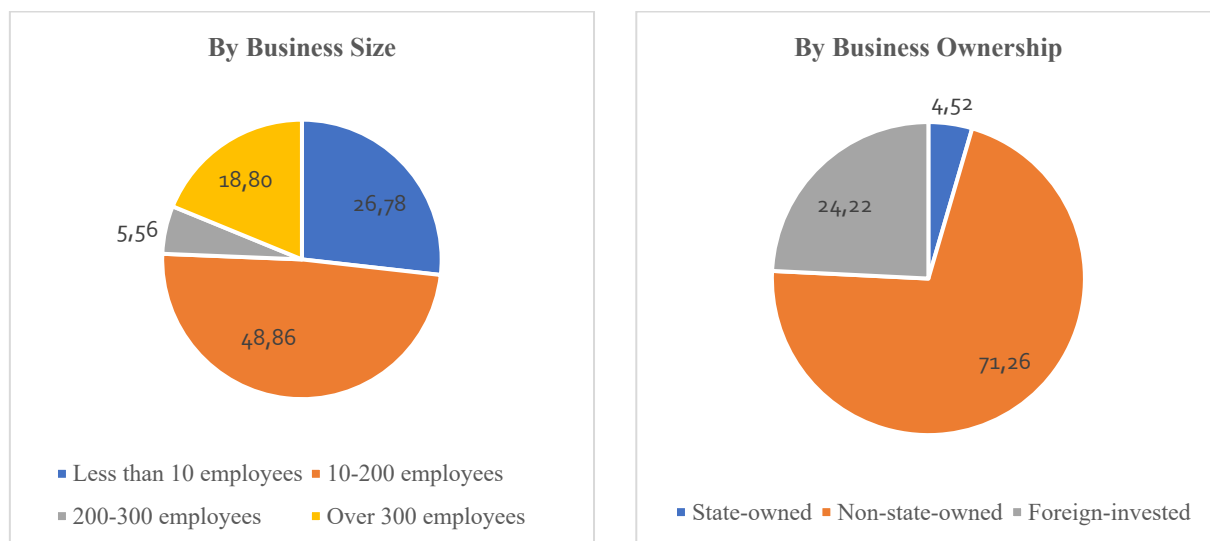
The qualitative survey, with working tools being in-depth interviews, was conducted after the quantitative survey. In the context of the qualitative survey, in-depth interviews were conducted by experts with two target groups: (i) conglomerates and corporations; and (ii) enterprise participants in the quantitative survey. With the latter group, enterprises selected for in-depth interviews were located in Ha Noi and with high IR4.0 readiness levels. This saved time, travel costs and maximized information gathered about opportunities and challenges for enterprises accessing IR4.0. Another important aspect of in-depth interviews was to collect business proposals and recommendations on solutions to help Viet Nam's business sector accelerate IR4.0 readiness. For this purpose, a targeted questionnaire was prepared and used by the research team for in-depth interviews. Other information, such as the overall score and scores in each field obtained from quantitative analysis results as well as from general information about enterprises on web pages, was prepared and thoroughly examined before direct interviews were conducted.

### 3. RESEARCH RESULTS

#### 3.1. SAMPLE SURVEY: SIZE AND STRUCTURE

The sample size of respondents in the survey was 2,659<sup>9</sup> enterprises in different subsectors. Regarding the structure by enterprise size of the sample (Figure 3-1, left), 26.8% of enterprises had less than 10 employees, 48.9% had 10 to less than 200 employees, 5.6% had from 200 to less than 300 employees and 18.8% had more than 300 employees.

*FIGURE 0-1: STRUCTURE OF THE SAMPLE (%)*



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

Regarding the structure of sample by type of ownership, 71.3% were non-SOEs, 4.5% were SOEs and 24.2% were foreign-invested enterprises.

The structure of surveyed enterprises' responses from 18 subsectors<sup>10</sup> (including 17 MOIT priority subsectors and the remainder) is highlighted in Table 3-1 and Figure 3-2. As the oil and gas had a small number of enterprises (14) and respondents (10), due caution should be exercised when examining the analyses. The other subsectors have a sufficiently large number of observations, especially for information relating to the share of enterprises ready to access IR4.0<sup>11</sup>.

<sup>9</sup> These enterprises did not include 89 enterprises that participated in the survey, but did not have sample weight as they were not included in the initial survey list.

<sup>10</sup> According to information on the subsector of an enterprise in the initial survey list. The subsector structure of the survey sample and analysis results of the enterprises' self-declared readiness levels for I4.0 by subsector are referenced in Appendix 7.

<sup>11</sup> Notes on the use of survey results analyzed for each of two-digit subsectors: Sample design for each two-digit subsector of the survey (see Appendix 3) aimed to attain 95% confidence with key indicators. Analysis results are interpreted as being within the corresponding confidence interval. With the post-census data, this confidence interval depends on: (i) p - estimated probability, (ii) n - sample size in each two-digit subsector and (iii) overall sample size. In the case of this study, the sample size in each two-digit sector was small compared to the overall scale, so the factor (iii) was not significant and the confidence intervals were estimated from the first two factors. For example, the percentage of "outsider" enterprises in the food processing subsector (with 162 samples) is 84%, and this result should be interpreted as the (probability) percentage of "outsider" firms in the food processing subsector is in the range of 78.35-89.65% (95%). Similarly, the percentage of food processing subsector enterprises at the "beginner" level of 14% as provided in the report should be understood as the percentage of firms in the food processing subsector at the "beginner" level is about 8.66-19.34%. Since



TABLE 2-1: CHARACTERISTICS OF SURVEYED ENTERPRISES GIVING RESPONSES

No.	Industry		No. of enterprises nationwide	No. of surveyed enterprises giving responses by size		
	VSIC code	Industry name		Total	Large enterprises	SMEs
1	06	Oil and gas	14	10	3	7
2	10	Food processing	7,053	162	32	130
3	11	Beverages	2,230	155	18	137
4	13	Textiles	3,157	168	36	132
5	14	Garments	6,369	153	32	121
6	15	Leather and footwear	1,849	157	39	118
7	17	Paper products	2,429	143	26	117
8	20	Chemicals	3,305	146	25	121
9	22	Rubber and plastics	4,967	188	45	143
10	24	Basic Metal	1,148	146	26	120
11	25	Fabricated Metal	12,648	155	38	117
12	26	Electronics	1,375	174	31	143
13	27	Electrical equipment	1,349	146	31	115
14	28	Machinery and equipment	1,713	141	20	121
15	29	Motor vehicles	481	158	29	129
16	30	Other transportation vehicles	707	144	26	118
17	35	Electricity-gas-water	1,621	146	31	115
18		Other industries	15,708	167	50	117
INDUSTRY SECTOR			68,123	2,659	538	2,121

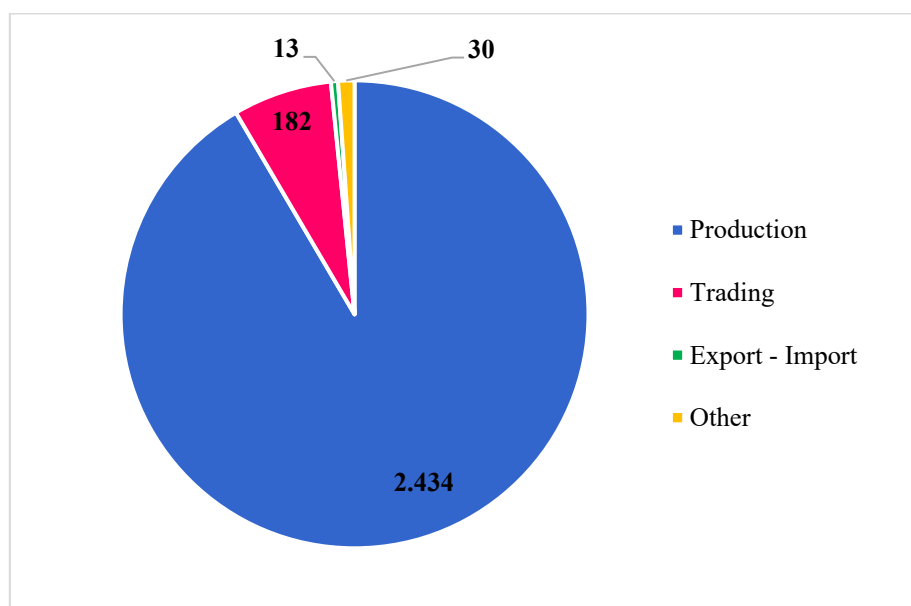
SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

Figure 3-2 highlights the overwhelming majority of surveyed enterprises operating in the manufacturing field (2,434 enterprises, accounting for 91.5% of those surveyed). The share of total surveyed enterprises operating in other sectors was less than 7%.

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the sample size used for some in-depth analyses was small (for too large corresponding confidence intervals), these analyses, such as those according to ownership and/or size of business in each two-digit subsector, will not be conducted. In addition, care should be taken to use the analysis results at a very small percentage (merely at few percentages), whereby the smallest and largest values of the confidence interval can be far from an estimated probability of more than 100% and the statistical significance of these results is not high.

FIGURE 3-2: BUSINESS TYPE OF ENTERPRISES IN SURVEY



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

## 3.2. RESULTS OF SURVEY DATA ANALYSIS

### 3.2.1 READINESS LEVEL OF THE INDUSTRY SECTOR: THE MAJORITY OF INDUSTRY SECTOR ENTERPRISES IN VIET NAM ARE "OUTSIDERS" IN TERMS OF IR4.0.

Figure 3-3 and Table 3-2 show the average readiness score of the entire sector is 0.53 ("outsider" level) and up to 85% of industrial enterprises in Viet Nam are "outsiders" of IR4.0. Some 13% of enterprises in the survey were at "beginner" level and only 2% of enterprises were assessed at "intermediate" level ("Learners" group), negligibly small numbers of firms rated as "experienced", "expert" and none as "top performers"<sup>12</sup>. However, it is noted that as IR4.0 newly started the high proportion of enterprises that are not ready can also be observed in Germany – the country at much higher development level compared to Viet Nam. The report on survey results on participation in 4.0 of German enterprises conducted in 2015 (using VDMA method) showed that the percentage of enterprises as "outsiders" of 4.0 among firms in the engineering and manufacturing subsectors was 38.9% and 58.2%, respectively; and the proportion of engineering subsector enterprises at "experienced" and "experts" were only 4.9% and 1% respectively, and no enterprise was at "leader" level (Source: VDMA 2015, p. 26).

<sup>12</sup> In Figure 3-3, percentages of these firms in the total number of surveyed firms were too small and thus rounded as "zero". At the same time, the percentages of these firms - at the "experienced" and "expert" levels - in the number of surveyed firms within a few subsectors (due to smaller numbers of surveyed firms) became more significant as shown in Table 3-2.

**FIGURE 3-3: IR4.0 READINESS LEVELS OF ENTERPRISES**

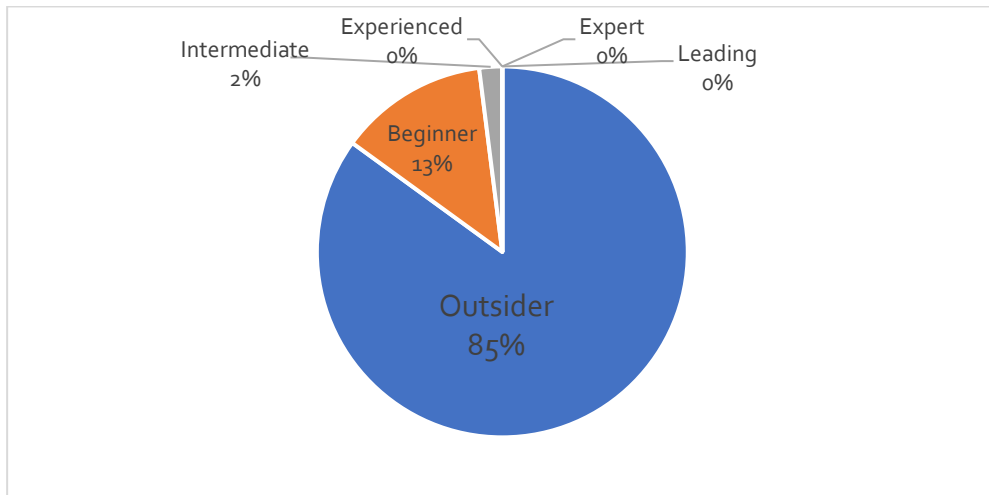


TABLE 0-2: RANKING OF ENTERPRISES BY IR4.0 READINESS

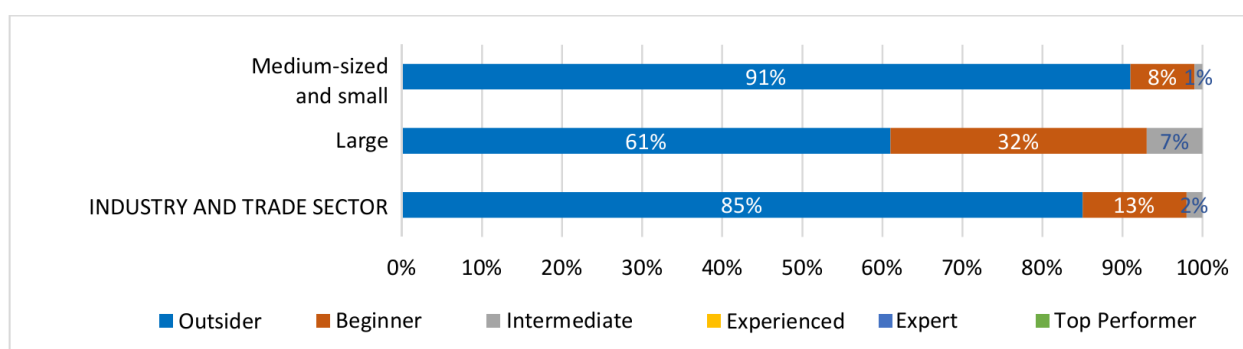
Surveyed Industry	No. of Samples	Score	Readiness Level					
			Outsider	Beginner	Intermediate	Experienced	Expert	Top Performer
ALL SUBSECTORS	2,659	0.53	85%	13%	2%	0%	0%	0%
Oil and gas	10	1.16	30%	60%	10%	0%	0%	0%
Food processing	162	0.55	86%	13%	1%	0%	0%	0%
Beverages	155	0.52	86%	12%	1%	0%	1%	0%
Leather and footwear	157	0.50	92%	6%	1%	0%	0%	0%
Textiles	168	0.45	92%	8%	1%	0%	0%	0%
Garments	153	0.49	90%	10%	0%	0%	0%	0%
Paper products	143	0.56	89%	8%	3%	0%	0%	0%
Chemicals .	146	0.67	73%	26%	1%	0%	0%	0%
Rubber and plastics	188	0.53	94%	5%	1%	0%	0%	0%
Basic Metals.	146	0.59	84%	16%	1%	0%	0%	0%
Fabricated Metals	155	0.43	92%	6%	1%	0%	0%	0%
Electrical equipment	146	0.62	87%	11%	2%	0%	0%	0%
Machinery and equipment	141	0.53	84%	13%	4%	0%	0%	0%
Other transportation vehicles	144	0.56	88%	10%	1%	0%	0%	0%
Motor vehicles	158	0.69	83%	11%	5%	1%	0%	0%
Electronics	174	0.82	72%	22%	6%	0%	0%	0%
Electricity-gas-water	146	0.69	73%	18%	8%	2%	0%	0%
Other industries	167	0.54	75%	22%	4%	0%	0%	0%
BY SIZE								
Large	538	0.88	61%	32%	7%	0%	0%	0%
Medium and small	2,121	0.51	91%	8%	1%	0%	0%	0%
BY OWNERSHIP								
State-owned	120	1.44	37%	47%	16%	1%	0%	0%
Non-State	1,895	0.50	89%	10%	1%	0%	0%	0%
Private	282	0.46	88%	11%	1%	0%	0%	0%
Partnerships	5	0.90	60%	40%	0%	0%	0%	0%
Limited liability	1,170	0.47	93%	6%	1%	0%	0%	0%
Joint stock company with State-invested capital	62	0.95	61%	37%	2%	0%	0%	0%
Joint stock company with no State-invested capital	376	0.63	82%	14%	4%	0%	0%	0%
With foreign-invested capital	644	0.60	81%	16%	3%	0%	0%	0%
100% foreign-invested capital	603	0.60	59%	16%	2%	0%	0%	0%
Joint venture	41	0.65	55%	20%	5%	2%	0%	0%

SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

## Size, ownership and nature of subsector make a significant difference in ir4.0 readiness levels

The size of an enterprise (as measured by number of employees) is closely related to readiness level, as the readiness score of large enterprises was 0.88, while that for smes was only 0.51 (table 3-2). the share of enterprises at "outsider" level of ir4.0 in the large business group was 61%, while this number of smes was 91% (compared to the sector average of 85%). the percentage of enterprises at "beginner" level of the large business group was 32% in contrast to 8% of smes (compared to the sector average of 13% (figure 3-4)).

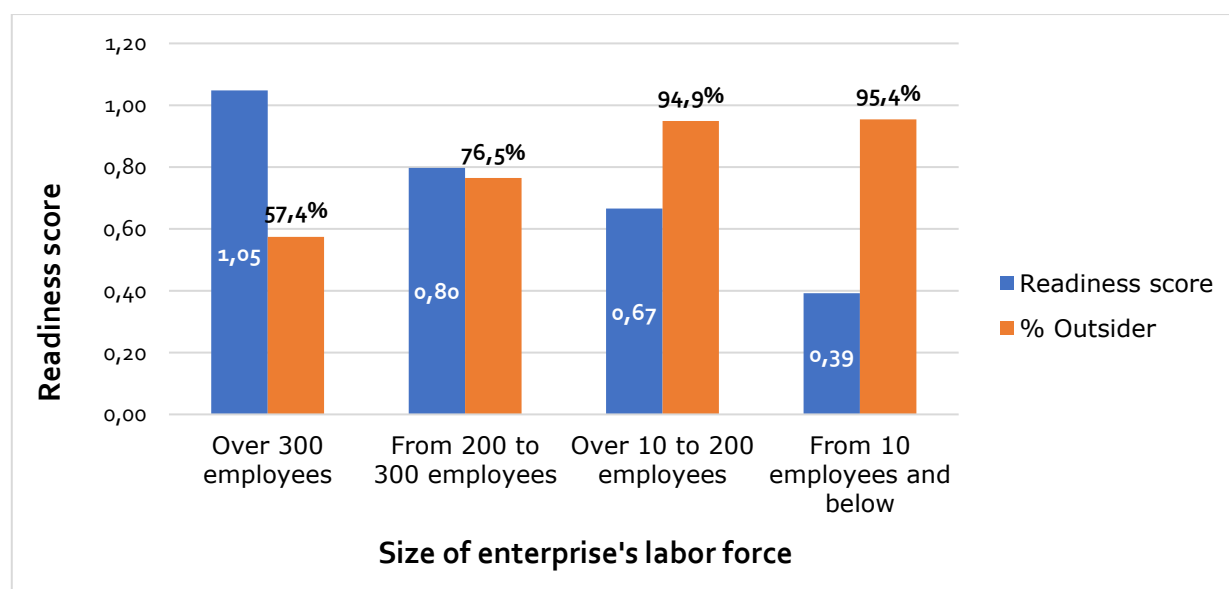
**FIGURE 3-4: IR4.0 READINESS LEVEL OF ENTERPRISES BY SIZE**



To better understand the relationship between size and readiness level, the research team analyzed this connection at more granular level: from 10 employees down, 10-199, 200-300 and more than 300 employees. The analyses showed the *share of enterprises as "outsiders" of IR4.0 gradually decreased as the size of enterprises increased*. This share was high at 95.4% for enterprises with less than 10 employees, decreases to the corresponding levels of 94.9%, 76.5% and 57.4% for enterprises with 10-200 employees, 200-300 employees and more than 300 employees, respectively. Figure 3-5. Econometric analysis<sup>13</sup> (see detailed results in Table PL6-1 - appendix) shows that, even with other conditions being equal, business size is an important factor that significantly influences an enterprise's level of access to IR4.0. Figure 3-5 also shows the readiness score increases as an enterprise's size grows.

<sup>13</sup> Econometric analysis was carried out with the division of enterprise groups according to seven size levels of greater granularity: (i) less than 10 employees, (ii) 10-24, (iii) 25-49, (iv) 50-99, (v) 100-299, (vi) 300-999 and (vii) from 1,000 or more employees.

FIGURE 3-5: DIFFERENCES IN READINESS SCORE AND SHARE OF ENTERPRISES BEING OUTSIDERS OF IR4.0 BY ENTERPRISE SIZE



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

On linkages between *ownership* and readiness levels: the proportion of domestic non-State enterprises (average readiness score of 0.50, lower than the sector average score of 0.53) being “outsiders” of IR4.0 was at a very high level of 89%<sup>14</sup>. This ratio of foreign-invested enterprises (average readiness score of 0.60) was also relatively high at 81%, while this proportion of SOEs (average readiness score of 1.44, much higher than the sector average score) was only 37%. Correspondingly, the share of enterprises at the *beginner* level was 10% considering the group of domestic non-State enterprises, 16% for foreign-invested enterprises and 47% for SOEs.

*Determinants of enterprises’ readiness level for IR4.0:* To clarify the root of the relationship between readiness level and ownership as well as avoid inconsistent comparisons (when only considering the ownership factor, but lacking control over other important determinants of an enterprise’s readiness level), the research team conducted an econometric analysis (Table PL6-1) on links between determinant levels of capital equipment, size, technological capabilities and concentration levels of production (see details of these important factors in Box 3-1 and differences in ownership types in Table 3-3). Results showed that if there was control of other business characteristics, there would be no differences (in technical terms, the difference was not statistically significant) in the form of ownership (except forms of partnership – Box 3-1). In other words, differences in readiness levels among enterprises of different types of ownership in terms of IR4.0 readiness levels were due to factors such as levels of capital equipment, size and concentration levels of production associated with these groups of enterprises (by ownership).

<sup>14</sup> Notably, 16% of SOEs were at “intermediate” level and 1% were “experienced” (belonging to the “leaders” group in the process of participating in I4.0) and the group of joint stock companies with State-invested capital has an average score of 0.95 (close to the “beginner” level), significantly higher than the 0.5 average score for domestic non-SOEs. Note: The numbers of samples collected in the groups of SOEs and joint stock companies with State-invested capital were only 120 and 62, respectively. This is relatively small compared to the sample size of 138 in the sampling design, and thus due caution should be taken when using the results in this footnote.

### BOX 3-1: CHARACTERISTICS OF ENTERPRISES RELATED TO IR4.0 READINESS LEVELS

Linking data from this survey of 2,659 enterprises with data from the General Statistics Office's Enterprise Census 2017 allows for an analysis of association characteristics with IR4.0 readiness levels of industrial enterprises in Viet Nam. Econometric analysis shows (see details in Table PL6-1), with other conditions being constant, that:

- If the level of capital equipment for one worker (K/L) increased to 1%, the score measuring IR4.0 readiness increased to 0.03%
- Business size: see detailed analyses above
- Type of ownership: Joint ventures have a higher score than other firms by 0.23
- If the concentration index of the industry of an enterprise<sup>15</sup> increased to 1%, the score measuring IR4.0 readiness increased to 0.01%
- If an enterprise operates in a high-tech industry (according to the NACE classification of the EU), the score measuring IR4.0 readiness increased to 0.05.

*Source: Calculated from IR4.0 Readiness Survey and the Enterprise Census 2017*

**TABLE 3-3: FACTORS RELATED TO ENTERPRISES' ABILITY TO ACCESS IR4.0 BY TYPE OF OWNERSHIP**

	K/L (million VND)	Size of labour force (people)	Concentration index	High-tech manufacturing (%)
All enterprises	953	113	8.17	0.13
SOEs	4,256	871	30.01	0.14
Non-State enterprises	841	65	8.14	0.11
Foreign-invested enterprises	1,319	334	6.10	0.27

**SOURCE: CALCULATED FROM ENTERPRISE CENSUS 2017**

For a variety of reasons, including the starting point and development process, factors such as level of capital equipment, size of labour force, concentration index and manufacturing field leave SOEs superior to business groups of the two remaining ownership types. These factors have resulted in the SOE group's higher readiness level. This finding is similar to that of factors of scale, level of capital equipment, concentration index and "high-tech" manufacturing industry - outstanding dominant elements of SOEs - being the main sources of SOEs' higher productivity, competitiveness, added value generation and that their investment capacity for technological

<sup>15</sup> In this study, the concentration index of the subsector at the three-digit level by district is calculated by the formula  $LQ_{ij} = L_{ij} / L_i \cdot (L_j / L_{..})$ , in which:  $L_{ij}$  - Number of workers of subsector  $i$  in district  $j$ ;  $L_i$  - Number of workers of subsector  $i$  nationwide;  $L_j$  - Number of workers in district  $j$ ;  $L_{..}$  - Number of workers nationwide. The high index will have a positive impact on technology and labour productivity owing to its increasing the ability to learn from each other when there is a high concentration of labour in the same subsector in the same area.



innovation, R&D and skills training for workers exceed that of enterprises in the other two forms of ownership.

### **Typical IR4.0 technologies are still in limited use at enterprises**

Table 3-4 shows that a small percentage of enterprises have applied technologies typical of IR4.0. In the table, technologies are presented from top-to-bottom according to the proportion of enterprises to have applied them. Only cloud computing<sup>16</sup> and connecting machines with equipment/products exceeded 10% of total enterprise applications. With other technologies the ratio was below 10%, with rates under 1% for additive manufacturing technology (3D printing) and data analysis and management (big data).

*TABLE 3-4: APPLICATION OF TYPICAL TECHNOLOGIES OF IR4.0 IN ENTERPRISES (%)*

Typical technologies of IR4.0	Being applied	Will be applied	No plan to apply	Irrelevant	Total
Cloud computing	15.1	4.5	65.6	14.8	100
Connecting machinery to equipment/products	12.4	6.1	68.9	12.6	100
Sensor technology	9.8	4.7	64.6	21.0	100
Mobile terminal technology	4.0	4.1	70.1	21.8	100
Real-time positioning technology	1.7	3.5	72.2	22.7	100
Radio frequency identification (RFID) technology	1.3	1.9	58.7	38.1	100
Artificial intelligence	1.3	3.0	72.8	22.9	100
Additive manufacturing technology (3D printing)	0.9	2.7	51.4	45.0	100
Data analysis and management (big data)	0.5	4.0	14.1	81.5	100

SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

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<sup>16</sup> Globally, cloud computing is also a I4.0 technology most commonly used as it helps enterprises, in particular SMEs, to cut costs due to use of data storage resources, software and data analysis services provided by a professional third party.

However, this is to be expected as even in developed countries, the application of advanced digital technologies is still limited. Table 3-5 shows that earlier this decade, only 19.2% of enterprises used cloud computing (the median value, as the measure to reject outlier values, was even lower at 13.5%), while the application of radio frequency identification technology was much lower at 4.2% of enterprises (median value was just 3%).

**TABLE 3-5: ADVANCED DIGITAL TECHNOLOGIES NOT WIDELY USED IN DEVELOPED COUNTRIES (% OF ENTERPRISES WITH 10 EMPLOYEES OR MORE)**

	PC	Internet	Broadband	Website	SCM	ERP	CRM	E-purchase	Cloud comp	E-sales	Cloud co	RFID
First quartile	96	95.25	93	62.5	37.5	22	20.25	14	11	9.25	5	3
Min	87	85	78	44	23	10	13	3	5	5	2	1
Median	98	97.5	95	75	51	31	26	19.5	15	13.5	8	3
Max	100	100	100	95	74	47	44	51	51	27	31	8
Third quartile	99	98	97	83.75	59.75	39	35.75	40	28	23	14	6
Average	97.0	96.2	94.2	72.6	48.7	30.2	27.8	24.8	19.2	15.1	10.4	4.2

SOURCE: WORLD BANK 2016 – "WORLD DEVELOPMENT REPORT 2016: DIGITAL DIVIDENDS"

Notes: (i) SCM: Supply Chain Management Software, CRM: Customer Relationship Management Software, ERP: Enterprise Resource Planning Software, RFID: Radio Frequency Identification Technologies and (ii) Data gathered from 32 high-income countries.

**TABLE 3-6: SHARE OF CLOUD COMPUTING USAGE BY SIZE AND OWNERSHIP (%)**

	Being applied	Will be applied	No plan to apply	Irrelevant	Total
<b>Classified by size (%)</b>					
Less than 10 employees	10.8	2.4	73.8	13.0	100
10-200 employees	17.0	4.3	64.6	14.0	100
200-300 employees	16.1	4.4	58.3	21.2	100
Over 300 employees	22.3	17.5	32.9	27.2	100
<b>Classified by type of business (%)</b>					
SOEs	28.7	22.4	23.3	25.6	100
Non-State enterprises	14.5	4.2	68.3	12.9	100
Foreign-invested enterprises	17.6	4.2	52.7	25.5	100

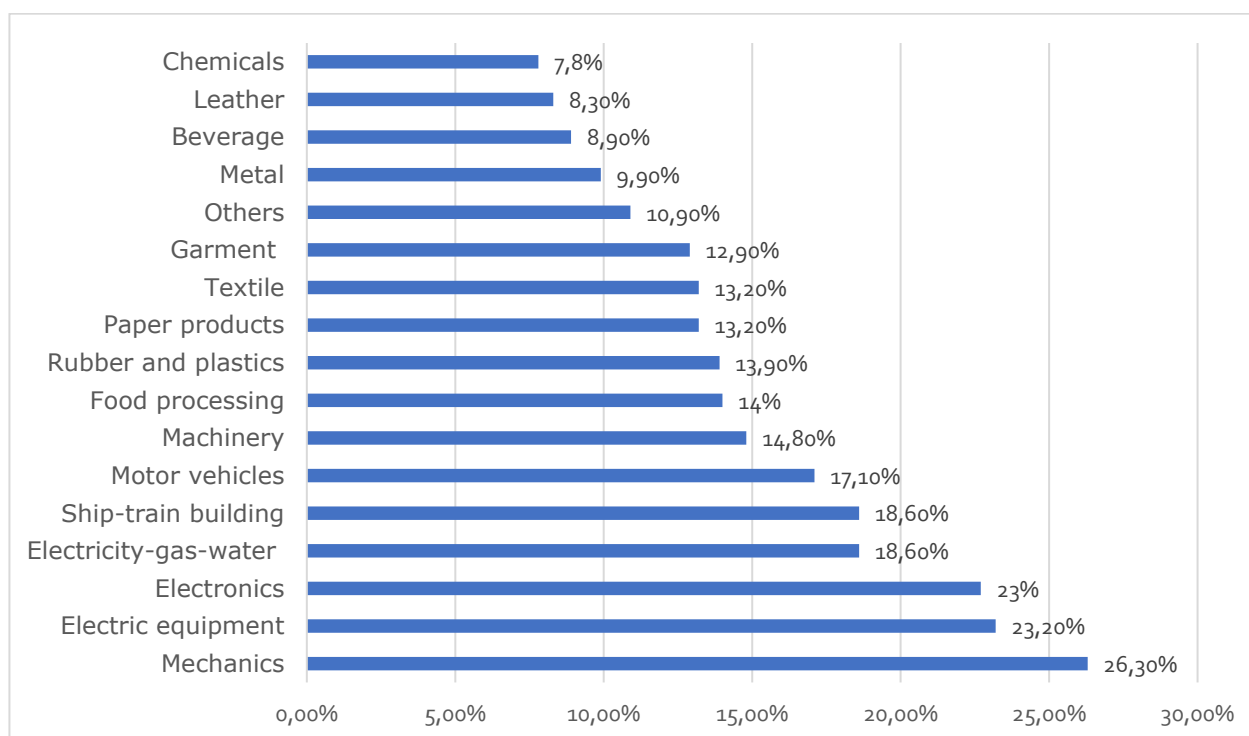
SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

There were also differences between enterprise groups in adoption rates of cloud computing. Table 3-6 shows the utilization rate tended to increase in step with scale (except groups of 10-200 and 200-300 employees). In terms of ownership, this proportion differed little between groups of foreign-invested enterprises and private domestic firms.

Significant differences were also apparent across subsectors. Figure 3-6 highlights ones where cloud computing application rates outperformed other subsectors, such as mechanical engineering (26.3%), electrical equipment (23.2%) and electronic products (22.7%). Meanwhile,

some subsectors had much lower rates such as beverages (8.9%), leather and footwear (8.3%), chemicals (7.8%).

*FIGURE 3-6: SHARE OF CLOUD COMPUTING APPLICATIONS IN SUBSECTORS (%)*



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

With the proportion of enterprises having applied these technologies (cloud computing and connecting machinery with equipment and products) exceeding 10%, it is possible to perform econometric analysis with the dependent variable being discrete variable (only one of two values "Yes" or "No" was accepted)<sup>17</sup>. Details of logit regression calculation results are presented in Table PL6-2).

For application of cloud computing, with other conditions being equal and compared to enterprises with 10 employees or less, enterprises with labour forces of 25-49, 100-299, 300-999, and 1,000 employees and above have a higher probability of applying this technology (7.7%, 12.1%, 13.7% and 16.9%, respectively). Compared to enterprises that do not use the internet for operations management, enterprises that do use the internet have a higher probability of using cloud computing by about 6.5%. Meanwhile, if other business characteristics are controlled, then ownership no longer makes a difference in terms of proportion of enterprises using cloud computing.

Regarding technology for connecting machinery to equipment/products, the econometric analysis showed that, with other conditions being equal, if the level of capital equipment per worker (K/L) of the business increased by 1%, it would help increase the ability of enterprises to apply this technology by 0.03%. The size of enterprise was also an influential factor: compared to

<sup>17</sup> Regarding other technologies, the application rate was too low with no division between enterprises in applying the technologies. Therefore, the econometric analysis was illogical in terms of economics as well as from a statistical mathematics perspective.

enterprises with less than five employees, those with labour forces of 3-9, 50-99, 100-299, 300-999 and 1,000 employees and above have greater capability to apply this technology (7.1%, 10.4%, 17.5%, 22.1% and 24.8%, respectively). Employee skill sets are also relevant: if the percentage of workers using computers increased by 1%, the probability of enterprises applying technology to connect machinery to equipment/products would increase by 0.1%.

### **A majority of enterprises did not have plans to make significant adjustments in the context of IR4.0**

About four-fifths of enterprises did not intend to make adjustments in the context of IR4.0, with 34% of enterprises reporting they did not know how to respond (Table 3-7 and Figure 3-7). Similar to assessments related to the ability to access IR4.0, there was a difference between groups of enterprises where the rate of responses "Do not know how to respond" and "Plan negligible changes" decreased as the size of an enterprise increased, lowest in the SOE group and highest in the domestic private enterprise group.

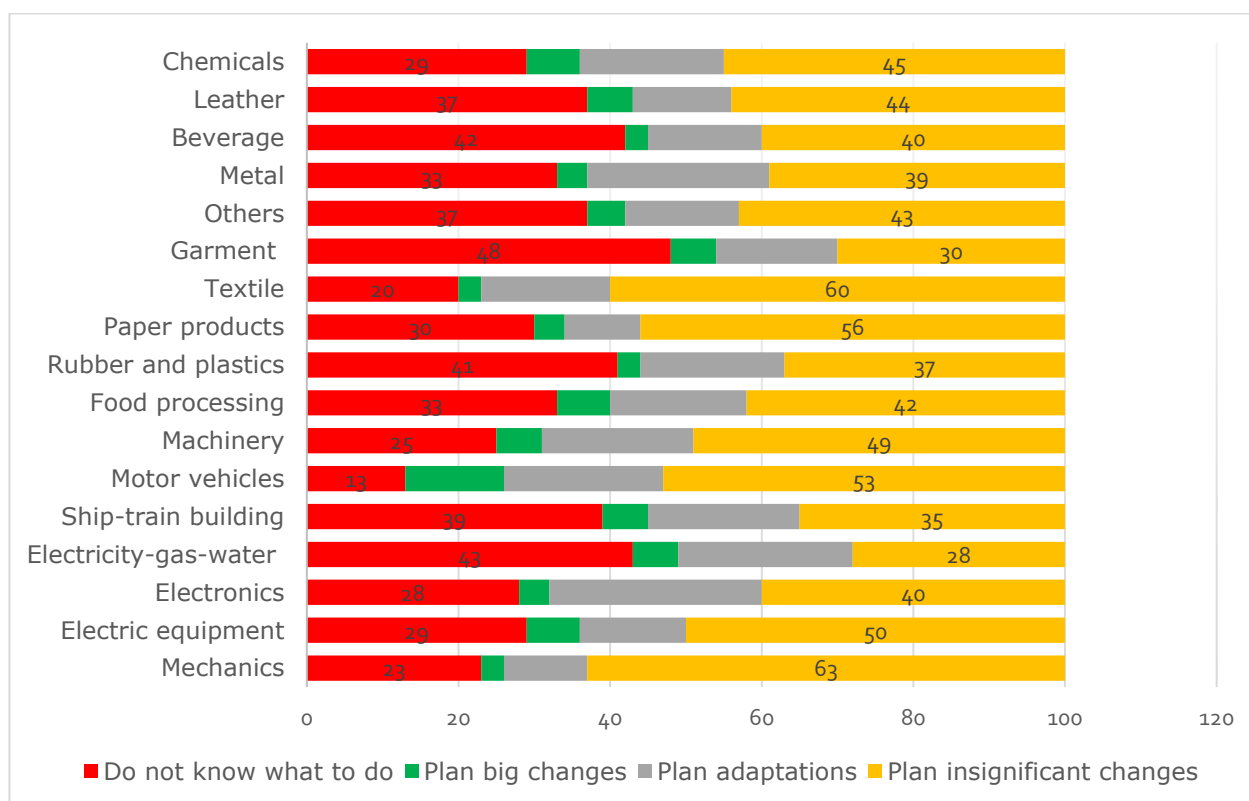
*TABLE 3-7: RESPONSES OF ENTERPRISES TO IR4.0 (%)*

	<b>Do not know how to respond</b>	<b>Plan large changes</b>	<b>Plan moderate changes</b>	<b>Plan negligible changes</b>	<b>Total</b>
<b>Overall</b>	<b>34.0</b>	<b>5.0</b>	<b>16.0</b>	<b>45.0</b>	<b>100</b>
<b>Classified by size</b>					
Less than 10 employees	37.1	2.0	8.8	52.1	100
10-200 employees	34.5	5.4	17.0	43.1	100
200-300 employees	23.7	7.8	29.7	38.8	100
Over 300 employees	13.3	17.0	36.6	33.1	100
<b>Classified by form of ownership</b>					
SOEs	6.6	33.8	34.9	24.8	100
Non-State enterprises	34.9	4.6	14.9	45.5	100
Foreign-invested enterprises	28.5	4.7	19.5	47.3	100

SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

There were also significant contrasts among firms in different subsectors regarding the rate of those who "Do not know how to respond" to IR4.0. This rate exceeded 40% in garments, rubber and plastics, chemicals, but less than 30% in mechanical engineering, electronics, electrical equipment, machinery and multi-disciplinary enterprises.

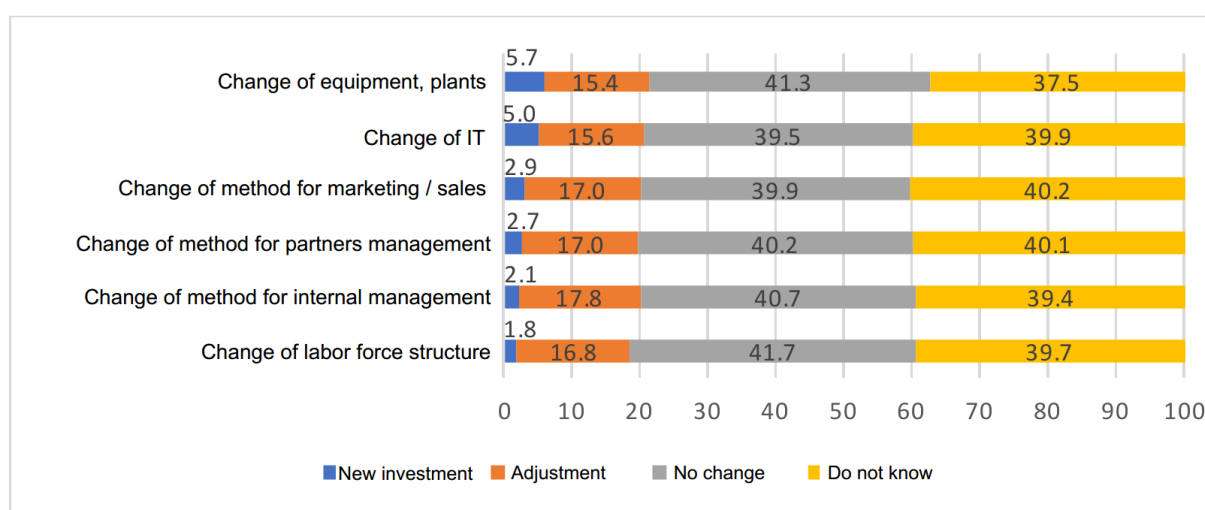
FIGURE 3-7: RESPONSE OF ENTERPRISES IN THE CONTEXT IR4.0 (%)



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

Regarding enterprises' expected adjustments in specific areas, approximately four-in-five firms either did not know or did not intend to change (Figure 3-8). With regard to investment, only two areas (IT and equipment-plants) were recipients of investments by more than 5% of enterprises.

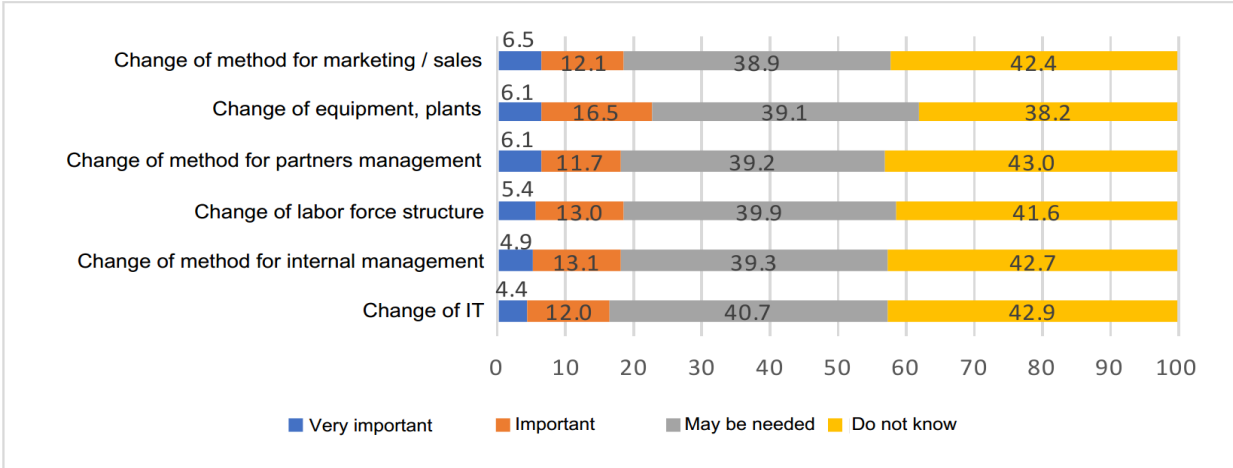
FIGURE 3-8: EXPECTED CHANGES IN ENTERPRISES (%)



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

Answering the question "What changes are the most important to business existence and development?", 22.7% of enterprises said equipment-plants played an important or very important role, and this ratio was significantly higher than those in the remaining areas, ranging from 16.4% to 18.6% (Figure 3-9).

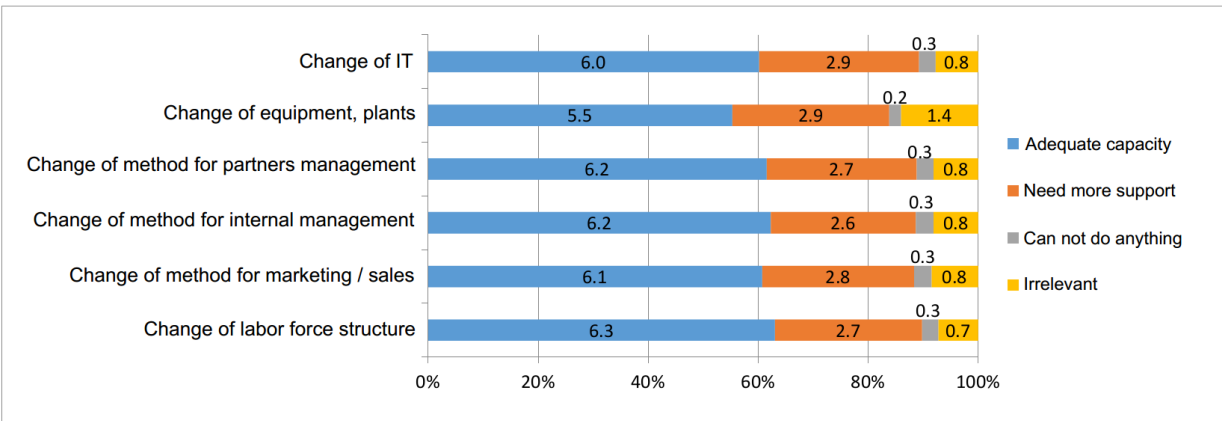
FIGURE 3-9: MOST IMPORTANT CHANGE WITH DEVELOPMENT AND EXISTENCE OF BUSINESS



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

Addressing the question "What is the ability of the enterprise to meet the above changes?", enterprises were quite confident, with the percentage of "adequate capacity" responses between 55.3% and 63%, varying by field of operation (Figure 3-10). Only 26.4-29.0% of enterprises found they needed support. The remaining 10.2-16.2% of respondents said they could not do anything or found no relevance.

FIGURE 3-10: CAPACITY OF ENTERPRISES TO COPE WITH CHANGES (%)

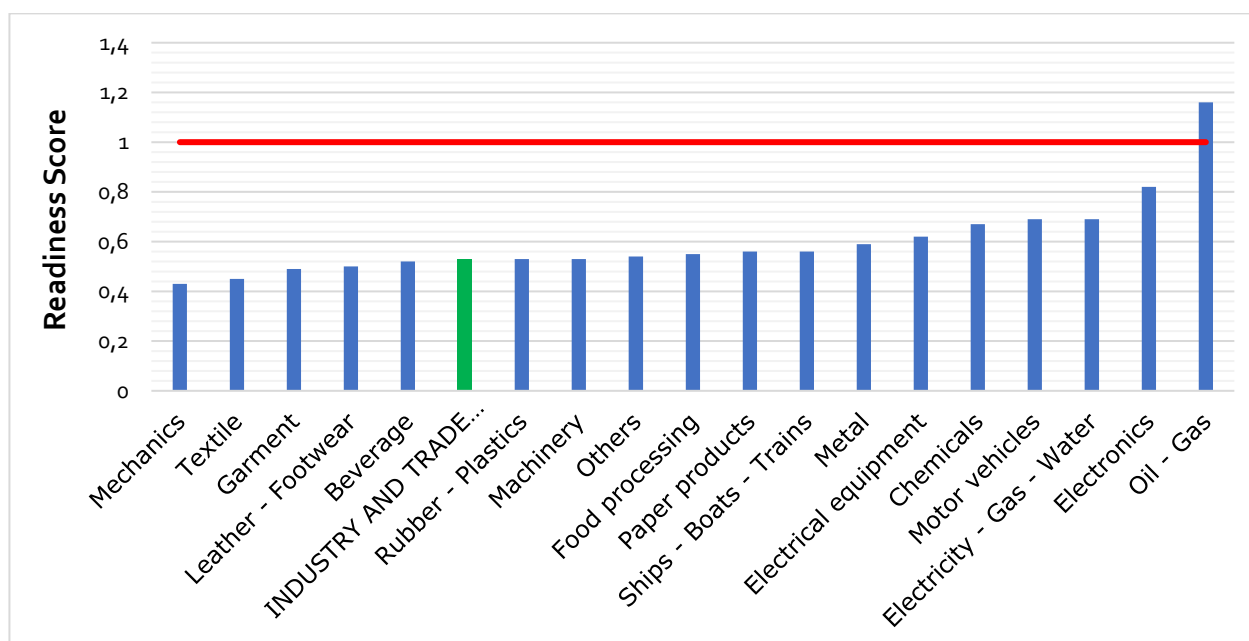


SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

### 3.2.2 READINESS LEVEL OF ENTERPRISES BY SUBSECTOR

Except for the oil and gas group<sup>18</sup> with a readiness score of 1.16 – being at the *beginner* level (only 30% of enterprises were “outsiders”, a considerable 60% at “beginner” level and 10% at “intermediate” level), other industry sector subsectors were at the “outsider” level with readiness scores varying from 0.42 to 0.80 (percentage of enterprises at “outsider” level of IR4.0 was from 73% to 92%, at “beginner” level 4% to 25% and at “intermediate” level from 1% to 6%) (see Table 3-2, Figure 3-11a and Figure 3-11b).

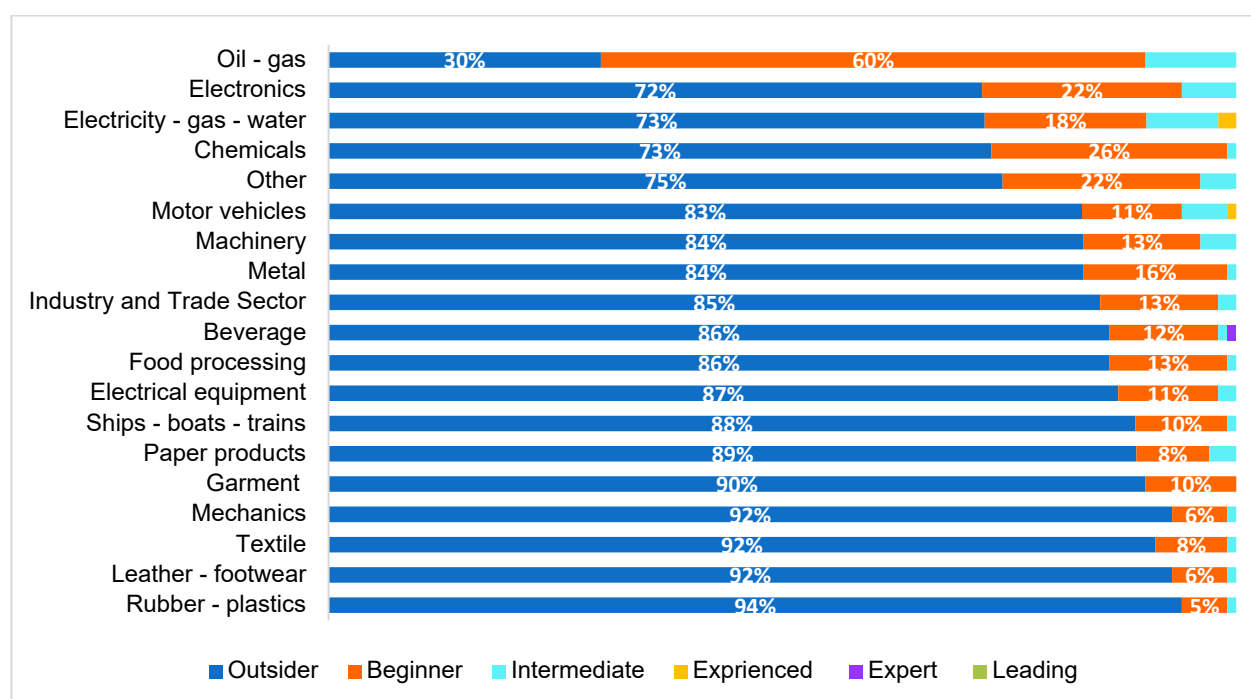
**FIGURE 3-11A: READINESS SCORES OF TWO-DIGIT SUBSECTORS AND AVERAGE OF THE INDUSTRY SECTOR  
(RED LINE IS A THRESHOLD OF “OUTSIDER” LEVEL)**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

<sup>18</sup> Note: The number of enterprises in the oil and gas subsector was only 14 and the sample size of oil and gas enterprises in the survey was 10.

**FIGURE 3-11B: SHARE OF ENTERPRISES AT VARIOUS READINESS LEVELS FOR IR4.0  
BY SUBSECTORS (%)**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

It is noteworthy that key subsectors with high export ratios and high levels of global value chain participation - such as textiles, garments, leather and footwear - also have the lowest readiness scores and highest proportion of firms at “outsider” level. Figure 3-11b shows that for enterprises in the rubber and plastics, mechanical engineering, textiles, garments, leather and footwear subsectors, the percentage of firms at “outsider” level was very high (above 90%). Enterprises in the oil and gas, electricity-gas-water sectors, chemicals, electronic products subsectors have percentages at “outsider” level of IR4.0 lower than 75%. Especially, electricity-gas-water had just 2%<sup>19</sup> of enterprises at “experienced” level.

### 3.2.3 READINESS LEVEL BY PILLARS AND DIMENSIONS

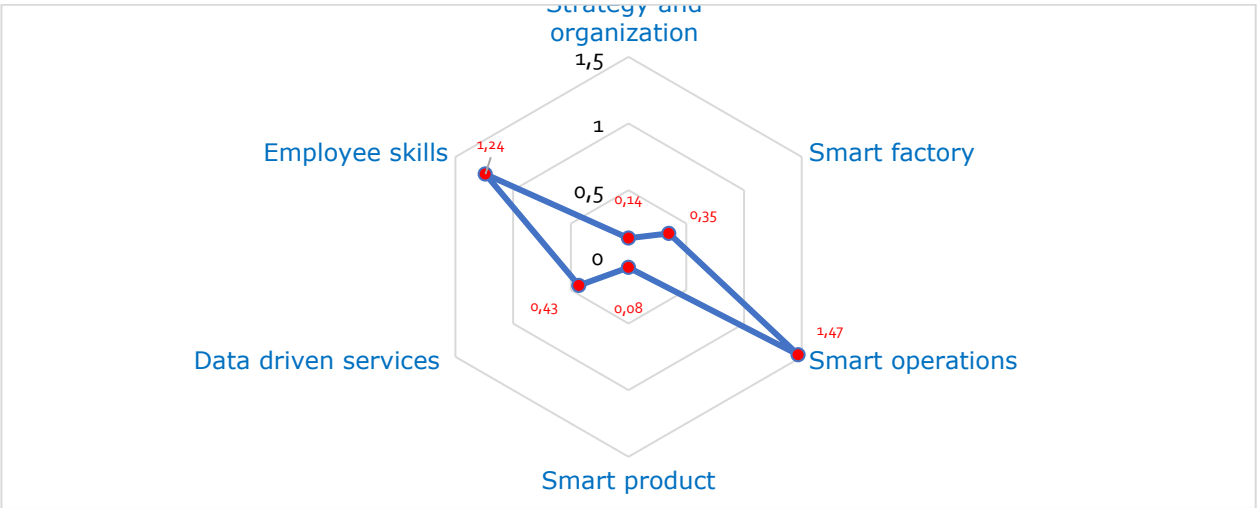
<sup>19</sup> That is three enterprises out of the survey sample of 146.



**IR4.0 readiness levels in Smart Operations and Employees pillars is well above other fields**

Table 3-8 and Figure 3-12 show IR4.0 readiness levels in *Smart Operations* and *Employees* were relatively higher than other pillars. The readiness scores of surveyed enterprises in the *Smart Operations* and *Employee* pillars were 1.47 and 1.24, respectively - at “beginner” level, while the readiness scores in the pillars of *Data-driven Services* (0.43) and *Smart Factory* (0.35) were low and in the *Strategy and Organization* (0.14) and *Smart Products* (0.08) they were very low - at “outsider” level.

**FIGURE 3-12: READINESS SCORES BY PILLARS – INDUSTRY SECTOR**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

**TABLE 3-8: READINESS LEVELS BY PILLARS – INDUSTRY SECTOR**

Readiness level	Score	Readiness level					
		Outsider	Beginner	Intermediate	Experienced	Expert	Top Performer
Pillar	0.53	85%	13%	2%	0%	0%	0%
B. Strategy and organization	0.14	83%	14%	2%	1%	0%	0%
C. Smart factory	0.35	65%	18%	14%	2%	1%	0%
D. Smart operations	1.47	13%	26%	56%	4%	1%	0%
E. Smart products	0.08	93%	4%	2%	1%	1%	0%
F. Data-driven services	0.43	67%	25%	3%	1%	2%	2%
G. Employees	1.24	11%	46%	41%	0%	1%	1%

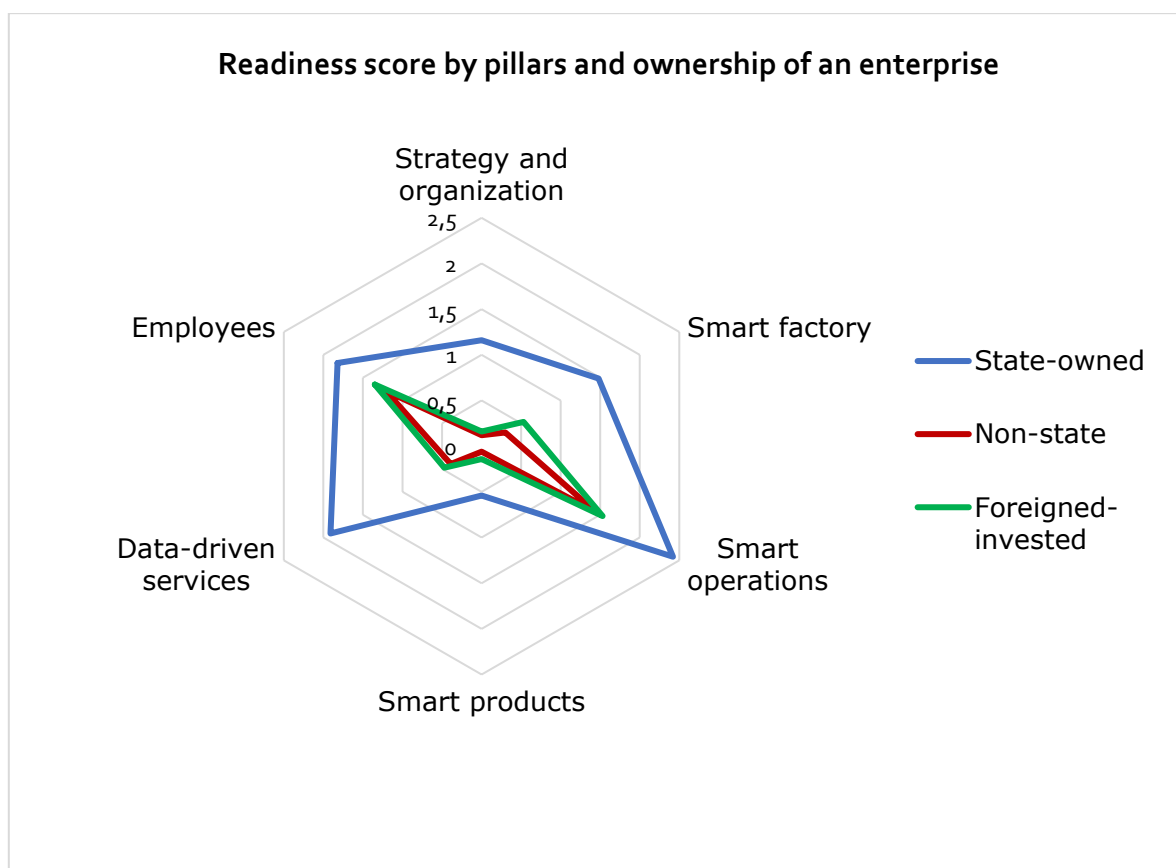
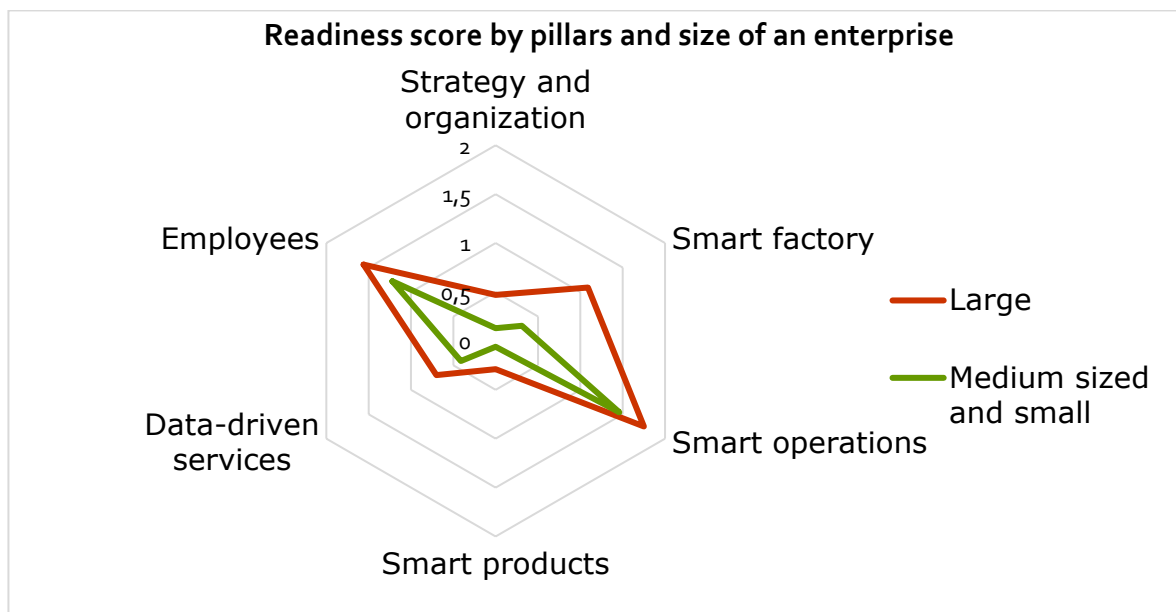
SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

Corresponding to the readiness scores by pillars, the proportion of surveyed enterprises at “outsider” level was the lowest at 11% in the *Employees* pillar and 13% in the *Smart Operations* pillar. Of these two pillars, the share of enterprises at “beginner” and “intermediate” levels is 82% in the *Smart Operations* pillar and 87% in the *Employees* pillar, significantly higher shares than in other pillars.

In *Strategy and Organization* and *Smart Products* - the two pillars with the lowest overall industry sector readiness score - 83% and 93% of enterprises were at the “outsider” level and these shares in the *Smart Factory* and *Data-driven Services* pillars were 65% and 67%, respectively. It is noteworthy that in the pillars (except for *Strategy and Organization*), including those with low readiness scores, there was a small number of firms having reached “experienced”, “expert” and “top performer”<sup>20</sup> levels. A more in-depth study of how these firms have achieved such high readiness levels by pillars, despite the entire sector’s low overall readiness level and within the same common policy framework, may be useful for generating experiences and useful lessons. Similar to the relationship between the overall readiness scores and factors of size and ownership, these factors are also closely related to the readiness scores by pillars. Figure 3-13 and Table 3-9 show that large corporations and SOEs (with strengths in other factors as analyzed above) have high readiness scores by all pillars, exceeding those of the SMEs group and groups of enterprises in other forms of ownership.

<sup>20</sup> A small number of enterprises achieved “top performer” level in the *Data-driven Services* and *Employees* pillars.

**FIGURE 3-13: READINESS SCORE BY PILLARS, SIZE AND OWNERSHIP OF ENTERPRISE**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

**TABLE 3-9: READINESS SCORE BY PILLARS, SIZE AND OWNERSHIP OF AN ENTERPRISE**

	Strategy and Organization	Smart Factory	Smart Operations	Smart Products	Data-driven Services	Employees
<b>Whole sector</b>	<b>0.14</b>	<b>0.35</b>	<b>1.47</b>	<b>0.08</b>	<b>0.43</b>	<b>1.24</b>
<b>Classified by size</b>						
Large	0.47	1.09	1.75	0.29	0.7	1.56
Small and medium-sized	0.13	0.31	1.46	0.06	0.41	1.22
<b>Classified by ownership</b>						
State-owned	1.16	1.48	2.42	0.54	1.91	1.82
Non-State	0.12	0.3	1.45	0.06	0.39	1.21
Foreign-invested	0.16	0.53	1.53	0.14	0.47	1.35

A detailed analysis of IR4.0 readiness in each of the pillars and dimensions will be provided in the following sections.

### 3.2.3.1 PILLAR B - STRATEGY AND ORGANIZATION

The readiness score for Pillar B concerning strategy and organizational development for the entire sector was very low (0.14), largely due to the fact that enterprises did not have sets of performance measurement indicators (B2) as well as the lack of integrated strategies formulated to deal with IR4.0 (B1). However, component strategies for responding to IR4.0 are being developed by firms and in the future, there may be some changes regarding scores of B1 and B2 dimensions (also pillar B - *Strategy and Organization*). Incorporating component strategies into the IR4.0 strategy as well as supporting enterprises to develop adequate and sufficient performance measurement indicators will be necessary to increase the readiness of enterprises in this pillar.

The readiness score for Pillar B, *Strategy and Organization*, is measured by the lowest score of the four dimensions: B1 (Development and implementation of strategy), B2 (Completeness of strategic performance measurement indicators), B3 (Level of investments in technology application for the industrial revolution) and B4 (Areas of innovation management)<sup>21</sup>.

The low readiness score (0.14) and the high rate (83%) of enterprises in the industry sector at “outsider” level in Pillar B (*Strategy and Organization*) are largely due to 81% of enterprises not having developed strategies, 95% not having indicator sets for performance measurement (B2), 50% not having innovation activities and 44% not having invested in science and technology towards IR4.0 (Figure 3-14).

<sup>21</sup> The minimum score of these four dimensions is: 0 for B1, B3 and 1 for B2 and 2 for B4. Firms that do not have a plan to develop an IR 4.0 strategy (B1), or have no investment activities in science and technology (B3) will have a zero score.

FIGURE 3-14: SHARE OF ENTERPRISES WITH NO ACTIVITIES  
IN DIMENSIONS OF PILLAR B

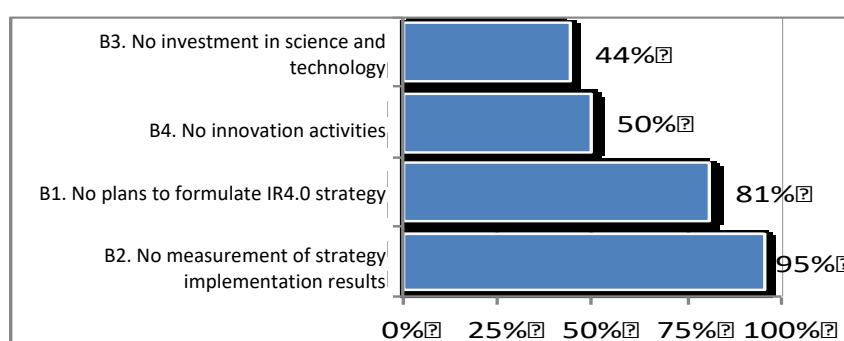
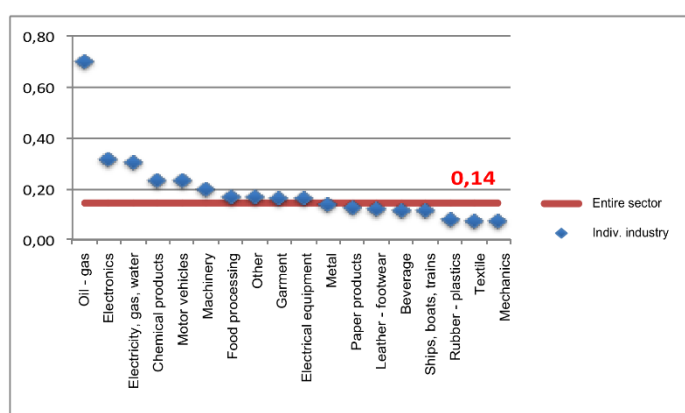


FIGURE 3-15: READINESS SCORE IN PILLAR B  
BY SUBSECTOR

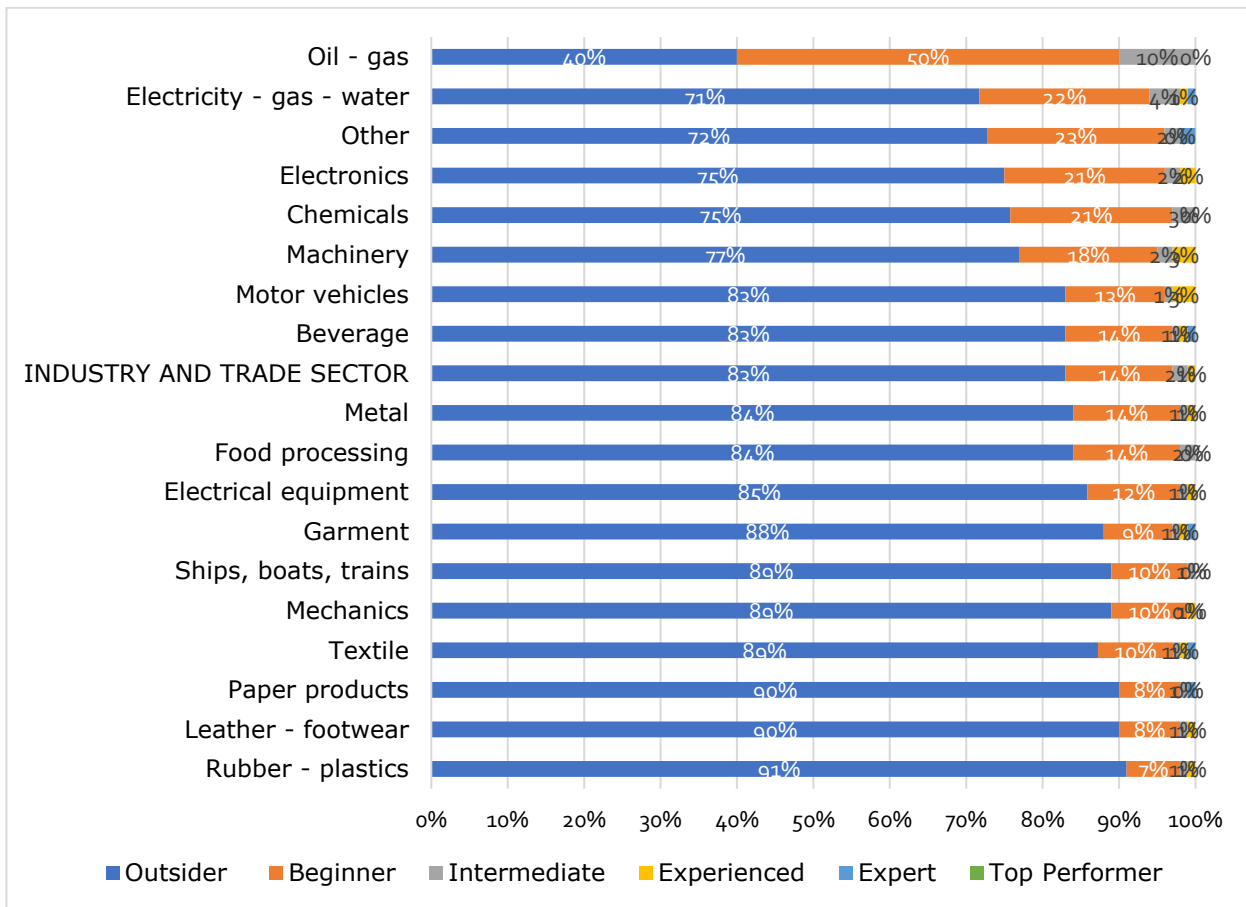


Subsectors with readiness scores in the *Strategy and Organization* pillar above the sector average were oil and gas, electronics, electricity-gas-water, chemicals, motor vehicles, machinery and equipment n.e.c, food processing, garments and electrical equipment. Subsectors with readiness scores in the *Strategy and Organization* pillar notably below the sector average were: fabricated metal products (mechanical engineering), textiles, rubber and plastics, leather and footwear as well as beverages (Figure 3-15). Accordingly, there was a high proportion of firms at “outsider” level in Pillar

B in these subsectors. It is noteworthy that in a number of subsectors (including those with relatively low readiness scores in Pillar B such as leather and footwear, textiles, beverages), there was a small number of enterprises having achieved “experienced” level and in the textiles, garments, paper products, electricity-gas-water subsectors some enterprises have reached “expert” level in Pillar B (Figure 3-16).

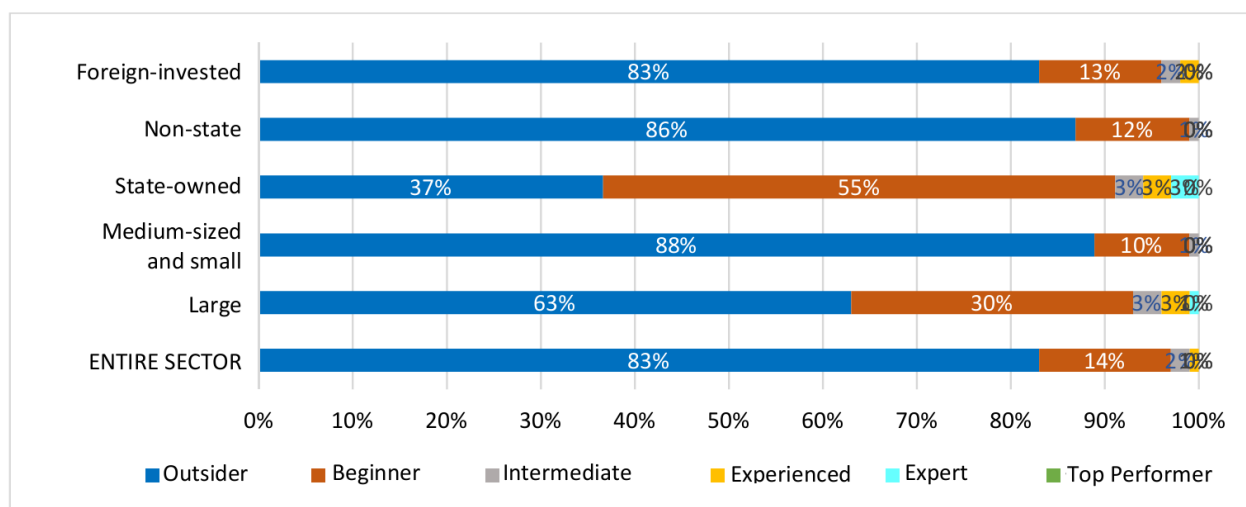
Groups of large enterprises and SOEs (for factors related to readiness levels associated with these groups of enterprises see Box 3-2) have lower rates of enterprises at “outsider” level (and proportion of firms at higher readiness levels – “beginner”, “intermediate”, “experienced” and “expert” - is higher) compared to groups of SMEs and other forms of ownership (Figure 3-17).

**FIGURE 3-16: SHARE OF ENTERPRISES BY READINESS LEVEL IN STRATEGY AND ORGANIZATION PILLAR BY SUBSECTOR**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

**FIGURE 3-17: SHARE OF ENTERPRISES BY READINESS LEVEL IN STRATEGY AND ORGANIZATION PILLAR BY SIZE AND OWNERSHIP**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

**BOX 3-2: FACTORS RELATED TO READINESS LEVEL IN STRATEGY AND ORGANIZATION PILLAR**

The model estimation results (Column (1) of Table PL6-3) confirm the role of enterprise size, form of ownership as described in Figure 3-17. In addition, other important factors for readiness level of an enterprise in the pillar *Strategy and Organization*, include the concentration index of capital/labour, level of technology applied, age structure of labour force and location of enterprise. In general, the larger the size of the enterprise or higher the ratio of capital/labour being a State-owned/joint venture enterprise, the higher the score. Enterprises in manufacturing industries having medium level technology, enterprises with higher proportions of employees equipped with less than three months vocational training or a higher proportion of workforce aged 30-60 years, had a lower readiness score. The detailed correlation between the factors and readiness levels for an area for each level/group is summarized in Table 3-10.

**TABLE 3-10: FACTORS RELATED TO READINESS LEVEL IN STRATEGY AND ORGANIZATION PILLAR**

	Readiness level					
	Outsider	Beginner	Intermediate	Experienced	Expert	Top Performer
Capital/labour ratio	-	+	+	+	+	
Enterprises with 10-49 employees	-	+	+	+		
Enterprises with 100-299 employees	-	+	+	+	+	
Enterprises in manufacturing industries with medium-level technology	+	-	-	-		
SOEs	-	+	+	+		
Foreign-invested enterprises	+	-	-	-		
Share of employees using internet	-	+	+	+		
Share of employees aged from 31-60 years	+	-	-	-		

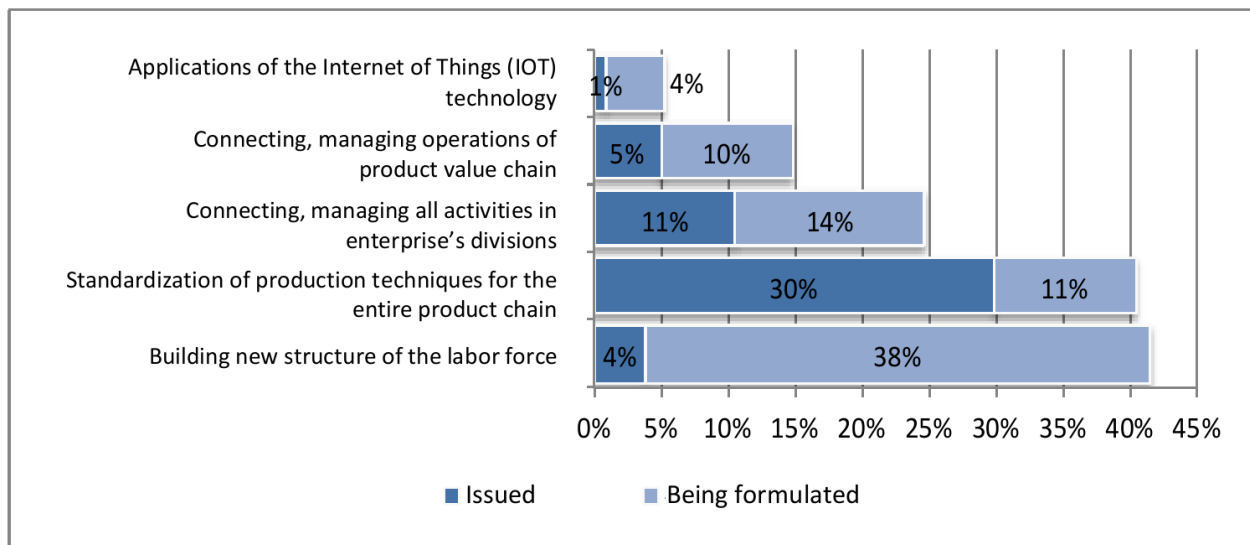
Note: Change in one unit of factor corresponds to a higher readiness level (+) or lower (-)

**SOURCE: CALCULATED FROM THE ENTERPRISE CENSUS 2017**

### 3.2.3.1.1 BUILDING AND IMPLEMENTING THE IR4.0 (B1) STRATEGIC STRATEGY

Some 81.3% of surveyed enterprises reported that no IR4.0 strategy had been developed as yet. Of the surveyed enterprises, only 7.1% were implementing a IR4.0 strategy and 11.6% were building or had experimental initiatives to develop such a strategy. Although no surveyed enterprises reported to have developed and implemented a strategy explicitly named 'Industrial Revolution 4.0', they were found to be rolling out some related strategies. Notably, up to 30% of surveyed enterprises have implemented a standardization strategy for an entire product chain and 38% were developing strategies to build new labour structures (Figure 3.18).

**FIGURE 3-18: SHARE OF ENTERPRISES ENGAGED IN DEVELOPING STRATEGIES TO SUPPORT RESPONSES TO IR4.0**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

### 3.2.3.1.2 PERFORMANCE MEASUREMENT INDICATORS FOR STRATEGY IMPLEMENTATION (B2)

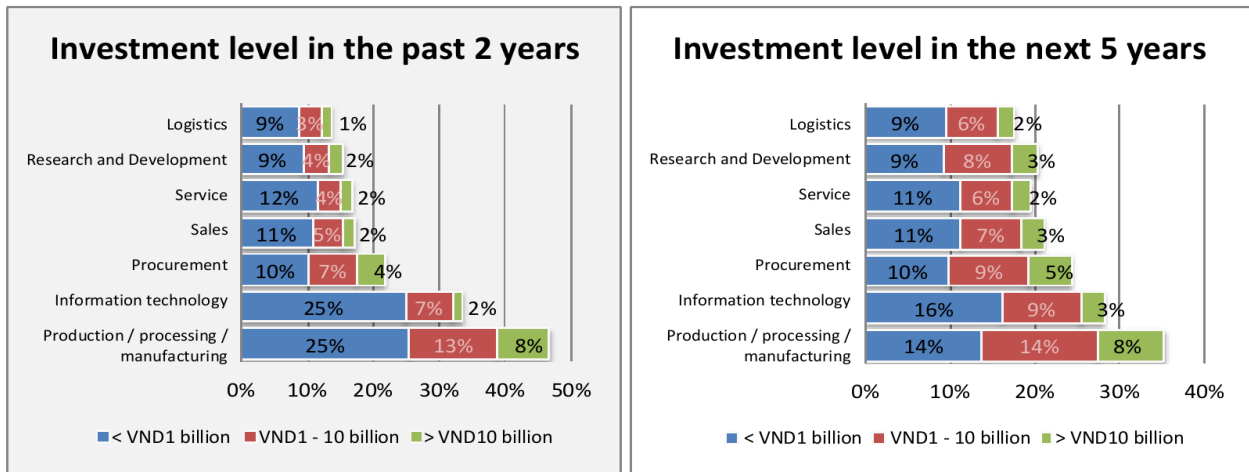
Some 95.3% of surveyed enterprises reported they had not developed a set of performance measurement indicators for strategy implementation, with 4.5% having had an initial set of indicators and only 0.2% a full set of indicators.

### 3.2.3.1.3 INVESTMENTS IN APPLICATION OF TECHNOLOGY (B3)

This was one of the strengths of enterprises in the industry sector. As many as 56% of enterprises said they had invested in application of technologies related to IR4.0 in the past two years in the seven surveyed areas, of which the proportion of enterprises investing in processing and manufacturing was highest (47%). The share of enterprises that planned to invest in these technologies within the next five years slightly reduced, however, the number of enterprises to have invested more than VND 10 billion increased, especially in IT (2% to 3%), procurement (4% to 5%), sales, R&D (2% to 3%) and logistics (1% to 2%) (Figure 3-19).



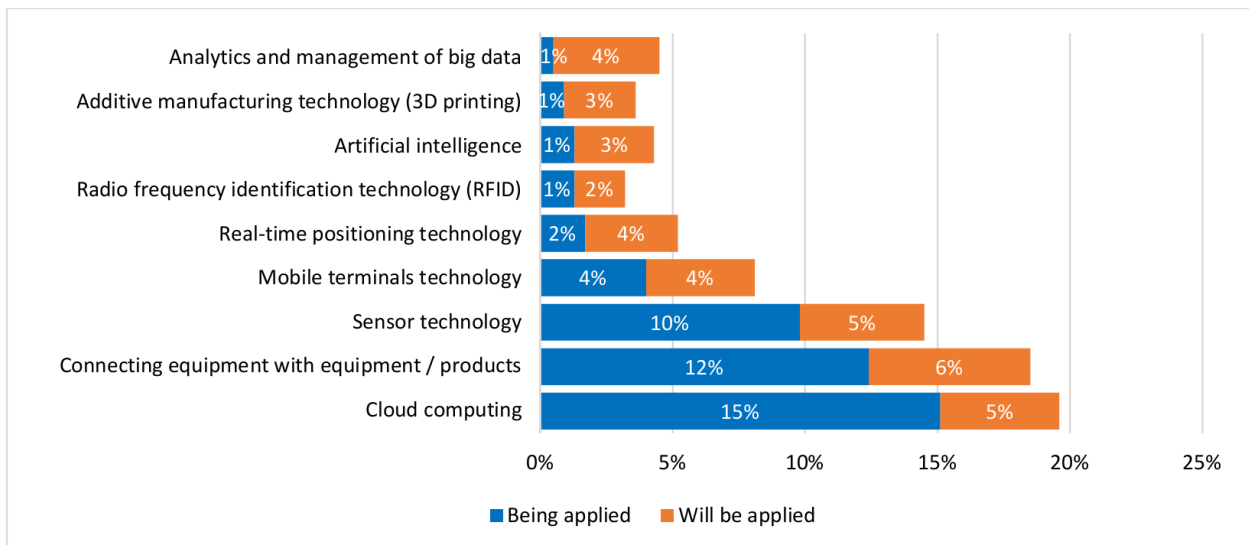
**FIGURE 3-19: SHARE OF ENTERPRISES INVESTING IN TECHNOLOGY**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

Of the 10 technologies surveyed related to IR4.0, those connecting machinery to equipment/products were reasonably applied by enterprises (12.4%) and “planned to deploy” (6.1%). This shows there will be improvements in enterprise’ readiness in the three pillars of *Smart Factory*, *Smart Operations* and *Smart Products* (Figure 3-20).

**FIGURE 3-20: SHARE OF ENTERPRISES HAVING USED AND PLANNING TO USE TECHNOLOGY RELATED TO IR4.0**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

#### 3.2.3.1.4 INNOVATION MANAGEMENT (B4)

As many as 50% of surveyed enterprises reported to have implemented management of innovation and technology in one to five survey areas related to IR4.0. The rate of enterprises managing innovation and technology was highest in the fields of manufacturing (41%), IT (19%), product development (8%), general management (6%) and management services (4%).

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### 3.2.3.2 PILLAR C - SMART FACTORY

The readiness score in Pillar C - *Smart Factory* was quite low (0.35) due to the low readiness scores in all three dimensions: C2 (ability to connect equipment by demand in future), C3 (application of digital models) and C1 (features for controlling and connecting current equipment). The percentage of enterprises using equipment without control by IT or upgrading for connection between equipment and other systems was high (70% and 52% of surveyed enterprises). Although enterprises all collected data on production processes, the percentage of enterprises achieving online data collection was low, ranging from 3-10%. Some 14% of enterprises have used collected data to serve automatic control purposes.

To increase readiness for applying *Smart Factory* models, incentives and support should be given to investments in equipment that have features for connecting to systems (upgrade or replacement) and deployment of digital management models. The share of enterprises which need support for these activities is high, as up to 22% of enterprises need to upgrade equipment and 52% need equipment replaced.

The *Smart Factory* pillar is defined as a factory where the production system communicates directly with IT systems (or MES, ERP, SCM systems) and with smart products. A smart factory has the highest level of value chain digitization by integrating and self-regulating all processes, especially production ones. The biggest barrier to smart factory realization is high investment costs. The goal of providing information and using materials effectively can be achieved through a consistent interaction of production, information and human systems, including workers and customers. One of the main smart factory features is provision of sensor technology for the entire plant as well as all machines and systems at main data collection points. This feature aims to gather all relevant process and transaction data in real time and quickly process data to streamline order processing. This high volume of data creates a heavy burden on IT systems and infrastructure. Big data is analyzed for informational purposes and requires a computer system with powerful high performance configuration.

The score measuring the readiness level for the *Smart Factory* pillar was calculated by the lowest score of the five dimensions: C1 (controlling, connecting features of equipment), C2 (level of responses to connectivity requirements of equipment), C3 (digital management model), C4 (data collection methods) and C5 (purpose of data use)<sup>22</sup>.

The low readiness score in this pillar and the relatively high percentage (71%) of “outsider” enterprises was due to the impact of 58% of enterprises failing to control equipment and 70% of firms’ facilities not being upgradeable to connect equipment (Figure 3-21).

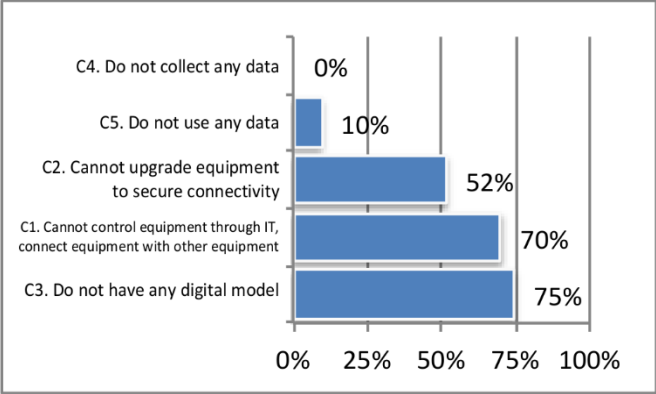
Ten subsectors whose readiness scores in the *Smart Factory* pillar were higher than the sector average (0.35) included: oil and gas, electricity-gas-water, electronics, motor vehicles, basic metals, chemicals, electrical equipment, other transportation vehicles, food processing and paper products. Major export industries such as garments, textiles and fabricated metals (mechanical engineering) had the lowest readiness scores below the sector average (Figure 3-22) and in these subsectors, the percentage of firms at “outsider” level in Pillar C (Figure 3-23) was

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<sup>22</sup> Compared to the VDMA methodology, this survey did not have data for assessing the C6 dimension being the level of coverage of information technology systems to business operations. The survey questionnaires concerned only how the information technology and security activities were organized, and did not provide enough data to analyze the C6 dimension, and therefore, this content was treated like a field having no information (with maximum score). The minimum score of these five dimensions is 0 for C1, C2 and 1 for C3, C4 and C5. Enterprises that can not control equipment using IT (C1) or can not be upgraded to perform connectivity (C2) will have a zero score.

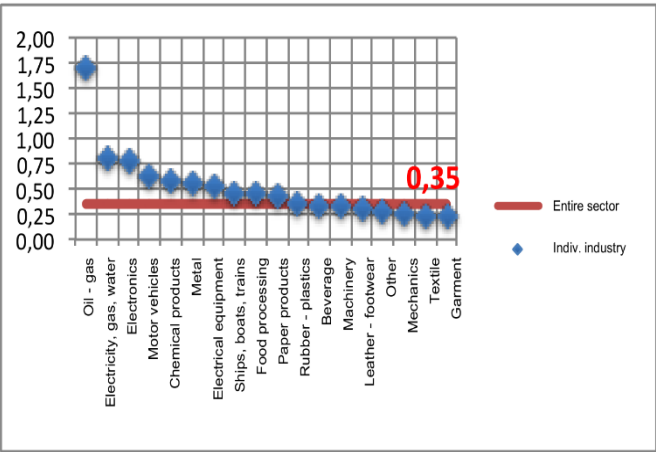
quite high (from 74% - fabricated metals (mechanical engineering) to 78% - garments). It is noteworthy that in some subsectors (including those with relatively low readiness scores in Pillar C, such as textiles and beverages) a small number of enterprises achieved “experienced” or “expert” levels, whereas electricity-gas-water had few enterprises to have reached “expert” or “top performer” levels in Pillar C (Figure 3-23).

FIGURE 3-21: SHARE OF ENTERPRISES WITH NO ACTIVITY IN PILLAR C’S DIMENSIONS

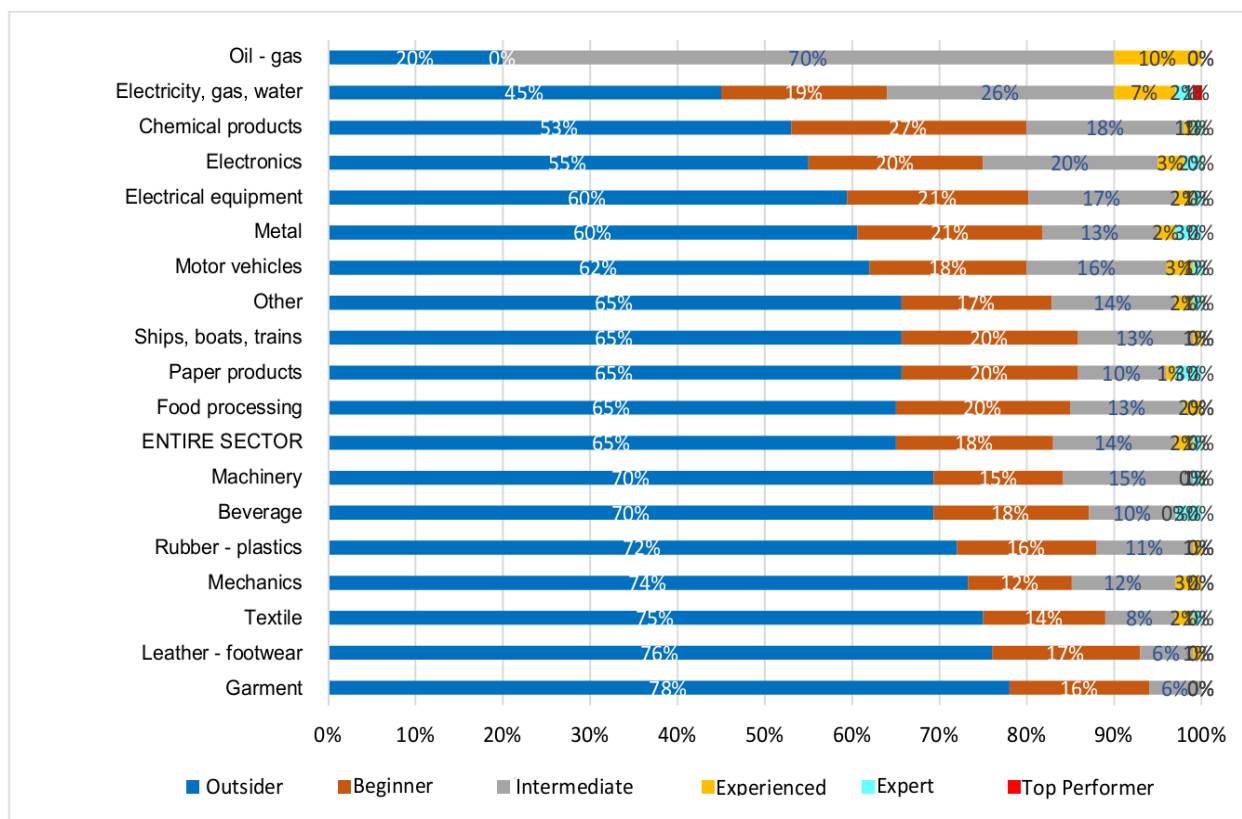


The groups of large enterprises and SOEs (with factors related to readiness levels for IR4.0 associated with these groups see Box 3-3) have lower shares of firms at “outsider” level (and higher shares of firms at higher levels: “beginner”, “intermediate”, “experienced” and “expert”) compared to groups of SMEs and enterprises in other forms of ownership (Figure 3-24).

FIGURE 3-22: READINESS SCORE IN PILLAR C BY SUBSECTOR

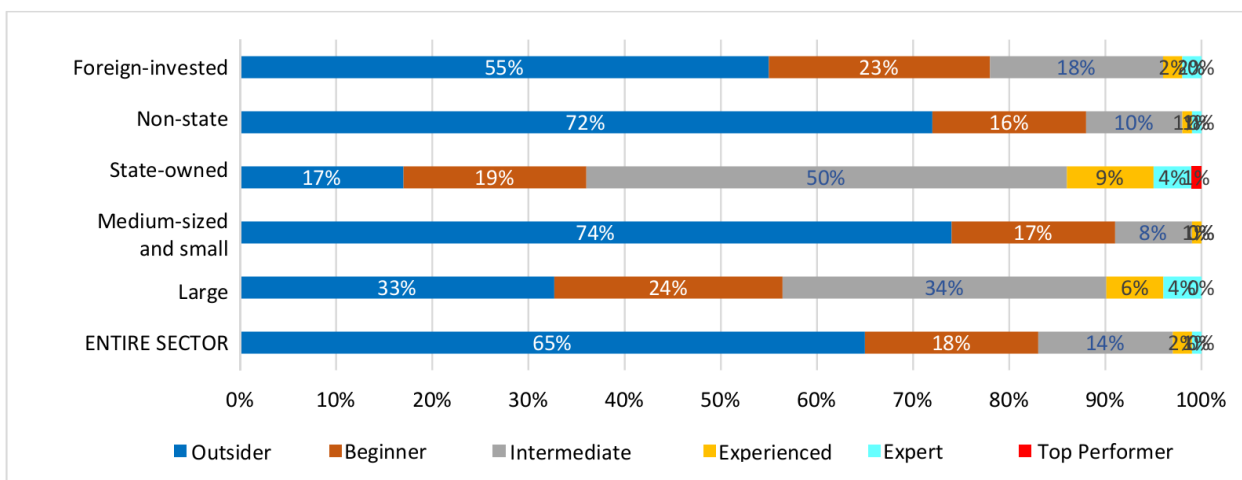


**FIGURE 3-23: SHARE OF ENTERPRISES BY READINESS LEVEL IN SMART FACTORY PILLAR BY SUBSECTORS**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

**FIGURE 3-24: SHARE OF ENTERPRISES BY READINESS LEVEL IN SMART FACTORY PILLAR BY SIZE AND OWNERSHIP.**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

### BOX 3-3: FACTORS RELATED TO READINESS LEVEL IN SMART FACTORY PILLAR

In general, regression results show that the readiness score in the *Smart Factory* pillar is proportional to the size of enterprise (the larger the size, the higher the level of participation) and similar to Figure 3-24, proportional to capital/labour ratio, concentration index, percentage of employees using computers. Enterprises with managers with university qualifications or higher, joint ventures and enterprises using the internet for operations management have a higher readiness level. Enterprises with workers who do not have elementary or intermediate vocational qualifications or university degrees, tended to have a lower levels of participation in the area. The readiness level was also inversely proportional to the age of the enterprise's manager. The detailed correlation between the factors and readiness level for the area of each group level is summarized in Table 3-11.

**Table 3-11: Factors related to readiness level in *Smart Factory* pillar**

	Readiness level					
	Outsider	Beginner	Intermediate	Experienced	Expert	Top Performer
Capital/labour ratio	-	+	+	+	+	
Size of labour force	-	+	+	+	+	
Managers with university qualifications or higher	-	+	+	+		
Manager's age	+	-	-	-	-	
Concentration index	-	+	+	+	+	
Share of employees using computers	-	+	+			
Enterprises using the internet for operations management	-	+	+			
Share of employees having other certificates	+	-	-	-	-	

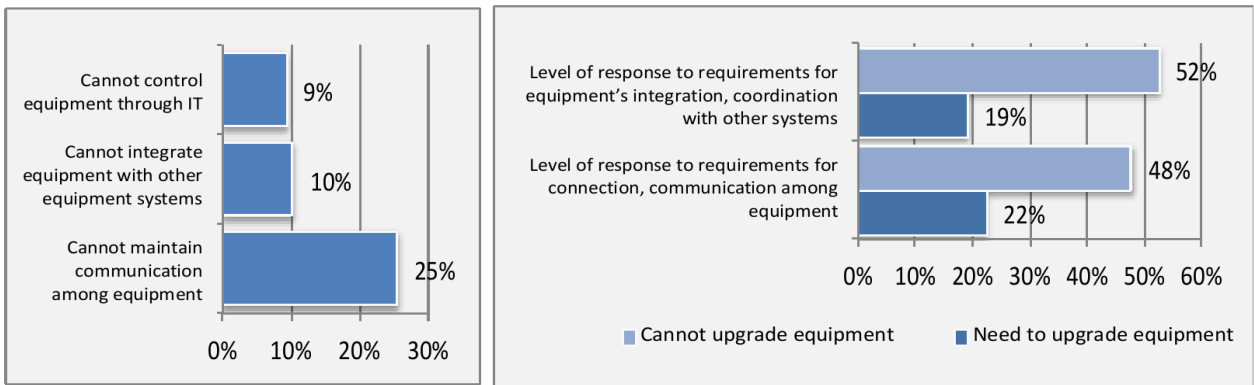
Note: Change in one unit of factor corresponds to a higher readiness level (+) or lower (-)

*SOURCE: CALCULATED FROM THE ENTERPRISE CENSUS 2017*

3.2.3.2.1 CONTROLLING, CONNECTING FEATURES OF CURRENT EQUIPMENT AND CAPABILITY TO MEET REQUIREMENTS IN THE FUTURE (C1 AND C2)

Of the three key features of equipment to readily access IR4.0 in smart factories, only 9% of enterprises reported equipment could not be controlled by applying IT, while as many as 25% claimed connections could not be set up between equipment, 10% of enterprises also said the equipment could not connect to other systems. The proportion of enterprises that needed to upgrade and replace equipment to swiftly meet IR4.0 requirements was significant, from 19-52% of enterprises nationwide (Figure 3-25).

FIGURE 3-25: SHARE OF ENTERPRISES LACKING CONNECTING FEATURES OF EQUIPMENT

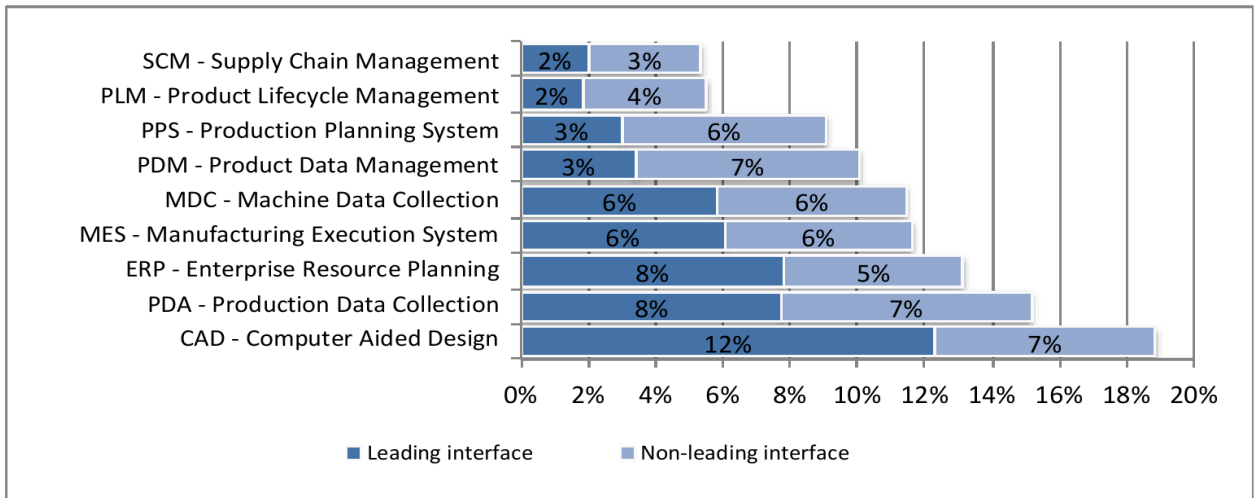


SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

3.2.3.2.2 DEPLOYING THE DIGITAL MODEL (C3)

Nine digital models surveyed were rolled out by enterprises with different application rates, of which 19% of business respondents said they had applied designed software with machines' support and it was the most widely used software. When applying digital models, on average, 50% of enterprises had chosen a leading interface and 50% had chosen a non-leading interface (Figure 3-26).

FIGURE 3-26: SHARE OF ENTERPRISES USING DIGITAL MODELS

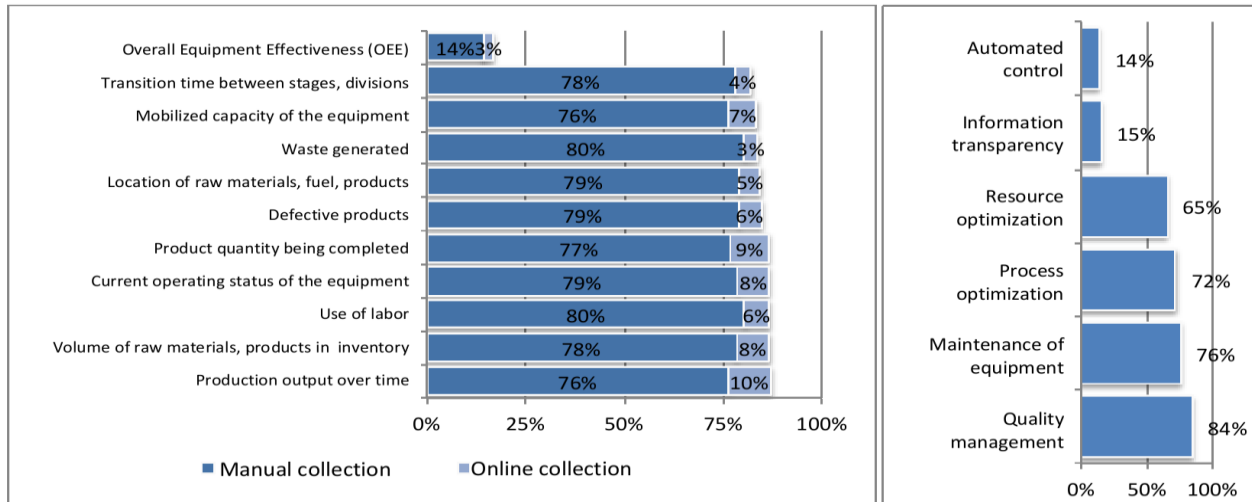


SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

### 3.2.3.2.3 COLLECTION AND USE OF DATA (C4, C5)

All surveyed enterprises collected data, but only 92% of enterprises utilized it. Among types of production data, the percentage of firms collecting performance indicator data of OEE equipment was the lowest (17%). Much of the data was collected manually, only 10% of companies collected data on output quantity over time using online tools (Figure 3-27). This is one of the reasons for the sub-optimal quality of data processing and the limited ability to manage and control the process automatically.

**FIGURE 3-27: SHARE OF ENTERPRISES HAVING COLLECTED AND USED DATA**



### 3.2.3.3. PILLAR D - SMART OPERATIONS

The readiness score in the *Smart Operations* pillar (1.47) was the highest among the pillars because the scoring criteria depended on readiness for data collection and information security, two areas where Viet Nam's enterprises have rolled out certain activities. At present, about 80% of enterprises do not meet initial criteria for using cloud computing technology, automation of management and production operations. These three criteria are not the decisive factors for an enterprise to belong to the early "*learners*" group, but will have a great influence on guiding enterprises to achieve a high readiness level for IR4.0.

In order to improve readiness for *Smart Operations* activities, it is necessary to focus on supporting 80% of industrial enterprises in the application of technology, cloud computing services, management and operations automation. These activities will need to connect and increase business' readiness in *Smart Factory* operations through investments, upgrades of equipment, and securing connectivity and information sharing between equipment and systems.

Integrating or connecting all components and systems of a factory are an essential requirement for IR4.0 readiness. This is the basis for the horizontal and vertical integration of the value chain. The horizontal integration value chain implies the connection of all internal and external partners, from the supplier to customer. This connection creates a network from business planning among enterprises to full product lifecycle management with a focus on meeting customer needs. Vertical integration describes the connection between parts in an enterprise, from sales to product development and comprehensive planning for production processes, after-sales service and financial matters. The integration of these production systems provides potential solutions to improve productivity, quality and flexibility in production and business. Making decisions on priorities and implementing order processing in the value chain should be based on data analysis with the highest possible accuracy. Therefore, the collection, analysis and use of data is very important for IR4.0 and is one of the main drivers for development in the *Smart Operations* pillar. Sensor technology can be installed in the production process to record transactional and processing

data. These data are then processed and analyzed with the aid of integrated intelligence systems. Successfully capturing detailed data allows for more accurate forecasting (interruptions and malfunctions) and improves production processes. The more accurate the data, the more valuable the in-depth information. The score assessing *Smart Operations* is measured by the lowest score of the dimensions: D1 (information sharing), D2 (automation), D3 (autonomous process), D4 (information security) and D5 (use of cloud computing)<sup>23</sup>.

The readiness score for Pillar D – *Smart Operations* of the industry sector reached 1.47 and had the highest readiness score among all six pillars. The relatively low proportion (13%) of enterprises at “outsider” level in the *Smart Operations* pillar was the result of only 9% of enterprises that did not share information nor exercised information security. Nevertheless, nearly 85% did not use cloud computing and more than 80% did not apply management and operations automation following changes (Figure 3-28).

The 12 subsectors with readiness scores higher than the sector average included: oil and gas, other transportation vehicles, products, motor vehicles, electrical equipment, other manufacturing industries, rubber and plastics, garments, basic metals, paper products, chemicals and food processing. The subsectors with readiness scores lower than the sector average included fabricated metals (mechanical engineering), electricity-gas-water and beverages (Figure 3-29).

FIGURE 3-28: SHARE OF ENTERPRISES WITH NO ACTIVITIES IN PILLAR D’S DIMENSIONS

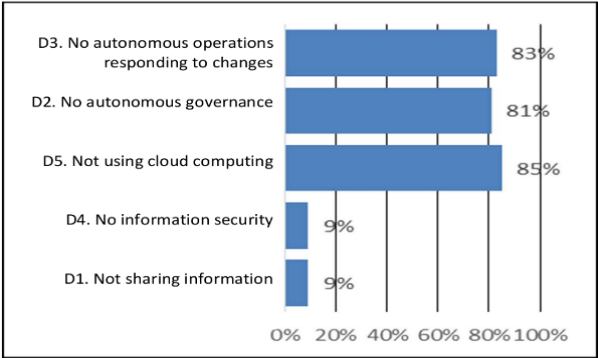
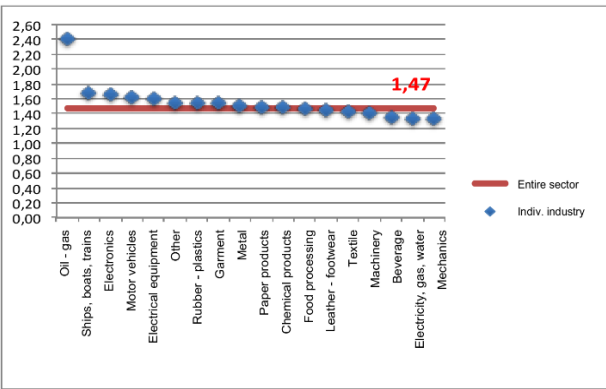


FIGURE 3-29: READINESS SCORE IN PILLAR D BY SUBSECTOR



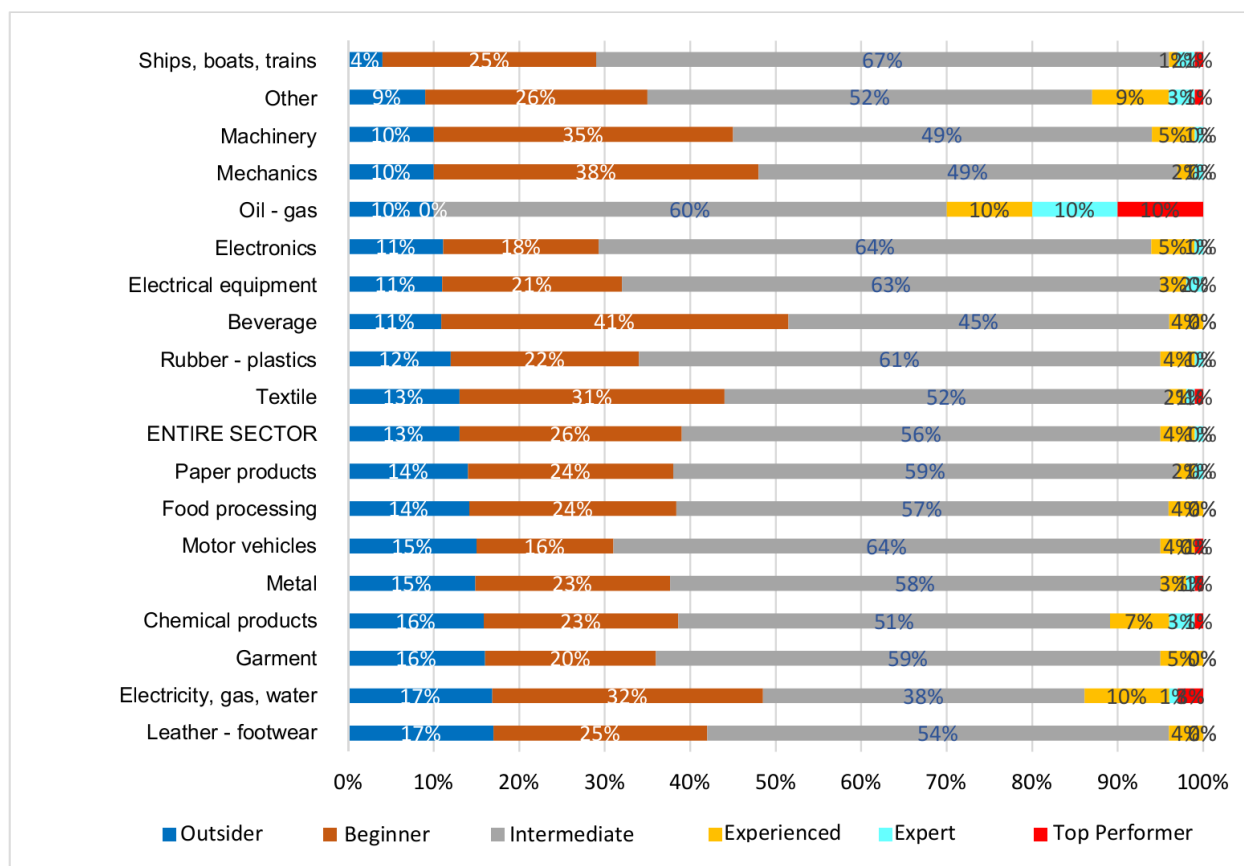
<sup>23</sup> The minimum score for these five pillars is 0 for D1 and D4, 2 for D5 and 3 for D2 and D3. Enterprises that did not share information (D1) or did not exercise information security (D4) would have an assessment score of zero.



It is noteworthy that the percentage of enterprises at “outsider” level in this pillar was quite low (4% for other transportation vehicles to 17% for leather and footwear as well as electricity-gas-water). The proportion of firms at “intermediate” level was rather high (50% to more than 60%) and the number of firms in the “leaders” group (comprising readiness levels of “experienced”, “expert” and “top performer”) was the highest compared to other pillars (Figure 3-30).

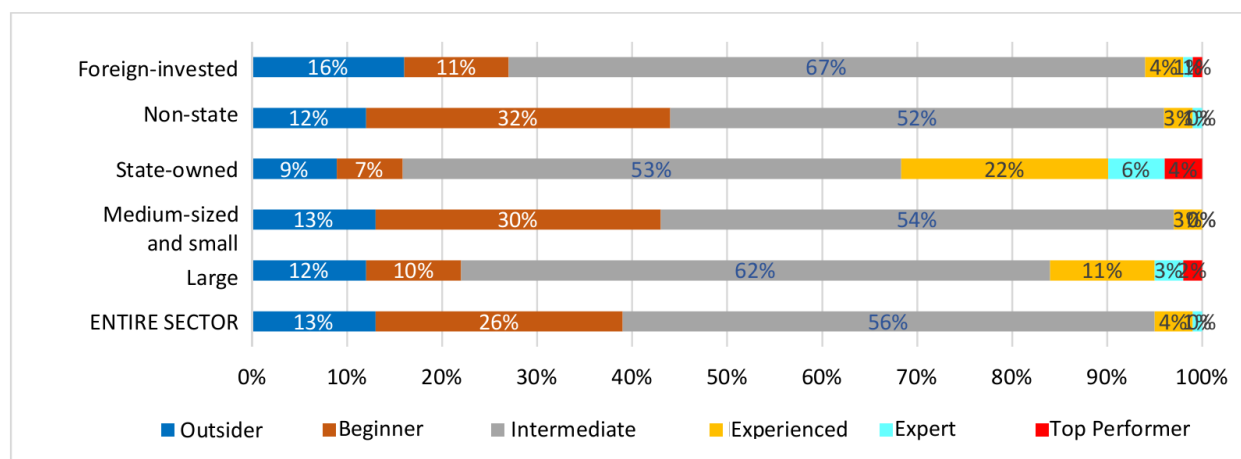
The groups of large enterprises and SOEs (for factors related to readiness levels associated with these groups of enterprises - see Box 3-4) had a much higher proportion of enterprises at high readiness levels (“experienced”, “expert” and “top performer”) compared to the group of SMEs and other forms of ownership (Figure 3-31).

**FIGURE 3-30: SHARE OF ENTERPRISES BY READINESS LEVEL IN SMART OPERATIONS PILLAR BY SUBSECTOR**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

**FIGURE 3-31: SHARE OF ENTERPRISES BY READINESS LEVEL IN SMART OPERATIONS PILLAR BY SIZE AND OWNERSHIP**



SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA

**BOX 3-4: FACTORS RELATED TO READINESS LEVEL IN SMART OPERATIONS PILLAR**

Regression results do not demonstrate the correlation between size and readiness level in the Smart Operations pillar. On average, higher readiness levels in this pillar are usually found in enterprises with a higher concentration index, SOEs and enterprises with their own websites. The higher readiness level corresponds to enterprises with high proportions of foreign workers, high rates of employees in foreign-invested enterprises in a district and high proportions of workers using the internet. The detailed correlation between the factors and readiness level for the area for each group level is summarized in Table 3-12.

For most enterprises, the first barrier to a higher readiness level in the Smart Operations pillar was a low level of system integration with an external setting. Most companies did very well integrating the system internally, but have yet to implement it in the field of external integration. On the other hand, streamlined media channels and integrated procurement-sales automation into other processes can help reduce costs and improve efficiency. The next barrier is the lack of control automation procedures (about 80% of enterprises do not have control automation procedures). While the main criterion of IR4.0 is production control automation, with product parts self-moving to the next processing station, self-determining paths and own sequences as well as communicating necessary production parameters for equipment, only about 10% of enterprises met this criterion. Some 85% of enterprises did not have or just have an initial plan to use cloud computing, while 15% initially implemented a solution and implemented many solutions for cloud computing.

**TABLE 3-12: FACTORS RELATED TO READINESS LEVEL IN SMART OPERATIONS PILLAR**

	Readiness level					
	Outsider	Beginner	Intermediate	Experienced	Expert	Top Performer
Share of foreign workers	+	+	-	-	-	
Concentration index	-	-	+	+	+	+

Share of employees in foreign-invested enterprises in a district	+	+	-	-	-	
SOEs	-	-	+	+	+	+
Enterprises in the Mekong Delta	-	-	+	+	+	+
Share of workers using internet	+	+	-	-	-	-
Enterprises have their own websites	-	-	+	+	+	+

Note: Change in one unit of factor corresponds to a higher readiness level (+), or lower (-)

*SOURCE: CALCULATED FROM THE ENTERPRISE CENSUS 2017*

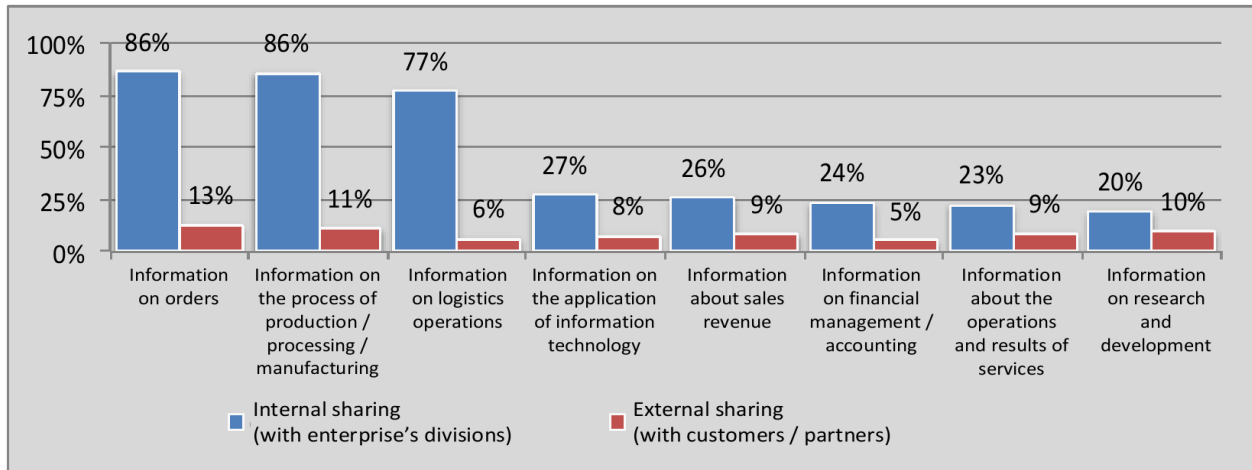
### 3.2.3.3.1. CONNECTING, SHARING INFORMATION (D1)

Connecting, sharing information is one of the two minimum requirements to start *Smart Operations*. Some 91% of enterprises reported they had shared information with other stakeholders, while eight survey information groups received feedback on different ways of sharing.

Information most frequently shared between departments by enterprises is directly related to production, commerce, such as information concerning orders, production processes and logistics (77%-86% of enterprises share this information), followed by the management information group. About 20-27% of business respondents said they internally shared information on R&D, performance and business results, sales as well as information technology application activities.

The percentage of enterprises responding about types of information shared with customers varied little and only 5-13% of enterprises said they shared information with customers and most shared information related to orders. The proportion of enterprises sharing information on manufacturing processes was 11% (Figure 3-32). The survey did not have information, in relation to such sharing, whether it was done at the request of customers or exercised by enterprises as fulfillment of their social responsibility.

**FIGURE 3-32: PROPORTION OF ENTERPRISES SHARING INFORMATION INTERNALLY AND WITH PARTNERS WITHIN THE ORGANIZATION AND WITH PARTNERS**

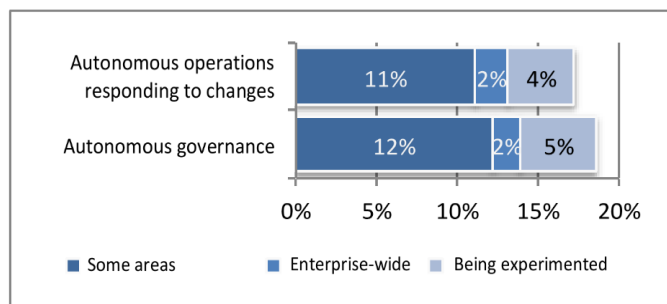


### 3.2.3.3.2 AUTOMATION (D2, D3)

Automation is not a compulsory factor for starting *Smart Operations*, but is a factor that affects the ability of a business to elevate its readiness level from “experienced” to an “expert” or “top performer” position.

The two operations automation methods examined were management automation according to specified processes and operations process control automation following changes achieved. The proportions of enterprises applying these two methods were 19% and 17%, respectively. Most automation activities were conducted within some part of the enterprise, but it is noteworthy that 2% of enterprises reported they had implemented automation operations within the whole enterprise and 4-5% of surveyed enterprises had piloted applications for operations automation (Figure 3-33).

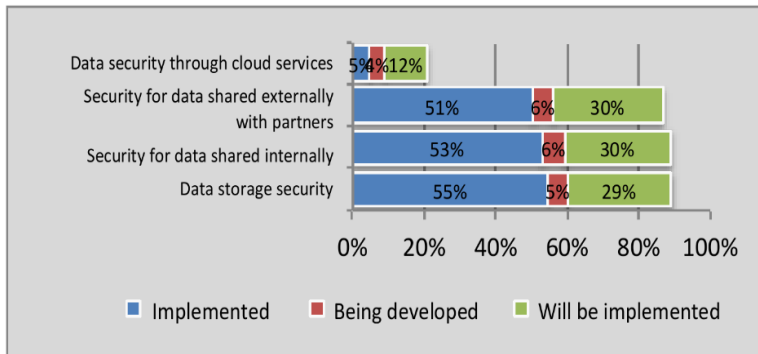
**FIGURE 3-33: SHARE OF ENTERPRISES APPLYING OPERATIONS AUTOMATION**



### 3.2.3.3.3. INFORMATION SECURITY (D4)

Information security is one of two minimum requirements to start *Smart Operations*. Although 80% of enterprises did not have an IT division, 17% had an information division for the whole enterprise and 3% had an information division for each department. The percentage of enterprises practicing information security activities for internal communication, data storage and information exchanges with business partners was similar (87-89%). Only 12% of enterprises reported to have exercised data security through cloud services (Figure 3-34). One reason for the low rates was only 15% of enterprises used cloud computing (see B3 and D5). The rate of enterprises implementing data security through cloud services should be monitored in parallel with the proportion of enterprises using this service in the future.

FIGURE 3-34: SHARE OF ENTERPRISES IMPLEMENTING INFORMATION SECURITY



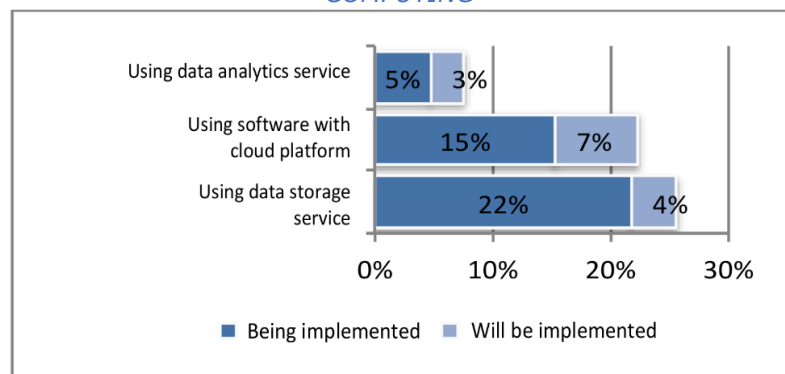
implementing data security through cloud services should be monitored in parallel with the proportion of enterprises using this service in the future.

### 3.2.3.3.4 USING FUNCTIONS, SERVICES OF CLOUD COMPUTING (D5)

Readiness in using cloud computing functions and services is not a compulsory factor for starting *Smart Operations*, but is a factor that affects the ability of a business to elevate its readiness level from the "learners" to "leaders" group.

Data storage services were most used by enterprises (22%), followed by software packages with a cloud platform (15%). Only 5% of enterprises reported having used data analytics services (Figure 3-35).

FIGURE 3-35: SHARE OF ENTERPRISES USING CLOUD COMPUTING



### 3.2.3.4. PILLAR E - SMART PRODUCTS

The readiness score in the *Smart Products* pillar was lowest (0.08) of the six pillars assessed and the readiness level in this pillar was the lowest and weakest of enterprises in the industry sector. This pillar has an important impact on the readiness level to respond to IR4.0 and the second highest importance weighting factor (18.5%), only behind the *Strategy and Organization* pillar. In order to improve readiness for *Smart Products*, it is necessary to focus on supporting 93% of the manufacturing enterprises (at present there is no data, information on products associated with IT) in incorporating IT into products so origins and characteristics can be traced over time, establishing the premise for product data services.

*Smart Products* are the foundation for *Smart Factory* and *Smart Operations*. Many *Smart Factory* features and potential benefits of *Data-driven Services* depend on comprehensive

information about a particular product as to whether it is readily available or not. A Smart Factory must know which products are in the production line to update the order status. Meanwhile, equipment manufacturers need extensive information about the time and intensity of equipment usage to provide customers with a maintenance plan based on actual usage levels. Meeting these needs requires the use of smart products - items equipped with IT. Thus each object has its own identity, which can interact with the environment, record information about its environment and its own state through sensors and provide various additional functionality during its operation.

In IR4.0, a processed part in production indicates next steps to be taken. Thus, this part needs information about itself and steps planned and implemented previously. Information can be collected through information functions about objects, monitoring functions and memory of the product. Built-in functions and self-reporting enable the product to communicate with machines on steps in a workflow. To enable the tracking of order progress, products must be able to automatically identify and locate themselves.

In the usage phase, similar functions allow implementation of data-driven services, such as remote maintenance or provision of device parameter settings to handle some materials. Manufacturers also have the opportunity to support product development by gathering all production data and critical uses. As a result, conditions of use can be analyzed in more detail, whereby the product continues to be developed, helping enterprises develop products and devise solutions appropriately adjusted to suit users or potential customers.

The readiness level in the *Smart Products* pillar is determined by considering additional IT functionalities of the product and level of analysis of data collected during the usage phase. Scores assessing *Smart Products* were calculated by the lowest E1 score (product's capability to provide data using IT) and E2 (use of product data)<sup>24</sup>.

The readiness score for Smart Products was the lowest (0.08) and share (93%) of enterprises at “outsider” level was the highest among the six pillars assessed. This low readiness score and high “outsider” ratio was due the high proportion of enterprises that did not have products with capabilities to provide data using IT. Some 53% of enterprises did not collect information about product data and 93% reported no information nor data associated with IT. Therefore, it was not possible to track a product in real time and by its actual location (Figure 3-36). This is one of the important requirements for *Smart Products* and should be prioritized in industrial development policies.

FIGURE 3-36: SHARE OF ENTERPRISES WITH NO ACTIVITIES IN PILLAR E'S DIMENSIONS

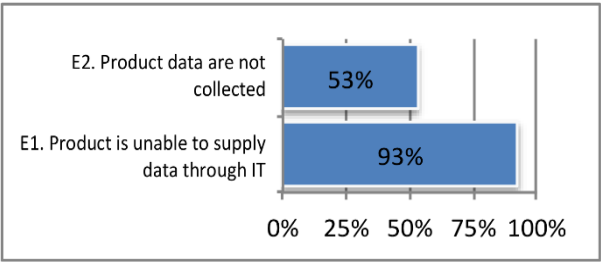
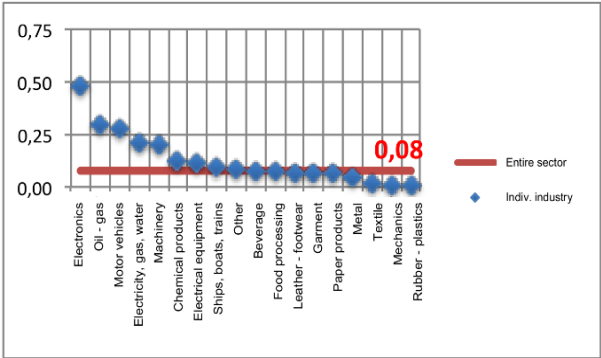


FIGURE 3-37: READINESS SCORE IN PILLAR E BY SUBSECTOR



<sup>24</sup> The minimum score for these two sub-pillars (dimensions) is 0 for E1 and 1 for E2. Enterprises without products featuring IT characteristics (E1) will have a zero score.

The nine industries with readiness scores exceeding the sector average were electronics products, oil and gas, motor vehicles, electricity-gas-water, machinery and equipment n.e.c, chemicals and, electrical equipment, other transportation vehicles and other manufacturing industries. Of note, the demand for smart products will grow, especially for those within global value chains, such as textiles, garments and leather-footwear, while the readiness scores of these subsectors were even lower than the very low averages of the entire sector (Figure 3-37).

Along with the lowest readiness score was the very high percentage of "*outsider*" enterprises of different subsectors in this pillar. This ratio in oil and gas was 70%, electrical equipment (80%), motor vehicles (85%), electricity-gas-water (86%), machinery and equipment n.e.c (87%) and all the other subsectors (more than 90%). It is worth noting that while the percentage of "*outsider*" firms in this pillar was very high, the number of enterprises (especially in industries such as electronics products, motor vehicles, electricity-gas-water and machinery and equipment n.e.c) at "*experienced*", "*expert*" and even "*top performer*" levels was rather sizeable (compared to other pillars in which the percentage of "*outsider*" firms was lower and readiness scores were higher). The rather large divide between enterprises of various subsectors regarding readiness level in the *Smart Products* pillar may be related to characteristics of products (production) of different firms in each subsector<sup>25</sup> (Figure 3-38).

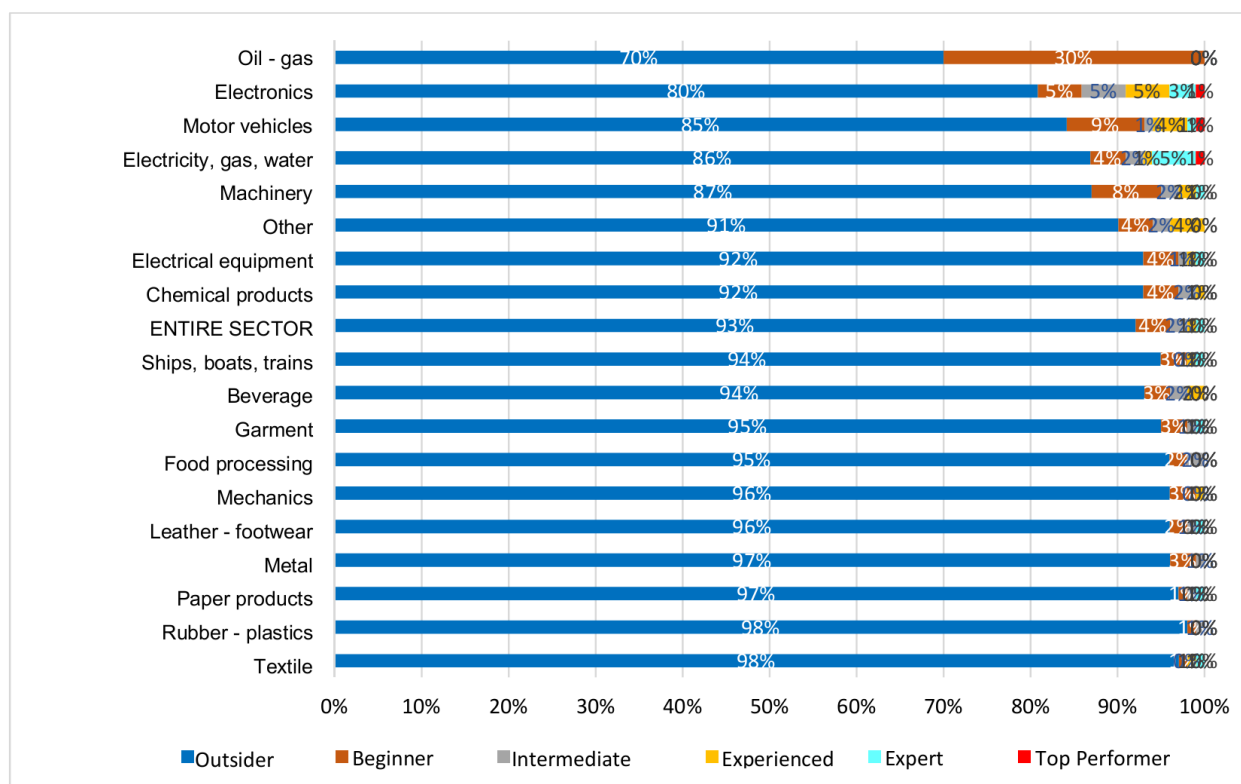
The groups of large enterprises and SOEs have much higher proportions of firms at high readiness levels ("*experienced*", "*expert*" and "*top performer*") compared to the SMEs group and other forms of ownership (Figure 3-39).

The regression results in column (4) of Table PL6-4 were consistent with the description in Figure 3-39 on the positive correlation between a firm's size and ability of its products to add ICT features. In addition, generally high readiness levels were often found in SOEs with a large workforce (300-1,000 employees), manufacturing enterprises using high technology, employing managers who have university qualifications or above and with high ratios of capital/labour concentrations. Enterprises with high proportions of employees aged 46-55 years old were more likely to have lower readiness levels.

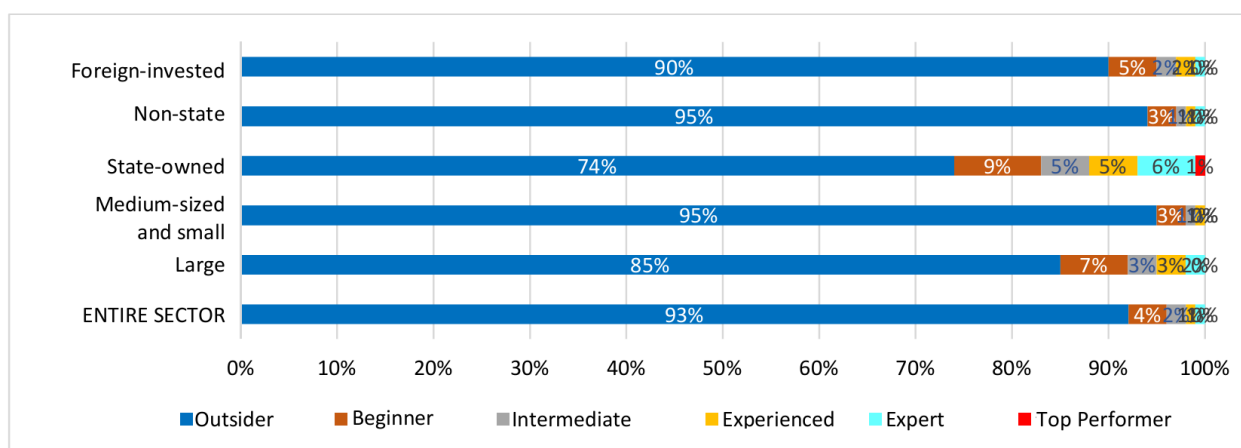
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<sup>25</sup> When using a measure (from the VDMA method designed and applied to the German mechanical engineering industry) of product data and products providing data by ICT, the readiness level can be assessed as high for products with characteristics that require such features and can be assessed as low for products that do not have these requirements (i.e., the measure is not "relevant" for those products). Using a measure that is "sensitive" only to particular products/production processes may lead to a result (of a large divide regarding readiness levels among firms in the same industry mentioned above, yet) not accurately indicating readiness levels of enterprises with products/production processes that are not sensitive to those measures. Although this needs to be verified, in the future, the formulation of indicators, dimensions and pillars, determination of weights and scoring methods and classification should be built in a more comprehensive process with participation, consultation of enterprises and industry experts and based on other empirical studies.

**FIGURE 3-38: SHARE OF ENTERPRISES BY READINESS LEVEL IN SMART PRODUCTS PILLAR BY SUBSECTOR**



**FIGURE 3-39: SHARE OF ENTERPRISES BY READINESS LEVEL IN SMART PRODUCTS PILLAR BY SIZE AND OWNERSHIP**



#### 3.2.3.4.1 AUTOMATIC DATA FEED CAPABILITY OF A PRODUCT (E1)

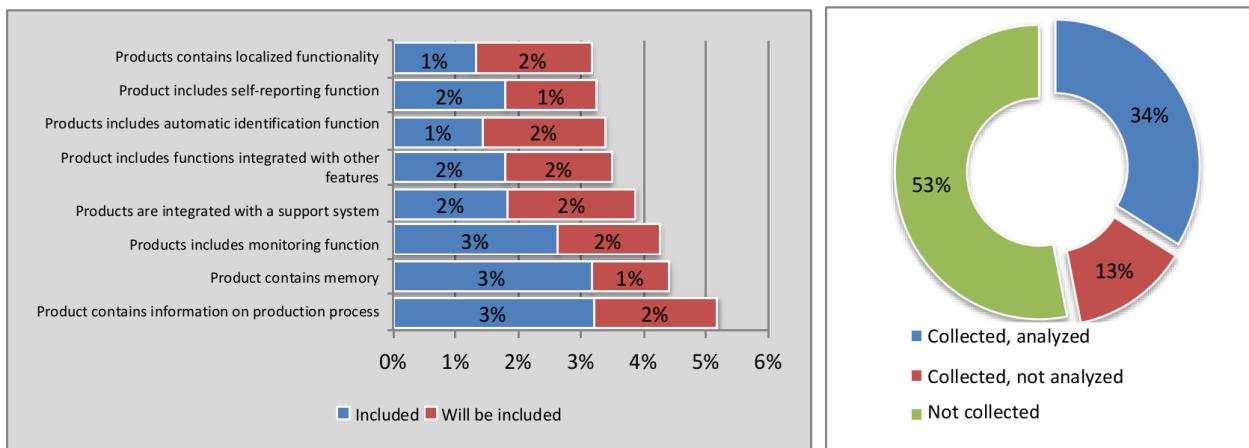
The automatic data feed capability of a product through equipping it with IT features is the minimum requirement to start with smart products. Eight data feed capabilities of products were surveyed and received a relatively low positive response rate from enterprises, as 1-3% of enterprises reported products as capable of generating data feeds and 1-2% of enterprises would add this capability to products (Figure 3-40).



### 3.2.3.4.2 COLLECTING DATA OF THE PRODUCT (E2)

Product data collection activities are not a compulsory factor to achieve “*beginner*” level in the *Smart Products* pillar, but are a factor that influences the ability of a business to elevate its readiness level from “*beginner*” to “*learners*” group and higher. Some 48% of firms said they collected data on products and 34% of firms analyzed this data, more than double the percentage of firms that only collected product data without analysis or utilization. This is a bright spot in promoting data service markets for products when products are equipped with data feed features.

**FIGURE 3-40: SHARE OF ENTERPRISES THAT EQUIP PRODUCTS WITH FEATURES AND USE PRODUCT DATA**



### 3.2.3.5 PILLAR F - DATA-DRIVEN SERVICES

The readiness score in the *Data-driven Services* pillar was low (0.42) due to the poor level of providing data services that integrate production process and product usage data. According to survey data, 100% of enterprises collected production data (Pillar D - *Smart Operations*), 47% of enterprises collected data on product usage (Pillar E - *Smart Products*), but the integrated data service for product manufacturing and use, and the degree of equipping products with IT features (Dimension E1), resulted in a low readiness score in Pillar F - *Data-driven Services*.

In order to improve the readiness for *Data-driven Services*, priority should be given to promoting the dimensions of Pillar E, namely to focus on supporting 93% of surveyed sub-sector enterprises in incorporating IT features in products, to trace the origin as well as product characteristics over time, as a premise for product data services.

IR4.0 is not only identified through the use of ICT, but also in the fundamental change of focus in business model towards enhancing customers’ benefits. Enterprises have an opportunity to implement digital modelling of the traditional business model and build a completely new business model to reap benefits from data collection and analysis.

Breakthrough, innovative IR4.0 business models go much further with the clear goal to open-up value chains and exploit new potential. For example, in the German mechanical engineering industry, manufacturers have recently tended to not only sell products in combination with services to increase consumers’ benefits, but also included the sale of machines with maintenance contracts committed to the availability of a data analysis system based on equipment information collected by the product to perform predictive maintenance.

The score measuring the readiness level in the *Data-driven Services* pillar was calculated by the lowest score of F1 (service integrating production and product use data) and F3 (level of collected data usage)<sup>26</sup>.

The percentage of enterprises that did not use data collected on production and products was 83% and those with no service integrating production and product use data was 67% (Figure 3-41). Industries with higher-than-sector average readiness scores were chemicals, oil and gas, electronics products, other manufacturing industries, motor vehicles, other transportation vehicles, electrical equipment, paper products, basic metals, electricity-gas-water, beverages, leather and footwear, rubber, plastics and food processing (the latter had a readiness score equal to the readiness score of the entire sector). Major export subsectors such as textiles, garments, fabricated metals (mechanical engineering) and machinery and equipment n.e.c had lower readiness scores than the entire industry sector's average (Figure 3-42). As many as 67% of enterprises were at "outsider" level against requirements for *Data-driven Services*. This high rate was influenced by the percentage of firms that did not integrate production data with product use data, thus indirectly affected by product data collection according to requirements of Pillar E. Of note in this pillar, 25% of enterprises were just at "beginner" level, 3% at "intermediate" level and some enterprises in the "leaders" group ("experienced", "expert" and "top performer" readiness levels). The fabricated metals (mechanical engineering), oil and gas, garments, machinery and equipment n.e.c, leather and footwear, textiles and electricity-gas-water subsectors have a high percentage of firms at "outsider" level (81-73%). This ratio in the other subsectors was also high (56-69%). Similar to the *Smart Products* pillar, there was a significant divide (possibly related to product characteristics) between enterprises in each subsector in the *Data-driven Services* pillar. In subsectors, including some with high rates of "outsider" enterprises (fabricated metals and mechanical engineering), garments and electricity-gas-water, the number of firms at "experienced", "expert" and "top performer" readiness levels were significant (Figure 3-43). The group of large enterprises and to a certain extent of SOEs had a much higher proportion of enterprises at high readiness levels ("experienced", "expert" and "top performer") compared to groups of SMEs and other types of ownership (Figure 3-44).

FIGURE 3-41: SHARE OF ENTERPRISES WITH NO ACTIVITIES IN PILLAR F'S DIMENSIONS

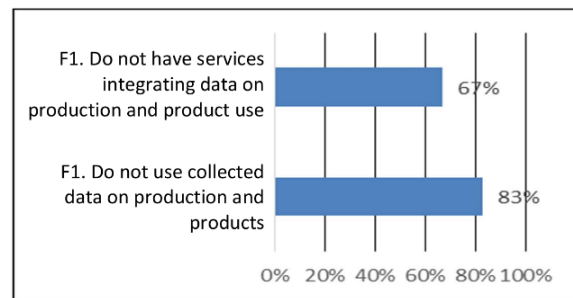
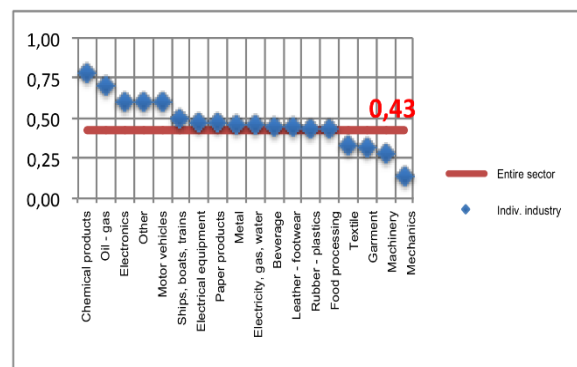
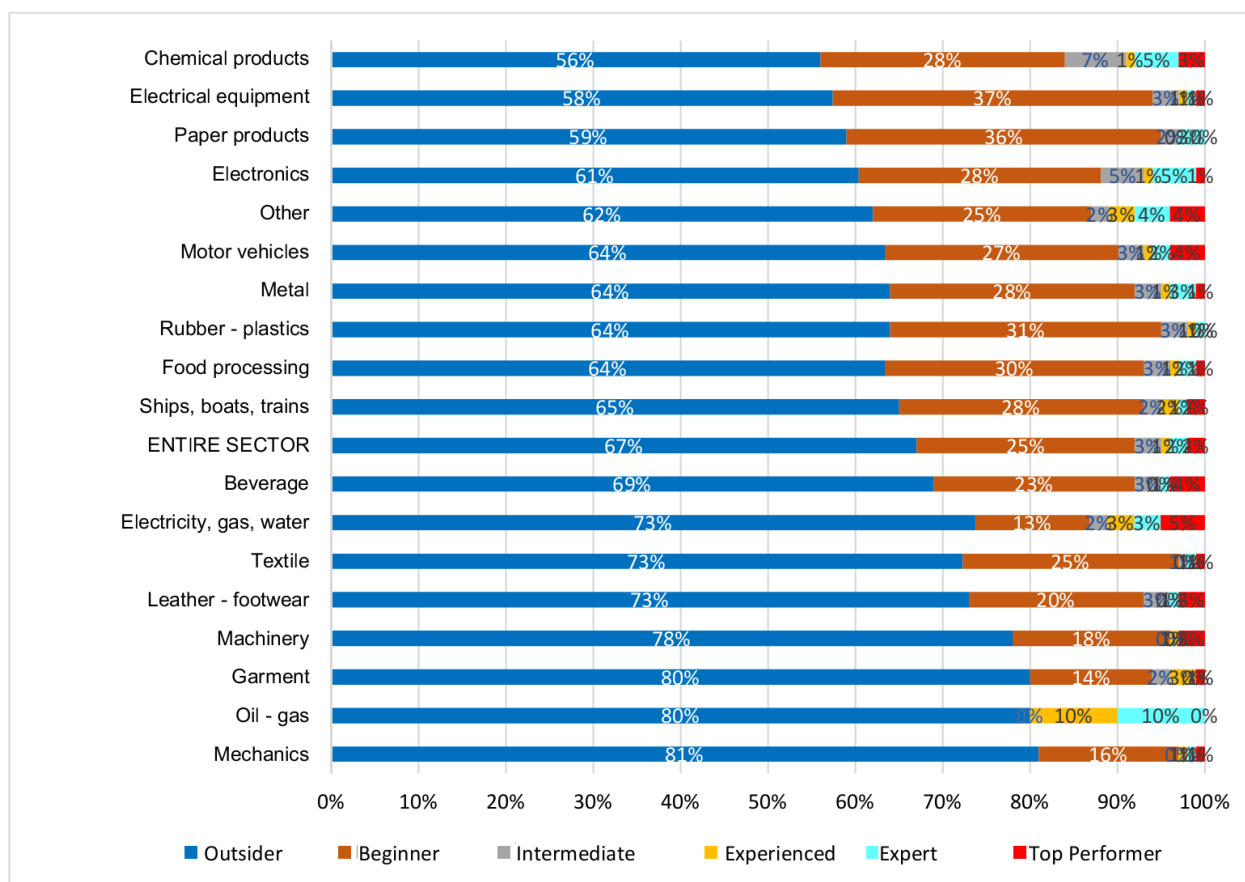


FIGURE 3-42: READINESS SCORE IN PILLAR F

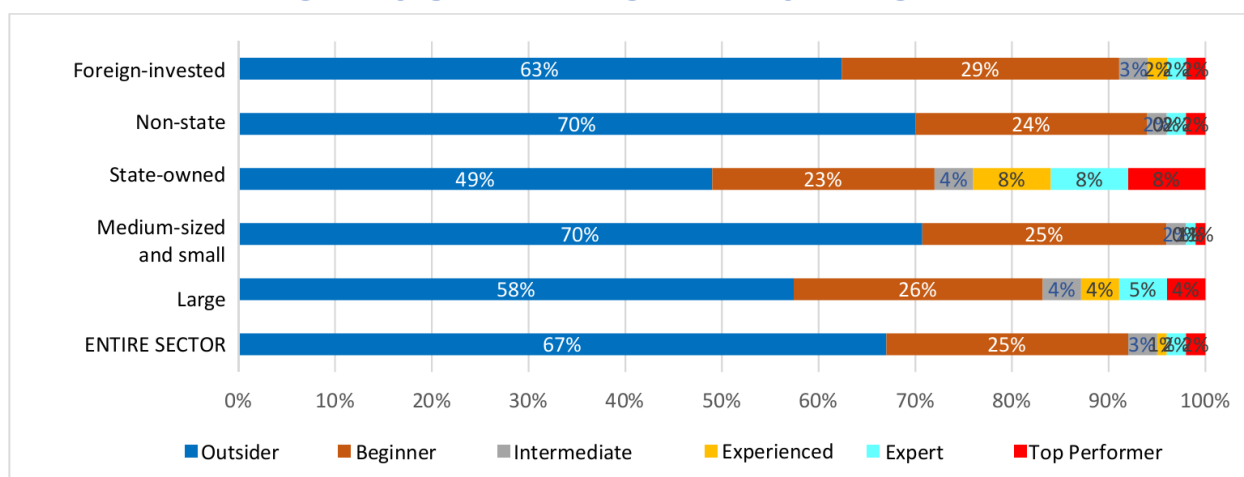


<sup>26</sup> Compared with the VDMA method, this survey did not have a F2 dimension - *contribution of the service to revenue*, and the score measuring this dimension was treated as having no information available. The minimum score for these two sub-pillars (dimensions) is 0 for F1 and 1 for F3. Firms that do not have a *service integrating production and product use data* (F1) will have a zero score. The evaluation for scoring the F3 dimension is as follows: 1 for not using data, 2 for using and analyzing 0-20% of collected data (equivalent to 1-2 data types used by enterprises to share information with the outside in Pillar D – *Smart Operations*), 4 for using and analyzing 20-50% of collected data (equivalent to 3-4 data types) and 5 for using and analyzing more than 50% of collected data (equivalent to more than four types of data).

**FIGURE 3-43: SHARE OF ENTERPRISES BY READINESS LEVEL IN DATA-DRIVEN SERVICES PILLAR BY SUBSECTOR (SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA)**



**FIGURE 3-44: SHARE OF ENTERPRISES BY READINESS LEVEL IN DATA-DRIVEN SERVICES PILLAR BY SIZE AND OWNERSHIP**



(SOURCE: CALCULATED FROM IR4.0 READINESS SURVEY DATA)

### BOX 3-5: FACTORS RELATED TO READINESS LEVEL IN DATA-DRIVEN SERVICES PILLAR

Similar to Figure 3-44, the regression results in Column (5) of Table PL6-3 show the percentage of firms performing *data-driven services* tended to increase by size of labour force, most prominent for the “*experienced*” level in this pillar. Enterprises employing managers with university qualifications or higher, with high ratios of capital/labour concentrations, usually had a higher readiness score in the *Data-driven Services* pillar. In the meantime, enterprises with higher proportions of employees trained for less than three months were more likely to attain a lower readiness score. The detailed correlation between factors and readiness level for the pillar for each readiness group level is summarized in Table 3-13.

**Table 3-13: Factors related to readiness level in *Data-driven Services* pillar**

	Readiness level					
	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
Capital/labour ratio	-	+	+			
Size of labour force	-	+	+			
Managers with university qualifications or higher	-	+	+			
Share of employees using computers	+	-	-			
Enterprises using the internet for making transactions	+	+	-	-	-	-
Enterprises using the internet for making financial transactions	+	+	-	-	-	-
Share of employees trained for less than three months	+	-	-			

Note: Change in one unit of factor corresponds to a higher readiness level (+), or lower (-)

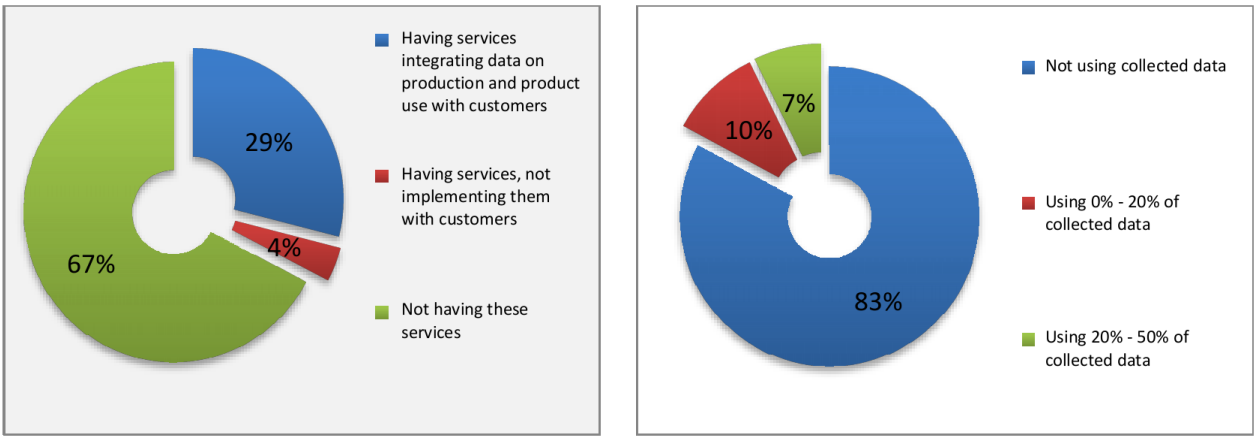
Source: Calculated from the Enterprise Census 2017

#### 3.2.3.5.1 CAPABILITY TO PROVIDE DATA INTEGRATION SERVICES (F1) AND DATA USE (F3)

Of the 33% of enterprises that provided services integrating production data and product data, 29% provided services to customers and 4% did not. The level of data provided to customers

remained low. Of the eight potential areas (dimensions) of *Smart Operations* (Pillar D), which could provide production data as a service, only 7% of enterprises provided data in four areas (Figure 3-45).

FIGURE 3-45: LEVEL OF DATA-DRIVEN SERVICES PROVISION



### 3.2.3.6. PILLAR G - EMPLOYEES

Readiness score in the *Employees* pillar (1.24) was the second highest following the *Smart Operations* pillar and was at “beginner” level. Of note, 11% of enterprises have not equipped employees with any knowledge and skills to cope with IR4.0 and the percentage of enterprises having sufficiently equipped employees with knowledge and skills was still low (2-4%).

Employees are impacted and have great influence in the digitalization process of a work environment. Changing work environments require employees to acquire new skills and professional qualifications. Preparing employees by means of appropriate and regular trainings to adapt and facilitate changes has become increasingly important to enterprises.

Employees play a key role in implementing an enterprise’s digitization process. Readiness in the *Employees* area was determined by analyzing employees' skills across multiple stages of business production and enterprise efforts to equip employees with skills.

The score measuring skills and qualifications of employees was determined by using the G1 dimension for seven survey areas, such as skills in using IT platforms, automation technology, data analysis techniques, information and communication security techniques, technical development and application of supporting technology, techniques to use collaborative

FIGURE 3-46. SHARE OF ENTERPRISES HAVING NO ACTIVITY IN PILLAR G'S DIMENSION EMPLOYEE SKILLS

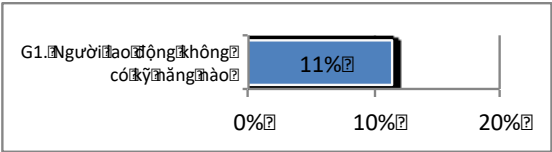
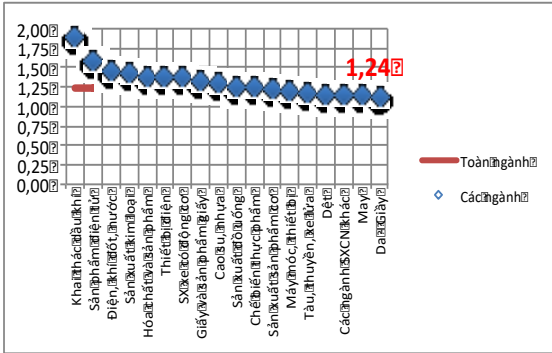


FIGURE 3-47. READINESS SCORE IN PILLAR G BY SUBSECTOR



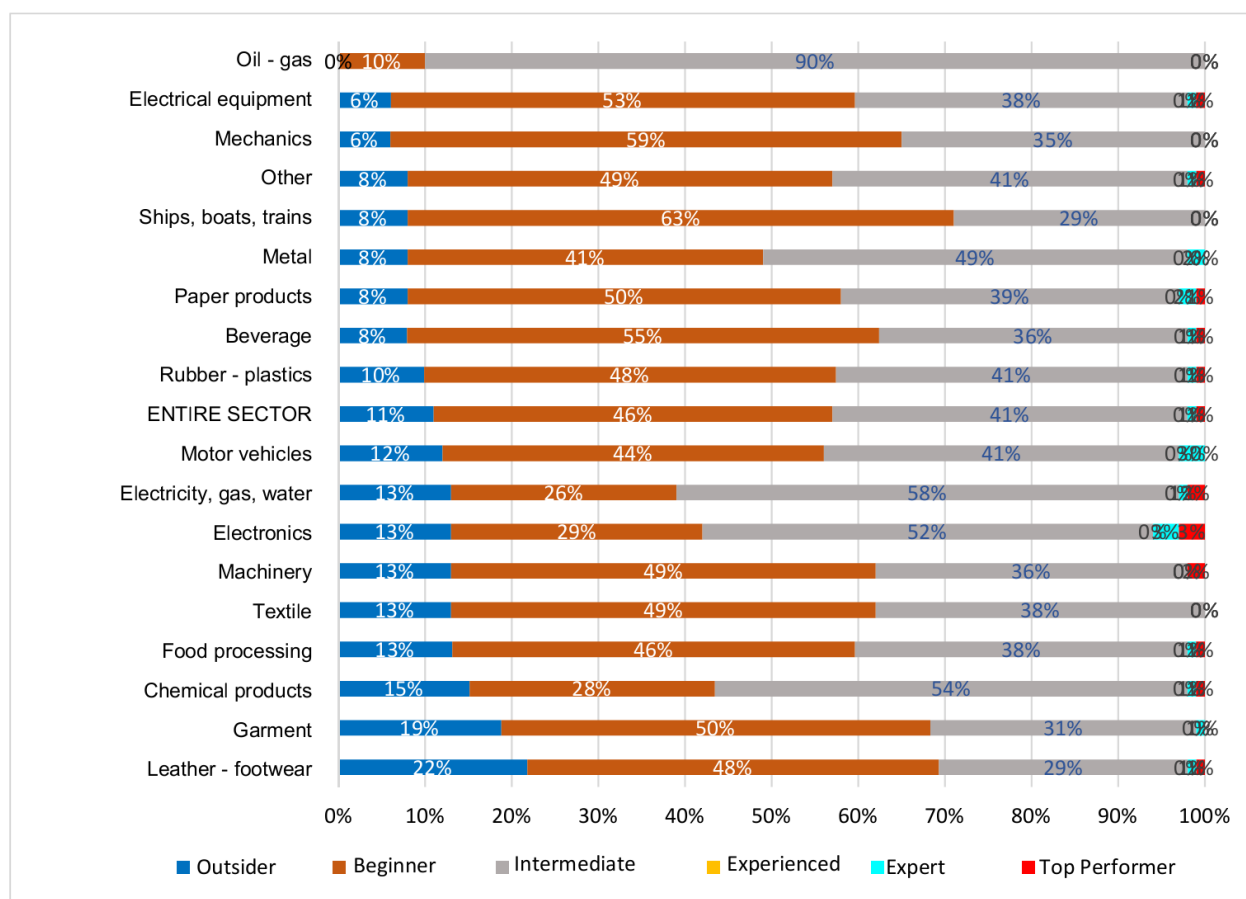
software packages and systemic thinking<sup>27</sup>. Interestingly, 11% of enterprises reported they had not equipped employees with any skills to cope with IR4.0 (Figure 3-46).

The readiness score for Pillar G concerning skills of employees in the industry sector was 1.24, thus this pillar had the second highest readiness score (following *Smart Operations*) of the six assessed. Industries with higher than sector average readiness scores were oil and gas, electronics products, electricity-gas-water, basic metals, chemicals, electrical equipment, motor vehicles, paper products, rubber, plastics, beverages and food processing. Interestingly, the textiles, garments and leather and footwear subsectors - as major exporters in the industry sector that are labour intensive and employers of workers with relatively low skills - have readiness scores below the sector's average (Figure 3-47). The leather and footwear, textiles, garments along with chemicals, food processing, machinery and equipment n.e.c, electronics products, electricity-gas-water and motor vehicles are subsectors with percentages of "outsider" enterprises in the *Employees* pillar ranging from 12-22% (higher than the sector average of 11%). This percentage in oil and gas was 0%, in the electrical equipment and fabricated metals (mechanical engineering) subsectors was 6%. Although firms in most subsectors were primarily concentrated in the two readiness levels, "beginner" and "intermediate", there was a significant number (1-3%) of enterprises to have achieved the two highest readiness levels "expert" and "top performer" in the *Employees* pillar (Figure 3-48).

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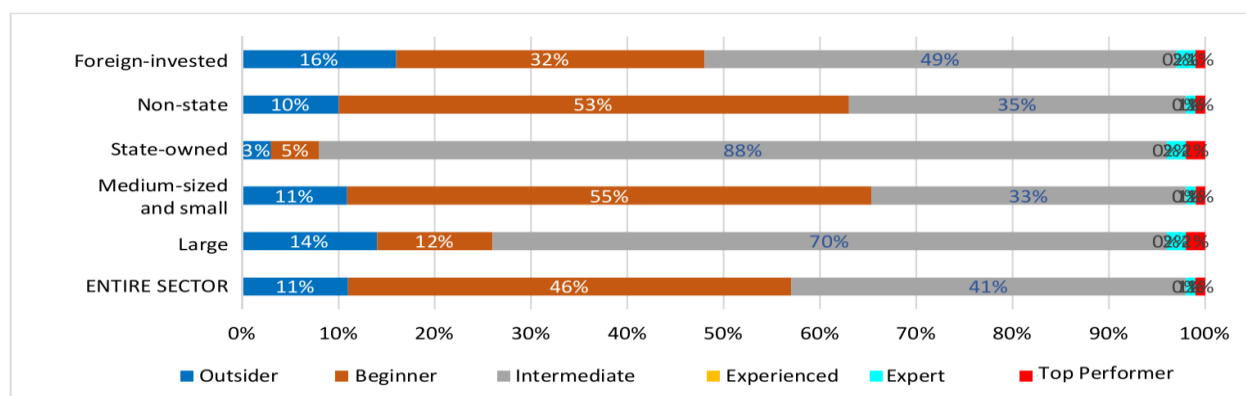
<sup>27</sup> The minimum score for G1 was 0, so enterprises that said employees did not have any skills in the seven surveyed areas would obtain an assessment score of zero.

**FIGURE 3-48: SHARE OF ENTERPRISES BY READINESS LEVEL  
IN EMPLOYEES PILLAR BY SUBSECTOR**



Similar to other pillars, size and ownership were related to readiness levels of enterprises in the *Employees* pillar. SOEs and large-scale corporations surpassed firms with other forms of ownership and SMEs in terms of proportion of enterprises having reached “*intermediate*” readiness level and above (Figure 3-49).

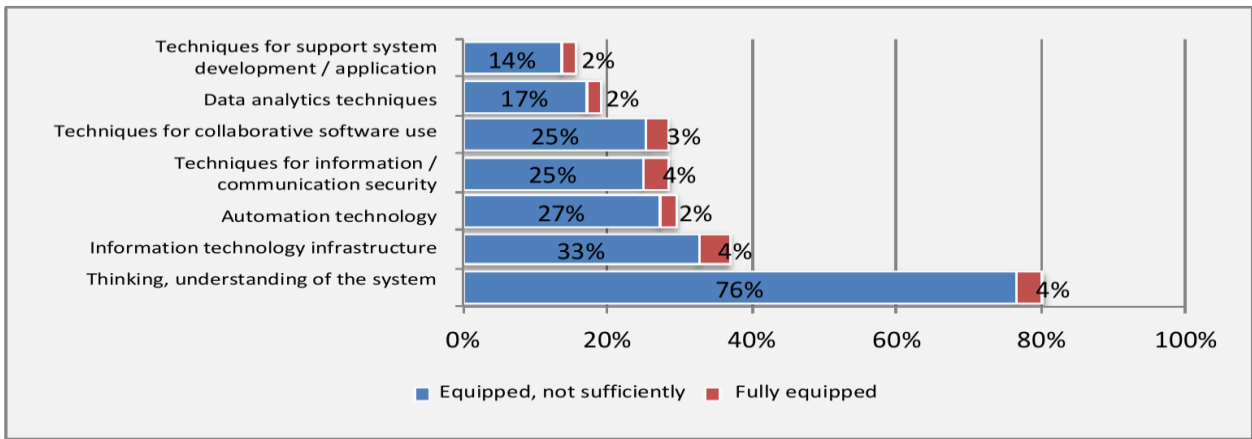
**FIGURE 3-49: SHARE OF ENTERPRISES BY READINESS LEVEL  
IN EMPLOYEES PILLAR BY SIZE AND OWNERSHIP**



It is noteworthy that although the group of foreign-invested enterprises had a higher proportion of enterprises reaching “*intermediate*” readiness level and above, compared to non-State enterprises in the *Employees* pillar, this gap was not as clearly visible as with other pillars.

Regarding Dimension G1 - equipping employees with skills, as much as 80% of enterprises had built production system capacity of employees, with 14-33% of enterprises reported to have equipped employees with specific techniques. However, the level of employees equipped with techniques and experience remains insufficient, as only 2-4% of enterprises said employees had adequate knowledge and experience in the surveyed fields (Figure 3-50).

**FIGURE 3-50: LEVEL OF EQUIPPING EMPLOYEES WITH KNOWLEDGE AND SKILLS, WHOLE SECTOR**





### BOX 3-6: FACTORS RELATED TO READINESS LEVEL IN EMPLOYEES PILLAR

The regression results in Column (6), Table PL6-3 show that factors related to readiness levels in the *Employees* pillar of enterprises were similar to factors related to readiness levels in other pillars. Specifically, the larger the number of employees in an enterprise, the greater likelihood the enterprise will reach a high readiness level in the *Employees* pillar. In addition, high levels of readiness in this pillar were often seen in enterprises with postgraduate education management that tended to score higher (firms with high concentrations of capital/labour, with management having a university degree or higher, or with high percentages of employees using computers). In the meantime, firms with employees trained for less than three months or with proportions of employees aged 46-55 years will be more likely to achieve a lower readiness score in the *Employees* pillar (Table 3-14).

**Table 3-14: Factors related to readiness level in *Employees* pillar**

	Readiness level					
	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
Capital/labour ratio	-	-	+	+	+	+
Enterprises with 10 employees and above	-	-	+	+	+	+
Managers with university qualifications or higher	-	-	+	+	+	+
Share of employees using computers	-	-	+	+	+	+
Share of employees trained for less than 3 months	+	+	-	-	-	-
Share of employees aged from 46-55 years	+	+	-	-	-	-

Note: Change in one unit of factor corresponds to a higher readiness level (+), or lower (-)

Source: Calculated from IR4.0 Readiness Survey data

#### 3.2.4 IR4.0 READINESS: INDUSTRY RECORD

To help readers learn more about readiness levels of specific sectors, this section will present results of the survey data analysis for each industry (17 surveyed subsectors, except for "Other industrial manufacturing enterprises"). The results of the analysis in each industry will be divided

according to the overall readiness level/score, each pillar/dimension and proportion of enterprises by readiness levels of each pillar<sup>28</sup>.

## 1. OIL AND GAS (I) READINESS LEVEL: "BEGINNER" (II) RANK: 1/17

**Summary:** Oil and gas has a small number of enterprises, large-scale investments, technology characteristics requiring the ability to connect equipment, connections with equipment and products as well as high technical capabilities of employees, the premise for the subsector's readiness, with a readiness score reaching: 1.16, at the "beginner" level to participate in IR4.0. The readiness level with requirements for Smart Operations, Employees and Smart Factory reached a readiness level of "beginner", while readiness for the remaining pillars, especially for Smart Products, were at "outsider" level. Policies of greatest interest to enterprises were those in management of units' linkages as well as labour restructuring developed and deployed in five out of 10 enterprises. With the subsector's high internal self-mobilization in areas responding to demands of market and production management, enabling the subsector's increased readiness level from "beginner" to "intermediate", priority should be given to supporting enterprises to deploy enterprise-wide automation, rather than just at some units as at present. Policies are also needed to promote the collection and delivery of products' data, enabling traceability of subsector products.

Readiness score of Oil and gas subsector (Industry sector's average)				1.16 (0.53)		Rank		1/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			3/10	6/10	1/10	0	0	0
Pillar B: Strategy and Organization								
Readiness score of Oil and gas subsector ( Industry sector's average				0.7 (0.14)		Rank		1/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			4/10	5/10	10	0	0	0
B1 - Develop and implement strategy		Share of enterprises that have issued/is issuing strategy (1)						6/10
		Share of enterprises that have no plan to develop strategy						4/10
B2 - Completeness of indicators measuring results		Share of enterprises that have issued/used sets of indicators						1/10
		Completeness of sets of indicators (which have been issued/used)						Incomplete
B3 - Investment in technology applications		Share of enterprises that have invested in science and technology (2)						8/10
		Share of enterprises that will continue investing in science and technology for production/processing/manufacturing						5/10
B4 - Innovation management		Share of enterprises implementing innovation activities for production management						7/10
		Share of enterprises implementing innovation activities for IT management and general management						2/10
		Share of enterprises implementing innovation activities for product development management						1/10
Pillar C: Smart Factory								

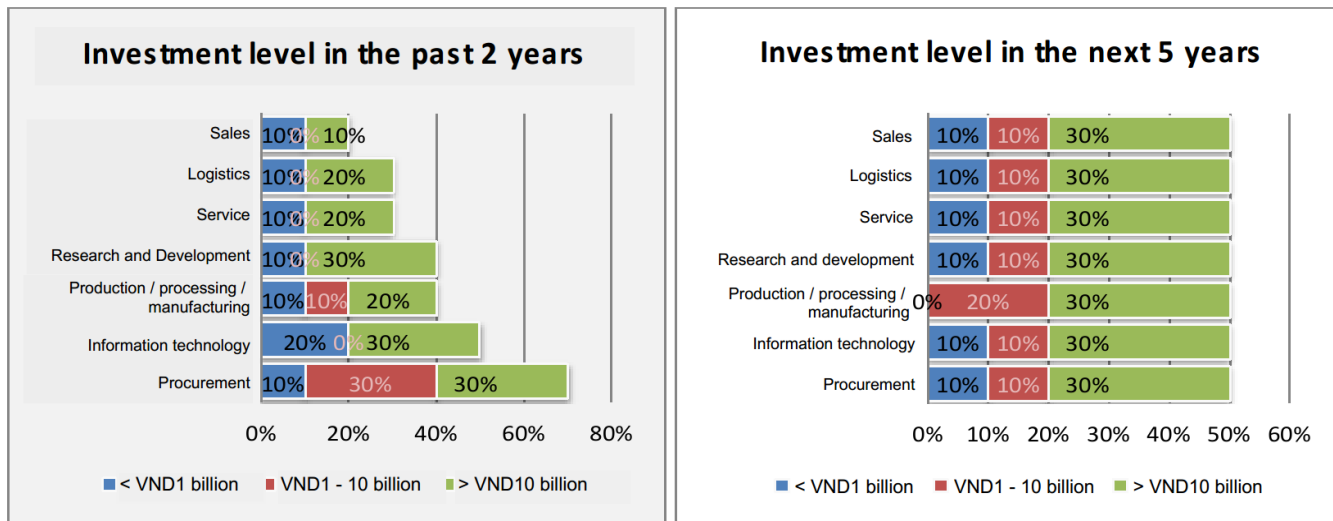
<sup>28</sup> Analyses of readiness score/level by ownership and enterprise size in each subsector will not be conducted because the sample size at that level was insufficient to ensure statistical significance of the analyses. See footnote 10 for "note about the use of analysis results by each two-digit subsector".

Readiness score of Oil and gas subsector ( sector's average)				1.7 (0.35)		Rank		1/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			2/10	0	7/10	1/10	0	0
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					10/10
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					2/10
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					2/10
C4 - Data collection method			Share of enterprises collecting data					10/10
C5 - Purpose of data usage			Share of enterprises using information					8/10
Pillar D: Smart Operations								
Readiness score of Oil and gas subsector ( sector's average)				2.4 (1.47)		Rank		1/17
Readiness level	Intermediate	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			1/10	0	6/10	1/10	1/10	1/10
D1 - Information sharing			Share of enterprises sharing information (5)					9/10
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					7/10
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					4/10
D4 - IT security			Share of enterprises having information security plan					9/10
D5 - Cloud usage			Share of enterprises using cloud computing					5/10
Pillar E: Smart Products								
Readiness score of Oil and gas subsector (Industry sector's average)				0.3 (0.08)		Rank		2/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			7/10	3/10	0	0	0	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/will have products, which can provide data through IT					3/10
E2 - Use of product data			Share of enterprises that have collected and used product data					5/10
Pillar F: Data-driven Services								
Readiness score of Oil and gas subsector (Industry sector's average)				0.7 (0.43)		Rank		2/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			8/10	0	0	1/10	1/10	0
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					8/10
F3 - Level of using data collected			Share of enterprises that don't use production and product data					6/8
Pillar G: Employees								
Readiness score of Oil and gas subsector ( Industry sector's average)				1.9 (1.24)		Rank		1/17

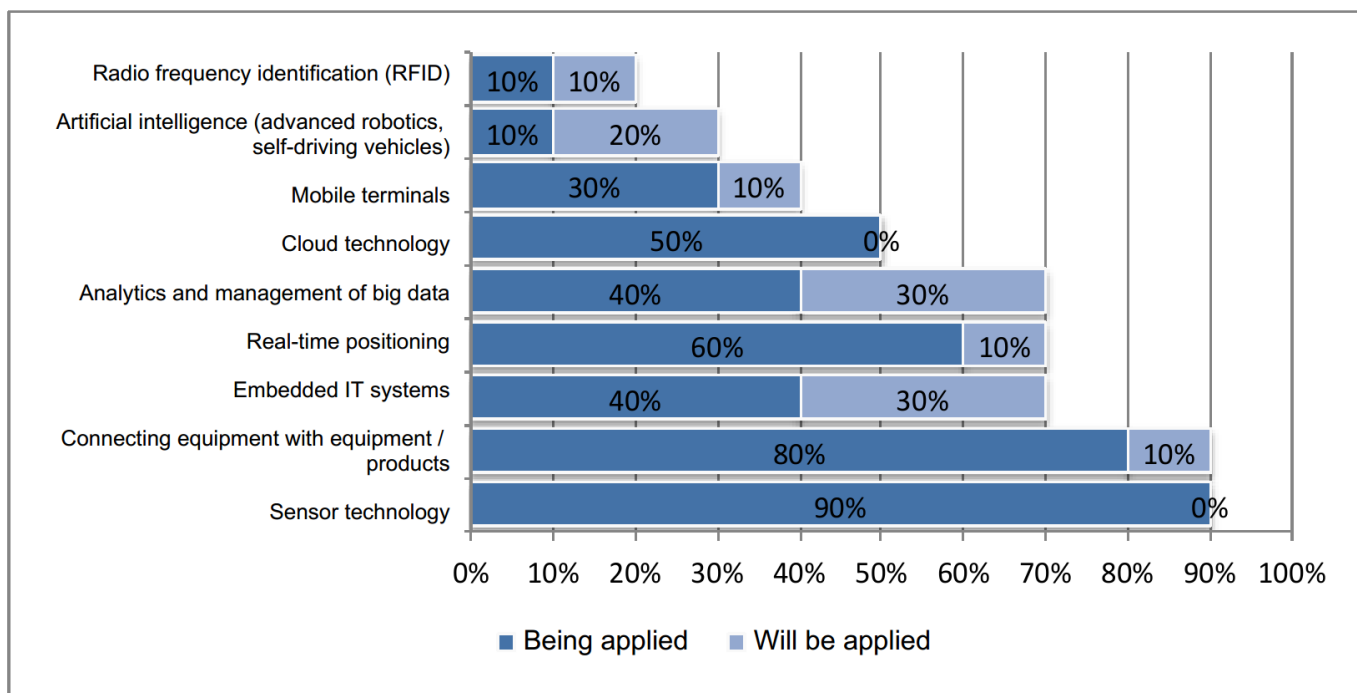
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			10	90	0	0	0	0
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					10/10

**Note:**

- (1) One out of 10 enterprises have issued and four out of 10 were developing new labour structure strategies, two out of 10 have issued (and one-three were developing) strategies for connecting management of all activities, two out of 10 enterprises reported they were building a strategy to apply Internet of Things (IoT) technology.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (3) Three out of 10 enterprises said they needed upgrades to exercise controls through IT, to communicate among equipment or integrate with other systems.
- (4) Of enterprises having used digital models, six out of 10 enterprises used “top performer” interfaces for collection of production and machinery data (1/10 - EPR, PLM, MES, PDM and PPS, 2/10 - CAD, 6/10 PDA and MDC). No enterprise used SCM models.
- (5) Nine of 10 shared information internally, between units of business. Only three out of nine shared information outside (partners).
- (6) The level of equipment was inadequate in the majority of seven surveyed areas: (i) Techniques for using collaborative software: eight out of 10 enterprises equipped, but not sufficiently, (ii) IT infrastructure: six out of 10 enterprises equipped, but not sufficiently, three out of 10 enterprises equipped sufficiently, one not equipped, (iii) Automation technology: four out of 10 enterprises equipped, but not sufficiently, five out of 10 enterprises equipped sufficiently, one not equipped, (iv) Data analysis techniques: eight out of 10 enterprises equipped, but not sufficiently and one out of 10 enterprises equipped sufficiently, (v) Information security techniques: five out of 10 enterprises equipped, but not sufficiently, four out of 10 enterprises equipped sufficiently, one not equipped, (vi) Techniques for developing, applying support systems: nine out of 10 enterprises equipped, but not sufficiently, one not equipped and (vii) Thinking and understanding of systems: nine out of 10 enterprises equipped, but not sufficiently, one out of 10 enterprises equipped sufficiently, one not equipped.

**Sample size:** Ten enterprises responded (out of 14 enterprises in the industry), including three large enterprises and seven medium-sized and small enterprises, eight SOEs and two foreign-invested enterprises (joint ventures). Due to the small sample size, the results should be considered with caution.

## 2. ELECTRONICS, INFORMATICS: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 2/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0, with the readiness score of 0.82 at "outsider" level. However, with the specificity of an subsector that deals extensively with data, there are a number of firms that have preparedness above the "intermediate" level. Labour restructuring and technical standardization of the entire production-product chain are currently being implemented with the highest percentage of enterprises having responded (59% and 47%). The percentage of enterprises that are and will inter-connect equipment was 31%. As many as 25% of enterprises have inter-connected equipment and 6% planned to, but faced infrastructure-related problems with 46% of enterprises unable to control equipment through IT or connect to other technology and 39% said they could not upgrade equipment to inter-connect with the system. Some 54% of enterprises did not use a digital model, while 25% of enterprises used ERP resource management model and 9% used the SCM supply chain management model. The majority of data was manually collected, 80% of enterprises could not supply product data through IT, 72% did not share data with customers and partners, and 61% did not have services integrating production data and product use. Notably, 13% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

The labour restructuring strategy and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with strengthened support activities for application of ERP, SCM and enhanced collection and exchange of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 39% of firms in the subsector. The rate of enterprises equipping workers with knowledge and techniques should further increase compared to the current level of 87%. Business models of enterprises at high readiness levels ("Leaders" group) in each pillar should be studied and disseminated for replication.

Readiness score of <i>Electronics, informatics</i> subsector (sector's average)				0.82 (0.53)	Rank			2/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			72%	22%	6%	0%	0%	0%
<b>Pillar B: Strategy and Organization</b>								
Readiness score of <i>Electronics, informatics</i> subsector (sector's average)				0.32 (0.14)	Rank			2/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			75%	21%	2%	2%		0
B1 - Develop and implement strategy		Share of enterprises that have issued/is issuing strategy (1)						26%
		Share of enterprises that have no plan to develop strategy						74%
B2 - Completeness of indicators measuring results		Share of enterprises that have issued/used sets of indicators						4%
		Completeness of sets of indicators (which have been issued/used)						Incomplete
B3 - Investment in technology applications		Share of enterprises that have invested in science and technology (2)						70%
		Share of enterprises that will continue investing in science and technology for production/processing/manufacturing						45%
B4 - Innovation management		Share of enterprises implementing innovation activities for production management						65%
		Share of enterprises implementing innovation activities for IT management and general management						22%

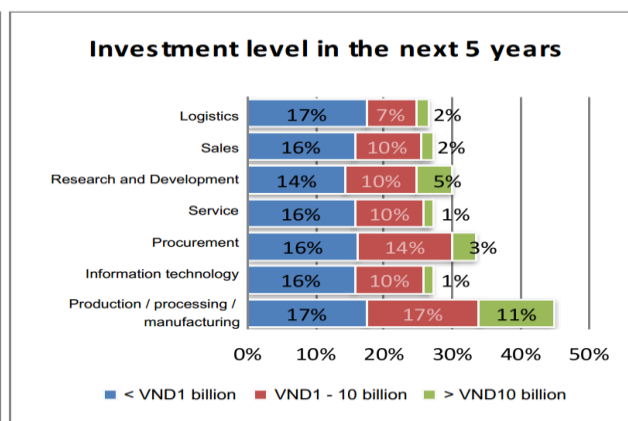
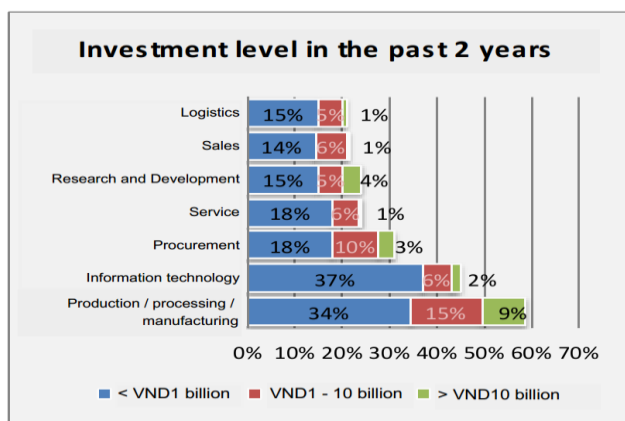
			Share of enterprises implementing innovation activities for product development management					14%
Pillar C: Smart Factory								
Readiness score of <i>Electronics, informatics</i> subsector ( sector's average)			0.77 (0.35)		Rank			3/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			55%	20%	20%	3%	2%	0
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					61%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					46%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					54%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					96%
Pillar D: Smart Operations								
Readiness score of <i>Electronics, informatics</i> subsector ( sector's average)			1.66 (1.47)		Rank			3/17
Readiness level	Beginner	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			11.5%	18.4%	64.4%	4.6%	1.1%	0
D1 - Information sharing			Share of enterprises sharing information (5)					92%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					24%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					27%
D4 - IT security			Share of enterprises having information security plan					92%
D5 - Cloud usage			Share of enterprises using cloud computing					29%
Pillar E: Smart Products								
Readiness score of <i>Electronics, informatics</i> subsector ( sector's average)			0.48 (0.08)		Rank			1/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			80.5%	5.2%	5.2%	5.2%	2.9%	1.1%
E1 - Products' capability to provide data through IT			Share of enterprises that have/will have products, which can provide data through IT					20%
E2 - Use of product data			Share of enterprises that have collected and used product data					40%
Pillar F: Data-driven Services								
Readiness score of <i>Electronics, informatics</i> subsector ( sector's average)			0.61 (0.43)		Rank			3/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			61.5%	27.6%	5.2%	0.6%	4.6%	0.6%
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					
F3 - Level of using data collected			Share of enterprises that don't use production and product data					
Pillar G: Employees								



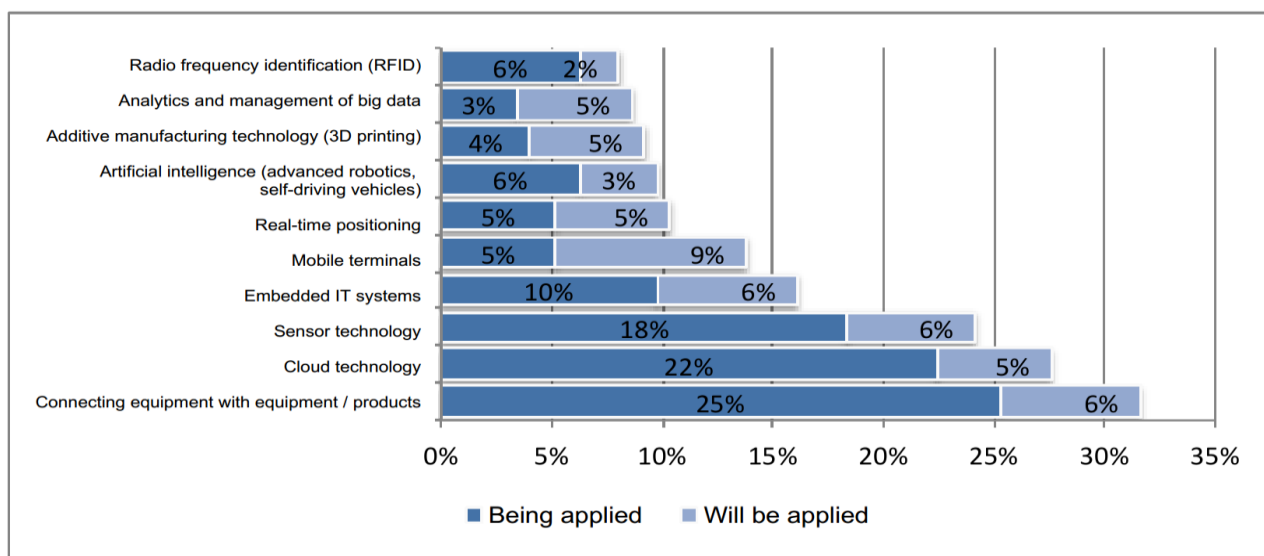
Readiness score of <i>Electronics, informatics</i> subsector (sector's average)				1.59 (1.24)	Rank			2/17
Readiness level	<i>Beginner</i>	Share of enterprises by readiness level	of Outsider	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				13%	29%	52%	0	3%
<i>G1 - Employees skills</i>				Share of enterprises having equipped employees with 4.0 skills (6)				77%

**Note:**

- (1) 53% of enterprises were developing strategies to restructure their labour forces, 34% of enterprises have developed and 13% of enterprises were developing strategies on technical standardization of the entire production-product chain, 26% of enterprises are and will be implementing strategies for connecting, managing units' activities.
- (2) Share of enterprises investing in technology in the surveyed areas:



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- (3) 46% of enterprises could not control equipment through IT or connect to other technology and 39% of enterprises said they could not upgrade equipment to simultaneously inter-connect equipment and with other systems.
- (4) In (46% of) enterprises using digital models, the models used included: CAD (28%), ERP (25%), PDA (16%), MES (15%), PDM (14%), MDC (13%), PPS (13%), SCM (9%) and PLM (7%).



- (5) 61% of enterprises did not collect and have services integrating product data with product use, and 72% did not share data with partners and customers.
- (6) The level of equipment was inadequate in the majority of the seven surveyed areas: (i) Techniques for using collaborative software: 37% of enterprises, equipped but not sufficiently, 7% equipped sufficiently, similarly in other areas, (ii) IT infrastructure: 44% and 7%, (iii) Automation technology: 28% and 4%, (iv) Data analysis techniques: 22% and 5%, (v) Information security techniques: 34% and 6%, (vi) Techniques for developing, applying support systems: 17% and 5% and (vii) Thinking, understanding of systems: 67% and 8%.

**Survey samples:** 174 enterprises responded, including 31 large enterprises and 143 medium-sized and small enterprises, 68 non-State enterprises and 106 foreign-invested enterprises.

### 3. MOTOR VEHICLES: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 3/17

**Summary:** Most enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.69 at "outsider" level. The 5% of enterprises at intermediate readiness level and 1% at experienced level could be levers for other companies at "outsider" level. Labour restructuring and technical standardization of the entire production-product chain is currently and will be deployed most, with enterprises' response rates of 48% and 50%. The percentage of enterprises that are and will be connected to equipment is 32%. Already 17% of enterprises have inter-connected equipment, 15% of enterprises planned to, but, faced infrastructure-related problems to implement this plan. Some 54% of enterprises could not control equipment through IT nor connect to other technology and 46% said they could not upgrade equipment to inter-connect and with systems, the biggest obstacle to getting ready for subsector. Some 57% of enterprises did not use digital modeling, 18% used the ERP model and 7% used the SCM model. The majority of data was manually collected, 85% of enterprises could not supply products' data by IT technology, 74% did not share data with customers and partners and 64% did not have services integrating production data and product use. Notably, 12% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

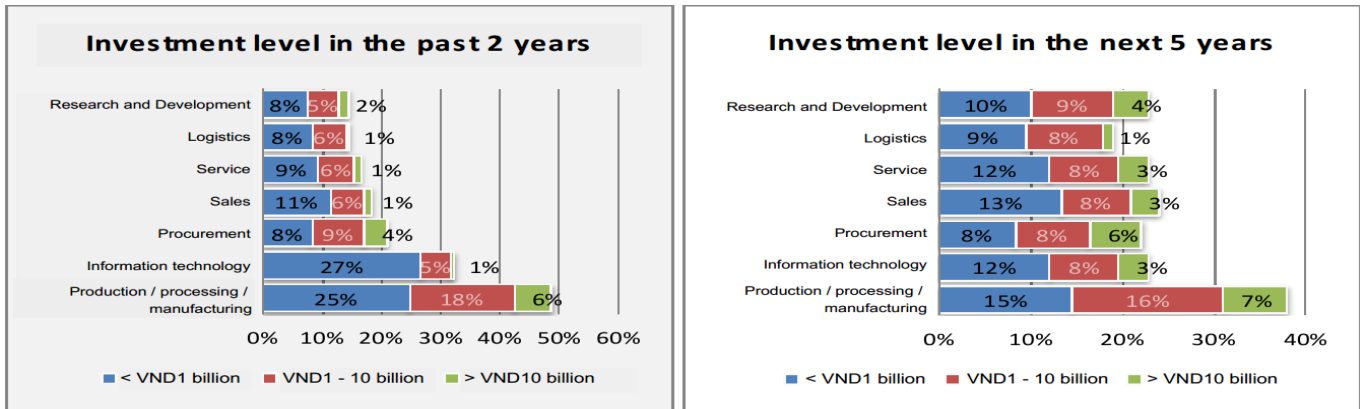
The labour restructuring strategy and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with strengthened support activities for application of ERP, SCM and enhanced collection and exchange of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 46% of firms. The rate of enterprises equipping workers with knowledge and techniques should further increase compared to the current level of 88%. Business models of enterprises (especially large and SOEs) at high readiness levels ("leaders" group) in each pillar should be studied and disseminated for replication.

Readiness score of <i>Motor vehicles subsector</i> ( sector's average)				0.69 (0.53)	Rank			3/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				83%	11%	5%	1%	0
Pillar B: Strategy and Organization								
Readiness score of <i>Motor vehicles subsector</i> ( sector's average)				0.23 (0.14)	Rank			5/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				83%	13%	1%	3%	0
<i>B1 - Develop and implement strategy</i>		<i>Share of enterprises that have issued/is issuing strategy (1)</i>						19
		<i>Share of enterprises that have no plan to develop strategy</i>						81
<i>B2 - Completeness of indicators measuring results</i>		<i>Share of enterprises that have issued/used sets of indicators</i>						0
		<i>Completeness of sets of indicators (which have been issued/used)</i>						N.A.
<i>B3 - Investment in technology applications</i>		<i>Share of enterprises that have invested in science and technology (2)</i>						57
		<i>Share of enterprises that will continue investing in science and technology for production/ processing/ manufacturing</i>						38
<i>B4 - Innovation management</i>		<i>Share of enterprises implementing innovation activities for production management</i>						55
		<i>Share of enterprises implementing innovation activities for IT management and general management</i>						18
		<i>Share of enterprises implementing innovation activities for product development management</i>						9

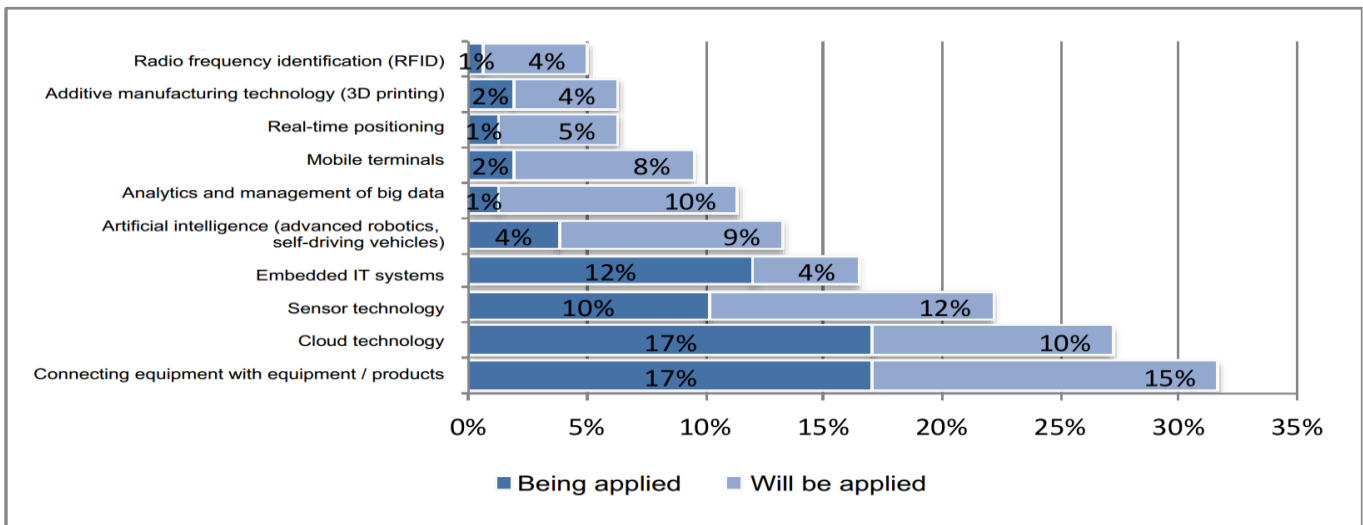
Pillar C: Smart Factory									
Readiness score of <i>Motor vehicles subsector</i> ( sector's average)				0.62 (0.35)	Rank				4/17
Readiness level	Outsider	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				62%	18%	16%	3%	1%	0
C1 - Feature for controlling, connecting equipment				Share of enterprises that have upgradable equipment for connections (3)					53%
C2 - Level of meeting equipment connectivity demand				Share of enterprises that can't control equipment through IT (3)					54%
C3 - Digital management model				Share of enterprises that don't have any digital model (4)					57%
C4 - Data collection method				Share of enterprises collecting data					100%
C5 - Purpose of data usage				Share of enterprises using information					92%
Pillar D: Smart Operations									
Readiness score of <i>Motor vehicles subsector</i> ( sector's average)				1.62 (1.47)	Rank				4/17
Readiness level	Beginner	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				15%	16%	64%	4%	0	1%
D1 - Information sharing				Share of enterprises sharing information (5)					90%
D2 - Automation				Share of enterprises having system autonomously responding to changes (some units)					16%
D3 - Autonomous processes				Share of enterprises having autonomous system (some units)					16%
D4 - IT security				Share of enterprises having information security plan					90%
D5 - Cloud usage				Share of enterprises using cloud computing					24%
Pillar E: Smart Products									
Readiness score of <i>Motor vehicles subsector</i> ( sector's average)				0.28 (0.08)	Rank				3/17
Readiness level	Outsider	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				84.8%	8.9%	1.3%	3.8%	0.6%	0.6%
E1 - Products' capability to provide data through IT				Share of enterprises that had and will have products, which can provide data through IT					15%
E2 - Use of products' data				Share of enterprises that have collected and used products' data					37%
Pillar F: Data-driven Services									
Readiness score of <i>Motor vehicles subsector</i> ( sector's average)				0.6 (0.43)	Rank				4/17
Readiness level	Outsider	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				63.9%	27.2%	2.6%	0.6%	1.9%	3.8%
F1 - Integrating production and products' data				Share of enterprises that don't have services for integrating production and products' data					64%
F3 - Level of using collected data				Share of enterprises that don't use production and products' data					74%
Pillar G: Employees									
Readiness score of <i>Motor vehicles subsector</i> ( sector's average)				1.38 (1.24)	Rank				7/17
Readiness level	Beginner	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				12%	44%	41%	0	3%	0
G1 - Employees skills				Share of enterprises having equipped employees with 4.0 skills (6)					86%

**Note:**

- (1) 44% of enterprises are working on issuance of strategies to rebuild labour structures, 44% have developed and 6% were developing strategies on technical standardization of the entire production chain, 22% have implemented and will implement strategies for connecting, managing units' activities.
- (2) Share of enterprises investing in technology in the surveyed areas:
- (3) In enterprises using digital models: 32% used CAD, 18% ERP, 16% PDA, 11% MDC, 9% MES, 7% PPS, 7% PDM, 7% SCM, and 6% PLM.



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (4) 54% of enterprises could not control equipment through IT or connect to other technology and 46% of enterprises said they could not upgrade equipment to inter-connect equipment and with systems.
- (5) All surveyed enterprises collected data, but only 92% shared information on collected data, mainly internal sharing, only 16% shared with external partners.
- (6) The level of equipment was inadequate in the majority of seven surveyed areas: (i) Techniques for using collaborative software: 30% of enterprises were equipped, but not sufficiently, 3% equipped sufficiently, similarly in other areas: (ii) IT infrastructure: 37% and 5%, (iii) Automation technology: 27% and 1%, (iv) Data analysis techniques: 19% and 2%, (v) Information security techniques: 24% and 4%, (vi) Techniques for developing, applying support

systems: 15% and 1% and (vii) Thinking, understanding of systems: 73% and 4%, respectively.

**Survey samples:** 158 enterprises responded, including 29 large and 129 medium-sized and small enterprises, of which seven were SOEs, 64 non-State enterprises and 87 foreign-invested enterprises.

#### 4. ELECTRICITY-GAS-WATER: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 4/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.69, at "outsider" level. The 8% of enterprises to have reached "intermediate" readiness level and 2% at "experienced" readiness level could be levers for those still at "outsider" level. Labour restructuring and technical standardization of the entire production-product chain are being implemented with the highest proportion of enterprises having responded (42% and 36%). The percentage of enterprises that are and will inter-connect equipment was 29%. Some 11% of enterprises have inter-connected equipment and 18% planned to, but faced infrastructure-related problems implementing this plan. Although 42% of enterprises could not control equipment through IT or connect to other technology, only 11% of enterprises said they could not upgrade equipment for inter-connectedness. Some 60% of enterprises did not use digital models. Models for data collection and management of production operations were used in 25% of enterprises, 23% used ERP model and 7% used the SCM model. Data were collected manually and online, 86% of enterprises could not supply product data through IT, 66% did not share any data with customers and partners and 73% did not have services integrating production data and product use. Notably, 13% of enterprises did not equip employees with knowledge and techniques to prepare them for IR4.0.

The labour restructuring strategy and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with strengthened support activities for application of ERP, SCM and enhanced collection and exchanges of information on production processes and products. The electricity-gas-water subsector already has infrastructure ready to connect equipment, enabling it to raise the readiness level and meet requirements for Smart Factory and Smart Operations. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 11% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should further increase compared to the current level of 87%. Business models of enterprises, especially large and SOEs, at high readiness levels ("leaders" group) in each pillar should be studied and disseminated for replication.

Readiness score of <i>electricity-gas-water</i> subsector (Industry sector's average)				0.69 (0.53)		Rank		4/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			73%	18%	8%	2%	0	0
<b>Pillar B: Strategy and Organization</b>								
Readiness score of <i>electricity-gas-water</i> subsector (Industry sector's average)				0.3 (0.14)		Rank		3/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			71.2%	21.9%	4.1%	1.4%	1.4%	0
B1 - Develop and implement strategy		Share of enterprises that have issued/is issuing strategy (1)						32%
		Share of enterprises that have no plan to develop strategy						68%
B2 - Completeness of indicators measuring results		Share of enterprises that have issued/used sets of indicators						2%
		Completeness of sets of indicators (which have been issued/used)						Incomplete
B3 - Investment in technology applications		Share of enterprises that have invested in science and technology (2)						62%
		Share of enterprises that will continue investing in science and technology for production/processing/manufacturing						31%

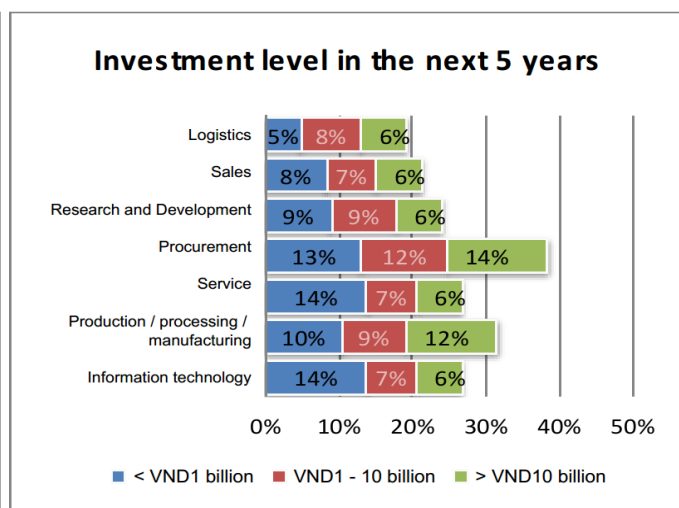
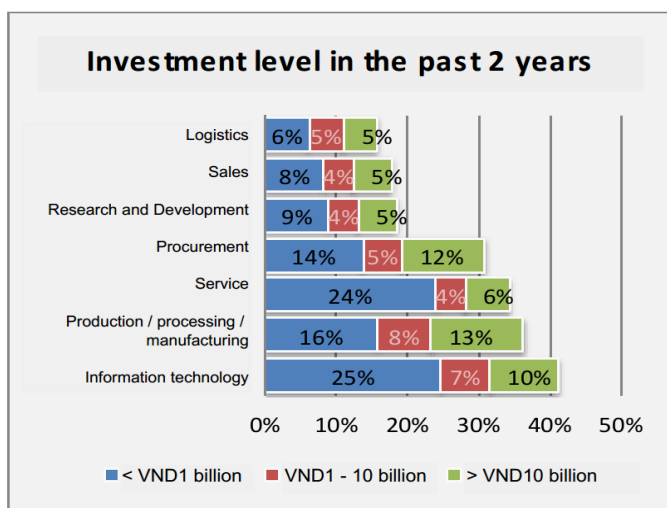
B4 - Innovation management	Share of enterprises implementing innovation activities for production management							58%
	Share of enterprises implementing innovation activities for IT management and general management							32%
	Share of enterprises implementing innovation activities for product development management							5%
Pillar C: Smart Factory								
Readiness score of electricity-gas-water subsector (Industry sector's average)				0.8 (0.35)		Rank		2/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			45%	19%	26%	7%	2%	1%
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					89%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					42%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					60%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					68%
Pillar D: Smart Operations								
Readiness score of electricity-gas-water subsector (Industry sector's average)				1.33 (1.47)		Rank		16/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			17.1%	31.5%	37.5%	10.3%	0.7%	2.7%
D1 - Information sharing			Share of enterprises sharing information (5)					88%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					32%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					28%
D4 - IT security			Share of enterprises having information security plan					88%
D5 - Cloud usage			Share of enterprises using cloud computing					36%
Pillar E: Smart Products								
Readiness score of electricity-gas-water subsector (Industry sector's average)				0.21 (0.08)		Rank		4/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			85.5%	4.1%	2.1%	1.4%	5.5%	1.4%
E1 - Products' capability to provide data through IT			Share of enterprises that have/ will have products, which can provide data through IT					24%
E2 - Use of product data			Share of enterprises that have collected and used product data					28%
Pillar F: Data-driven Services								
Readiness score of electricity-gas-water subsector (Industry sector's average)				0.45 (0.43)		Rank		9/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			73.3%	13%	2.1%	3.4%	3.4%	4.8%
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					73%



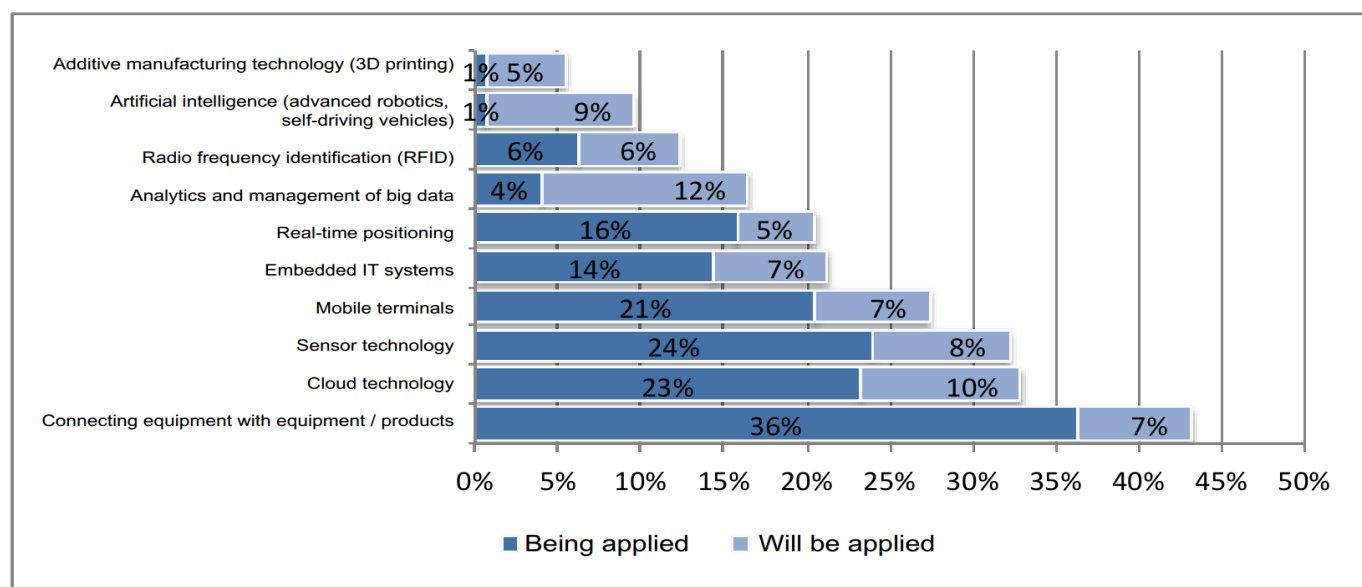
F3 - Level of using data collected			Share of enterprises that don't use production and product data					66%
Pillar G: Employees								
Readiness score of <i>electricity-gas-water</i> subsector (Industry sector's average)			1.46 (1.24)		Rank			3/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			13%	26%	58%	0	1%	2%
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					87%

**Note:**

- (1) 35% of enterprises were working on issuance of strategies to rebuild their labour structures, 24% of enterprises have developed and 12% were developing strategies on technical standardization of the entire production chain and 29% were developing strategies for connecting, managing units' activities.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**





- (3) In enterprises using digital models: 20% use CAD, 18% ERP, 23% PDA, 22% MDC, 25% MES, 12% PPS, 21% PDM, 7% SCM, and 9% PLM.
- (3) All surveyed enterprises collected data, but only 68% shared information on collected data among departments and 12% did not share information with concerned parties.
- (4) 42% of enterprises could not control equipment through IT or connect to other technology. Only 11% of enterprises said they could not upgrade equipment for inter-connections.
- (5) The level of equipment was inadequate in the majority of seven surveyed areas: (i) Techniques for using collaborative software: 38% of enterprises were equipped, but not sufficiently, 9% equipped sufficiently, similarly in other areas: (ii) IT infrastructure: 54% and 8%, (iii) Automation technology: 36% and 8%, (iv) Data analysis techniques: 19% and 2%, (v) Information security techniques: 34% and 8%, (vi) Techniques for developing, applying support systems: 23% and 4% and (vii) Thinking, understanding of systems: 69% and 8%.

**Survey samples:** 146 enterprises responded, including 31 large and 115 medium and small enterprises, of which 38 were SOEs, 104 non-State enterprises and four foreign-invested enterprises.

## 5. CHEMICALS: "OUTSIDER" (II) RANK: 5/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.67 at "outsider" level. Labour restructuring and technical standardization of the entire production-product chain is and will be implemented with the highest proportions of enterprises having responded (40% and 55%). The percentage of enterprises that are and will be inter-connecting equipment is 35%, of which 18% have inter-connected equipment and 17% planned to, but enterprises faced infrastructure-related problems in implementing this plan. Some 45% of enterprises could not control equipment through IT or connect to other technology and 31% of enterprises said they could not upgrade equipment to inter-connect and with systems. This was the biggest obstacle to preparing the subsector for readiness. Some 65% of enterprises did not use digital models, 18% used ERP model and 12% used the SCM model. The majority of data was manually collected, 92% of enterprises could not supply product data through IT, 63% did not share data with customers and partners and 56% did not have services integrating production data and product use. Notably, 15% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

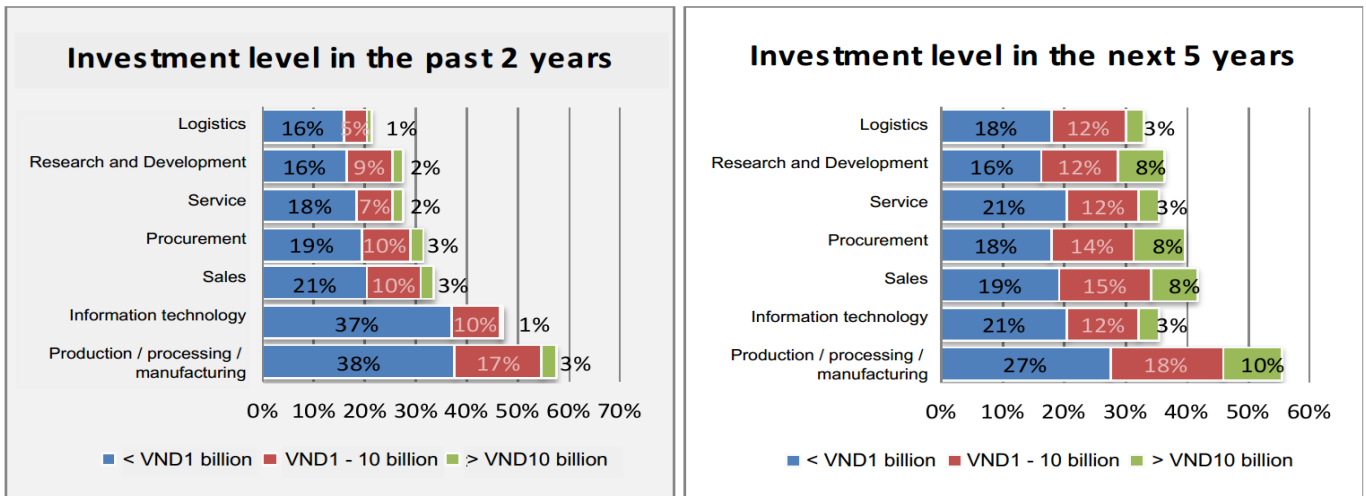
The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with support for application of ERP model, SCM model and enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products could only be achieved when replacement investments are made in 31% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should further increase compared to the current level of 85%.

Readiness score of <i>Chemicals</i> subsector ( average)				0.67 (0.53)	Rank			5/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			73%	26%	1%	0	0	0
Pillar B: Strategy and Organization								
Readiness score of <i>Chemicals</i> subsector (Industry sector's average)				0.23 (0.14)	Rank			4/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			75.4%	21.2%	3.4%	0	0	0
B1 - Develop and implement strategy		Share of enterprises that have issued/is issuing strategy (1)						27%
		Share of enterprises that have no plan to develop strategy						73%
B2 - Completeness of indicators measuring results		Share of enterprises that have issued/used sets of indicators						4%
		Completeness of sets of indicators (which have been issued/used)						Incomplete
B3 - Investment in technology applications		Share of enterprises that have invested in science and technology (2)						68%
		Share of enterprises that will continue investing in science and technology for production/processing/manufacturing						55%
B4 - Innovation management		Share of enterprises implementing innovation activities for production management						60%
		Share of enterprises implementing innovation activities for IT management and general management						21%
		Share of enterprises implementing innovation activities for product development management						15%
Pillar C: Smart Factory								

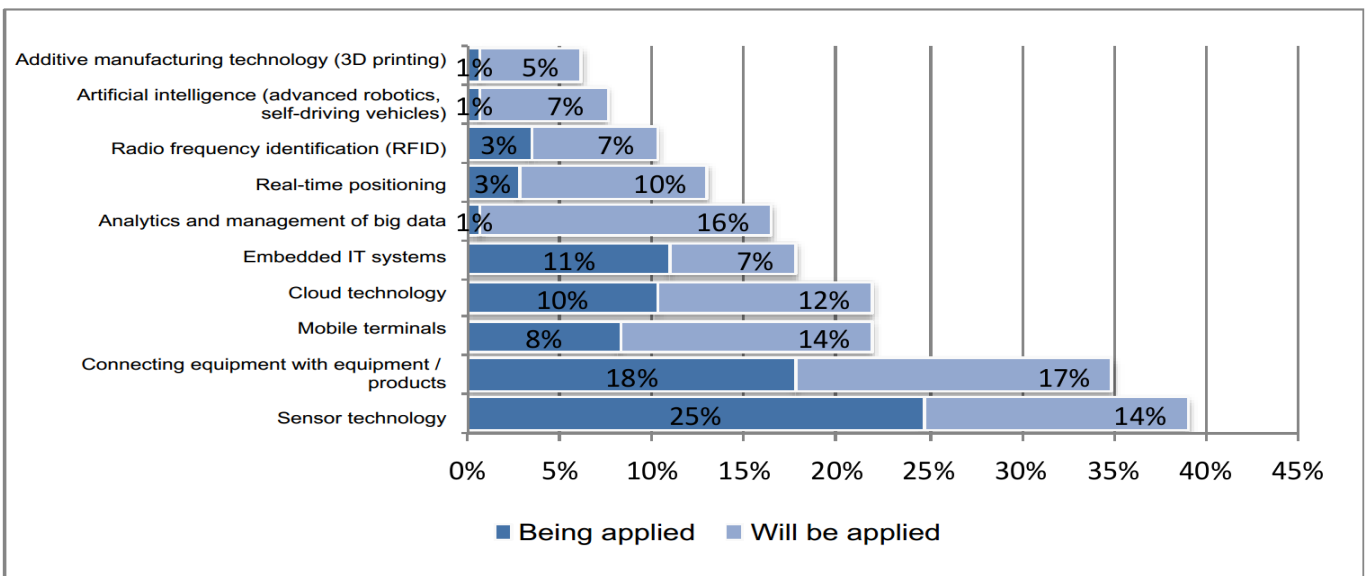
Readiness score of <i>Chemicals</i> subsector (Industry sector's average)				0.58 (0.35)	Rank			5/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				53%	27%	18%	1%	1%
C1 - Feature for controlling, connecting equipment				Share of enterprises that have upgradable equipment for connections (3)				69%
C2 - Level of meeting equipment connectivity demand				Share of enterprises that can't control equipment through IT (3)				45%
C3 - Digital management model				Share of enterprises that don't have any digital model (4)				65%
C4 - Data collection method				Share of enterprises collecting data				100%
C5 - Purpose of data usage				Share of enterprises using information				90%
Pillar D: Smart Operations								
Readiness score of <i>Chemicals</i> subsector (Industry sector's average)				1.49 (1.47)	Rank			10/17
Readiness level	<i>Beginner</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				16.4%	22.6%	50.8%	6.8%	2.7%
D1 - Information sharing				Share of enterprises sharing information (5)				79%
D2 - Automation				Share of enterprises having system autonomously responding to changes (some units)				28%
D3 - Autonomous processes				Share of enterprises having autonomous system (some units)				29%
D4 - IT security				Share of enterprises having information security plan				88%
D5 - Cloud usage				Share of enterprises using cloud computing				27%
Pillar E: Smart Products								
Readiness score of <i>Chemicals</i> subsector (Industry sector's average)				0.12 (0.08)	Rank			6/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				92.5%	4.1%	2%	1.4%	0
E1 - Products' capability to provide data through IT				Share of enterprises that have/will have products, which can provide data through IT				8%
E2 - Use of product data				Share of enterprises that have collected and used product data				44%
Pillar F: Data-driven Services								
Readiness score of <i>Chemicals</i> subsector (Industry sector's average)				0.78 (0.43)	Rank			1/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				56%	28%	7%	1%	5%
F1 - Integrating production and product data				Share of enterprises that don't have services for integrating production and product data				56%
F3 - Level of using data collected				Share of enterprises that don't use production and product data				63%
Pillar G: Employees								
Readiness score of <i>Chemicals</i> subsector (Industry sector's average)				1.31 (1.24)	Rank			5/17
Readiness level	<i>Beginner</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				15.1%	28.1%	54%	0	1.4%
G1 - Employees skills				Share of enterprises having equipped employees with 4.0 skills (6)				85%

**Note:**

- (1) 36% of enterprises were preparing to restructure their labour force, 55% have developed and were developing strategies on technical standardization of entire production chains, 39% of enterprises said they would implement technology for connecting, managing all activities of units.
- (2) Share of enterprises investing in technology in the surveyed areas:



### TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE



- (3) Among 35% of enterprises using digital models, 20% use PDA, 17% MES, 14% ERP, 17% PDM, 16% PPS, 14% MDC, 12% CAD, 10% PLM and 7% SCM.
- (4) All surveyed enterprises collected data, but only 90% shared information on collected data and 11% did not share information with concerned parties.
- (5) 45% of enterprises could not control equipment through IT or connect to other technology and 31% said they could not upgrade equipment to inter-connect and with systems.
- (6) Of 85% of enterprises to have equipped employees with skills, the majority self-assessed the level of equipment was inadequate in most surveyed areas: (i) Techniques for using collaborative software: 29% of enterprises equipped, but not sufficiently, 3% equipped sufficiently, similarly in other areas: (ii) IT infrastructure: 47% and 5%, (iii) Automation

technology: 42% and 2%, (iv) Data analysis techniques: 32% and 3%, (v) Techniques for developing, applying support systems: 21% and 2% and (vi) Thinking, understanding of systems: 64% and 3%.

**Survey samples:** 146 enterprises responded, including 25 large and 121 medium and small enterprises, of which 16 were SOEs, 111 non-State enterprises and 19 foreign-invested enterprises.

## 6. ELECTRICAL EQUIPMENT: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 6/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.62 at "outsider" level. The labour restructuring and technical standardization of the entire production-product chain are and will be implemented with the highest percentage of enterprises having responded (38% and 47%). The percentage of enterprises that are and will be inter-connecting equipment is 32%, of which 27% have inter-connected equipment, 4% are planning to, and some enterprises now face infrastructure-related problems implementing this plan. Some 51% of enterprises could not control equipment through IT or connect to other technology, and 47% said they could not upgrade equipment to inter-connect it and to the system, the biggest obstacle for subsector readiness. Some 59% of enterprises did not use digital models, 23% used ERP model and 7% used the SCM model. The majority of data was manually collected, 92% of enterprises could not supply product data through IT, 84% did not share data with customers and partners, 58% did not have services integrating production data and product use, while 6% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with support for application of the ERP model, SCM model and enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 47% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 94%. It is necessary to study and replicate business models implementing (requirements of) each component pillar of large SOEs.

Readiness score of <i>Electrical equipment</i> subsector (Industry sector's average)				0.62 (0.53)		Rank			6/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer	
				87%	11%	22%	0	0	0
Pillar B: Strategy and Organization									
Readiness score of <i>Electrical equipment</i> subsector (Industry sector's average)				0.16 (0.14)		Rank			9/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer	
				84.9%	12.3%	1.4%	1.4%	0	0
B1 - Develop and implement strategy		Share of enterprises that have issued/is issuing strategy (1)						16%	
		Share of enterprises that have no plan to develop strategy						84%	
B2 - Completeness of indicators measuring results		Share of enterprises that have issued/used sets of indicators						3%	
		Completeness of sets of indicators (which have been issued/used)						Incomplete	
B3 - Investment in technology applications		Share of enterprises that have invested in science and technology (2)						62%	
		Share of enterprises that will continue investing in science and technology for production/processing/manufacturing						34%	

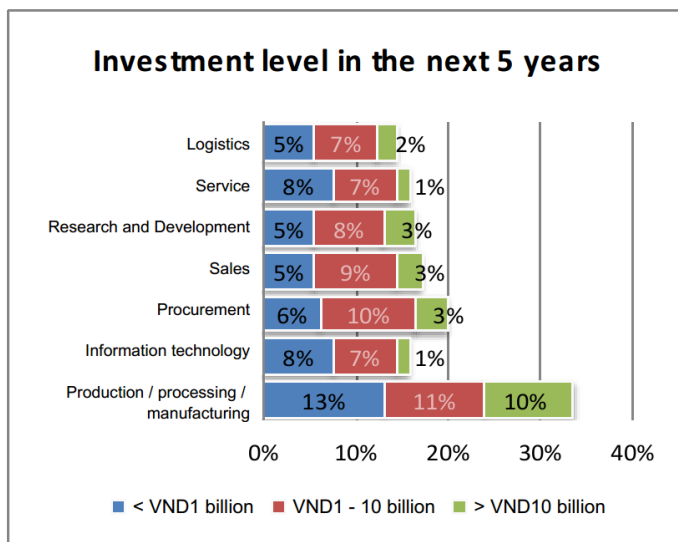
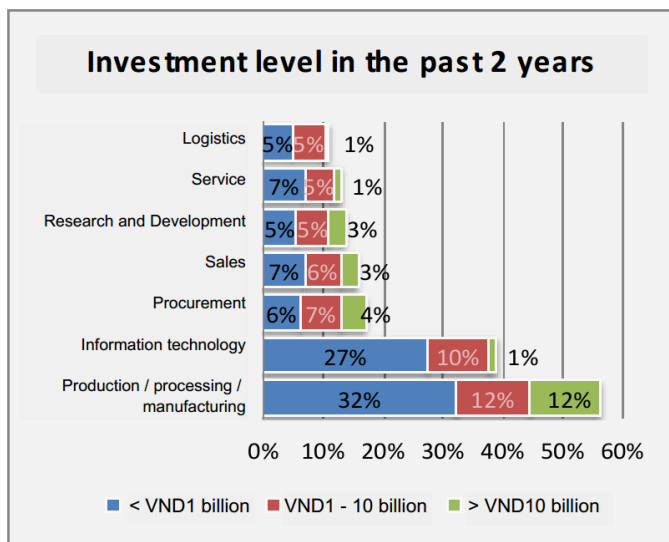
B4 - Innovation management	Share of enterprises implementing innovation activities for production management							54%
	Share of enterprises implementing innovation activities for IT management and general management							31%
	Share of enterprises implementing innovation activities for product development management							8%
Pillar C: Smart Factory								
Readiness score of <i>Electrical equipment subsector</i> (Industry sector's average)				0.54 (0.35)		Rank		7/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			59.6%	20.5%	17.1%	2.1%	0.7%	0
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					53%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					41%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					59%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					94%
Pillar D: Smart Operations								
Readiness score of <i>Electrical equipment subsector</i> (Industry sector's average)				1.61 (1.47)		Rank		5/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			11%	21%	63%	3%	2%	0
D1 - Information sharing			Share of enterprises sharing information (5)					92%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					13%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					16%
D4 - IT security			Share of enterprises having information security plan					92%
D5 - Cloud usage			Share of enterprises using cloud computing					29%
Pillar E: Smart Products								
Readiness score of <i>Electrical equipment subsector</i> (Industry sector's average)				0.12 (0.08)		Rank		7/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			92.4%	4.1%	1.4%	1.4%	0.7%	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/will have products, which can provide data through IT					8%
E2 - Use of product data			Share of enterprises that have collected and used product data					42%
Pillar F: Data-driven Services								
Readiness score of <i>Electrical equipment subsector</i> (Industry sector's average)				0.48 (0.43)		Rank		6/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			57.5%	37%	2.7%	0.7%	1.4%	0.7%
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					57%



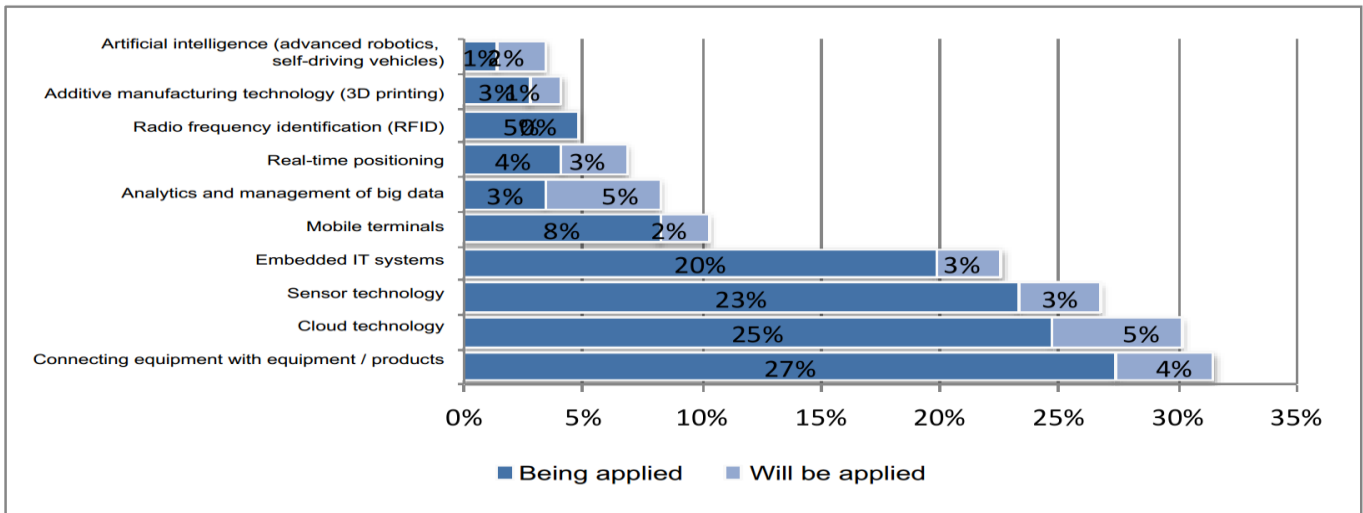
F3 - Level of using data collected				Share of enterprises that don't use production and product data					84%
Pillar G: Employees									
Readiness score of <i>Electrical equipment subsector</i> (Industry sector's average)				1.38 (1.24)	Rank				6/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer	
			6.2%	52.6%	38.4%	0	1.4%	1.4%	
G1 - Employees skills				Share of enterprises having equipped employees with 4.0 skills (6)					94%

**Note:**

- (1) Among enterprises that have developed and were developing strategies, 14% were developing, awaiting issuance of and 2% are implementing strategies. Some 35% of enterprises are preparing to rebuild their labour structures, 48% have developed and were developing strategies on technical standardization of the entire product chains, 27% said they would implement technology for connecting, managing all activities of units.
- (2) Share of enterprises investing in technology in the surveyed areas:



## TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE



- (3) Among 41% of enterprises using digital models: 26% used CAD, 17% PDA, 14% ERP, 12% MDC, 10% PPS, MES and PDM, and 6% SCM and PLM.
- (4) All surveyed enterprises collected data, but only 94% shared information on collected data, while 8% of enterprises did not share information with concerned parties.
- (5) 51% of enterprises could not control equipment through IT or connect to other technology and 47% of enterprises said they could not upgrade equipment to inter-connect and with systems.
- (6) Of the 94% enterprises that have equipped employees with skills, the majority self-assessed the level of equipment as inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 23% of enterprises were equipped, but not sufficiently and 3% were equipped sufficiently, similarly in other areas: (ii) IT infrastructure: 33% and 5%, (iii) Security techniques: 29% and 3%, (iv) Automation technology: 25% and 3%, (v) Data analysis techniques: 12% and 3%, (vi) Techniques for developing, applying support systems: 11% and 2% and (vii) Thinking, understanding of systems: 81% and 5%.

**Survey samples:** 146 enterprises responded, including 31 large and 115 medium-sized and small enterprises, of which 102 were non-State enterprises and 44 foreign-invested enterprises.



## 7. BASIC METALS: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 7/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.59, at "outsider" level. Labour restructuring and technical standardization of the entire production-product chain are and will be implemented with the highest percentage of enterprises having responded (44% and 45%). The percentage of enterprises that are and will be inter-connecting equipment was 31%, of which 18% inter-connected equipment, 12% plan to and some face infrastructure-related problems in implementing this plan. Some 49% of enterprises could not control equipment through IT or connect to other technology and 47% said they could not upgrade equipment to inter-connect and to systems, the biggest obstacle to subsector readiness. Some 68% of enterprises did not use any digital model, 23% used ERP model and 10% used SCM model. The majority of data was manually collected, 97% of enterprises could not supply product data through IT, 81% did not share data with customers and partners and 64% did not have services integrating production data and product use. Some 8% of enterprises did not equip employees with knowledge and techniques to prepare them for IR4.0.

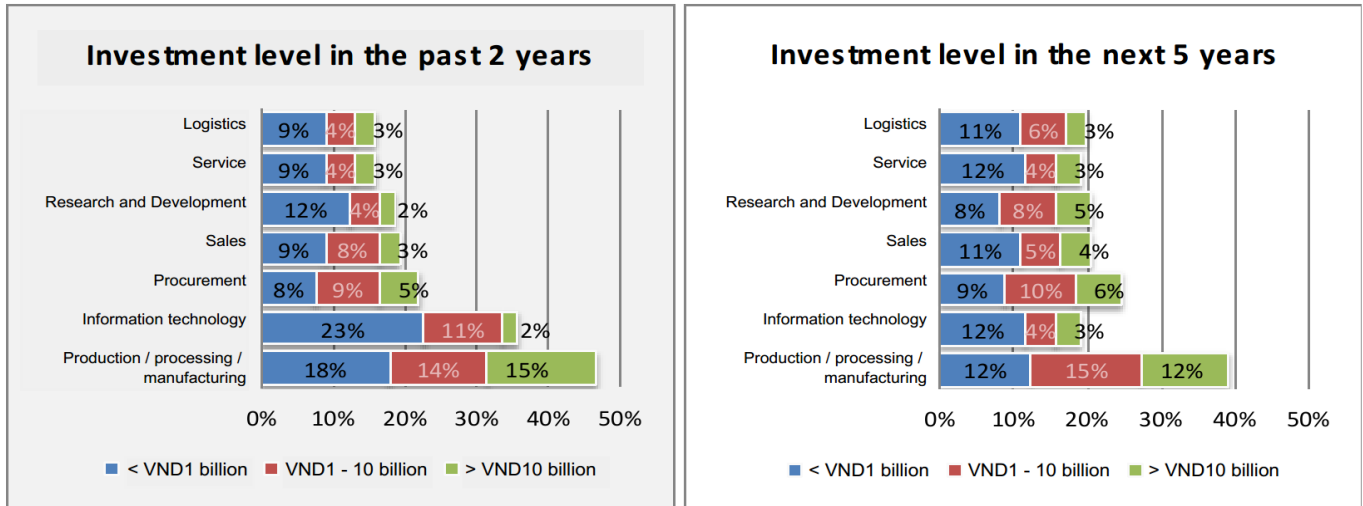
The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with support for application of the ERP model, SCM model and enhanced collection and exchange of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 47% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 92%. It is necessary to study and replicate the results of deploying the pillars of non-State SMEs for similar enterprises.

Readiness score of <i>Basic metals subsector</i> (Industry sector's average)				0.59 (0.53)	Rank			7/17
Readiness level	Outsider	Share of enterprises readiness level	by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				84%	16%	1%	0	0
Pillar B: Strategy and Organization								
Readiness score of <i>Basic metals subsector</i> (Industry sector's average)				0.14 (0.14)	Rank			10/17
Readiness level	Outsider	Share of enterprises readiness level	by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				84%	14%	1%	1%	0
B1 - Develop and implement strategy		Share of enterprises that have issued/is issuing strategy (1)						19%
		Share of enterprises that have no plan to develop strategy						81%
B2 - Completeness of indicators measuring results		Share of enterprises that have issued/used sets of indicators						2%
		Completeness of sets of indicators (which have been issued/used)						Incomplete
B3 - Investment in technology applications		Share of enterprises that have invested in science and technology (2)						55%
		Share of enterprises that will continue investing in science and technology for production/ processing/ manufacturing						39%
B4 - Innovation management		Share of enterprises implementing innovation activities for production management						53%
		Share of enterprises implementing innovation activities for IT management and general management						21%
		Share of enterprises implementing innovation activities for product development management						7%
Pillar C: Smart Factory								
Readiness score of <i>Basic metals subsector</i> (Industry sector's average)				0.54 (0.35)	Rank			6/17

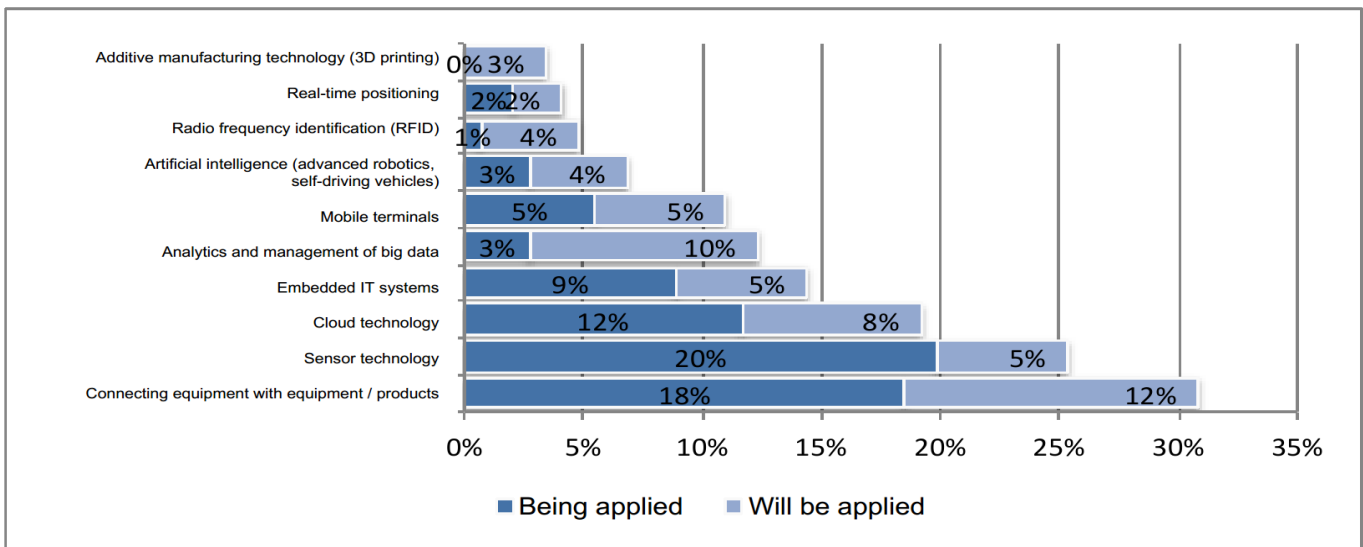
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			60.2%	21.3%	13%	2.1%	3.4%	0
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					53%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					49%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					68%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					96%
Pillar D: Smart Operations								
Readiness score of <i>Basic metals</i> subsector (Industry sector's average)				1.5 (1.47)		Rank		8/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			15.1%	22.6%	58.2%	2.7%	0.7%	0.7%
D1 - Information sharing			Share of enterprises sharing information (5)					90%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					20%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					19%
D4 - IT security			Share of enterprises having information security plan					92%
D5 - Cloud usage			Share of enterprises using cloud computing					19%
Pillar E: Smart Products								
Readiness score of <i>Basic metals</i> subsector (Industry sector's average)				0.05 (0.08)		Rank		14/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			96.6%	2.7%	0.7%	0	0	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/ will have products, which can provide data through IT					3%
E2 - Use of product data			Share of enterprises that have collected and used product data					39%
Pillar F: Data-driven Services								
Readiness score of <i>Basic metals</i> subsector (Industry sector's average)				0.46 (0.43)		Rank		8/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			64%	28%	3%	1%	3%	1%
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					64%
F3 - Level of using data collected			Share of enterprises that don't use production and product data					81%
Pillar G: Employees								
Readiness score of <i>Basic metals</i> subsector (Industry sector's average)				1.43 (1.24)		Rank		4/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			8%	41%	49%	0	2%	0
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					92%

**Note:**

- (1) The share of enterprises preparing to rebuild their labour structure was 38%, 45% have developed and were developing strategies for technical standardization of the entire production chains and 24% said they would implement technology for connecting, managing all activities of units.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (3) Among 42% of enterprises using digital models: 20% used PDA and 18% CAD, 15% ERP and 6% SCM.
- (4) 10% of enterprises did not share information with concerned parties.
- (5) 49% of enterprises could not control equipment through IT or connect to other technology, and 47% of enterprises said they could not upgrade equipment to inter-connect or with systems.
- (6) Of 92% of enterprises that have equipped employees with skills, the majority self-assessed the level of equipment as inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 36% of enterprises have equipped, but not sufficiently, 2% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 40% and 3%, (iii) Security

techniques: 32% and 4%, (iv) Automation technology: 34% and 3%, (v) Data analysis techniques: 20% and 2%, (vi) Techniques for developing, applying support systems: 19% and 3% and (vii) Thinking, understanding of systems: 80% and 5%.

**Survey samples:** 146 enterprises responded, including 26 large and 120 medium-sized and small enterprises, of which one was an SOE, 110 non-State enterprises and 35 foreign-invested enterprises.

## 8. OTHER TRANSPORTATION VEHICLES: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 8/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.56, at "outsider" level. Some large joint venture enterprises have taken preparatory steps above the "intermediate" readiness level. The labour restructuring and technical standardization of the entire production-product chain is currently and will be implemented with the highest percentage of enterprises having responded (35% and 45%). The percentage of enterprises that are and will inter-connect equipment is 24%, of which 17% have inter-connected equipment, 6% plan to and enterprises face infrastructure-related problems in implementing this plan. Some 61% of enterprises could not control equipment through IT or connect to other technology and 53% said they could not upgrade equipment to inter-connect and with systems, the biggest obstacle for subsector readiness. Some 60% of enterprises did not use digital models, 35% used ERP model and 6% used SCM model. The majority of data was manually collected, 94% of enterprises could not supply product data through IT, 81% did not share data with customers and partners and 65% did not have services integrating production data and product use. Some 8% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with support for the application of ERP model, SCM model and enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products could only be achieved when replacement investments were made in 53% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 92%. Where possible, it is necessary to study and replicate the deployment patterns of large enterprises and joint ventures in the subsector.

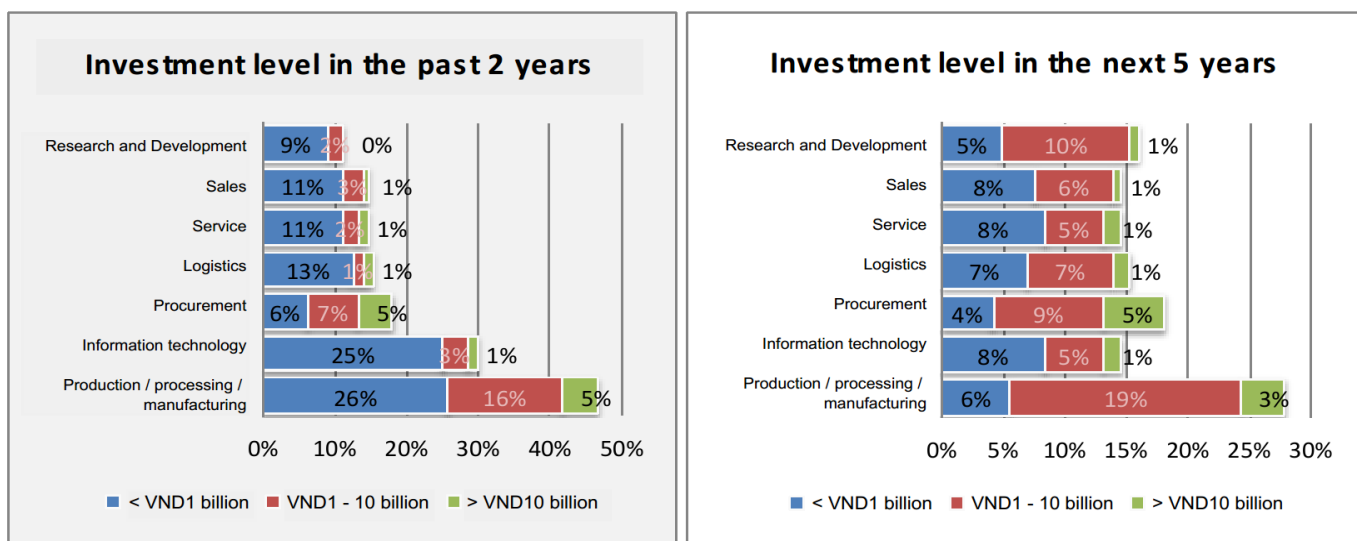
Readiness score of <i>Other transportation vehicles</i> subsector (Industry sector's average)				0.56 (0.53)	Rank			8/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			88%	10%	1%	0	0	0
<b>Pillar B: Strategy and Organization</b>								
Readiness score of <i>Other transportation vehicles</i> subsector (Industry sector's average)				0.12 (0.14)	Rank			14/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			89%	10%	1%	0	0	0
B1 - Develop and implement strategy		Share of enterprises that have issued/is issuing strategy (1)						11%
		Share of enterprises that have no plan to develop strategy						89%
B2 - Completeness of indicators measuring results		Share of enterprises that have issued/used sets of indicators						2%
		Completeness of sets of indicators (which have been issued/used)						Incomplete
B3 - Investment in technology applications		Share of enterprises that have invested in science and technology (2)						53%
		Share of enterprises that will continue investing in science and technology for production/processing/manufacturing						28%
B4 - Innovation management		Share of enterprises implementing innovation activities for production management						47%
		Share of enterprises implementing innovation activities for IT management and general management						17%

				Share of enterprises implementing innovation activities for product development management				6%
Pillar C: Smart Factory								
Readiness score of Other transportation vehicles (Industry sector's average)				0.46 (0.35)	Rank			8/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				65.3%	20.1%	13.2%	1.4%	0
C1 - Feature for controlling, connecting equipment				Share of enterprises that have upgradable equipment for connections (3)				47%
C2 - Level of meeting equipment connectivity demand				Share of enterprises that can't control equipment through IT (3)				61%
C3 - Digital management model				Share of enterprises that don't have any digital model (4)				60%
C4 - Data collection method				Share of enterprises collecting data				100%
C5 - Purpose of data usage				Share of enterprises using information				96%
Pillar D: Smart Operations								
Readiness score of Other transportation vehicles (Industry sector's average)				1.69 (1.47)	Rank			2/17
Readiness level	Beginner	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				4%	25%	67%	1%	2%
D1 - Information sharing				Share of enterprises sharing information (5)				90%
D2 - Automation				Share of enterprises having system autonomously responding to changes (some units)				12%
D3 - Autonomous processes				Share of enterprises having autonomous system (some units)				16%
D4 - IT security				Share of enterprises having information security plan				97%
D5 - Cloud usage				Share of enterprises using cloud computing				24%
Pillar E: Smart Products								
Readiness score of Other transportation vehicles (Industry sector's average)				0.1 (0.08)	Rank			8/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				94.4%	3.5%	0	0.7%	1.4%
E1 - Products' capability to provide data through IT				Share of enterprises that have/ will have products, which can provide data through IT				6%
E2 - Use of product data				Share of enterprises that have collected and used product data				36%
Pillar F: Data-driven Services								
Readiness score of Other transportation vehicles (Industry sector's average)				0.5 (0.43)	Rank			5/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				65%	28%	2%	2%	1%
F1 - Integrating production and product data				Share of enterprises that don't have services for integrating production and product data				64%
F3 - Level of using data collected				Share of enterprises that don't use production and product data				81%
Pillar G: Employees								

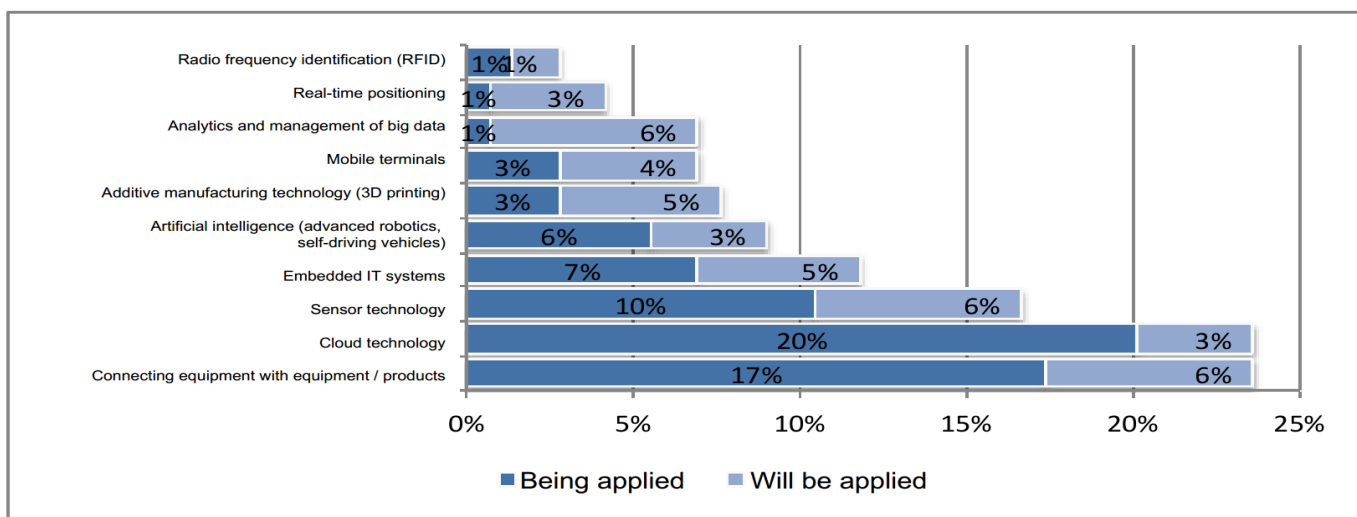
Readiness score of <i>Other transportation vehicles</i> (Industry sector's average)				1.17 (1.24)	Rank			14/17
Readiness level	<i>Beginner</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				8%	63%	29%	0	0
<i>G1 - Employees skills</i>				Share of enterprises having equipped employees with 4.0 skills (6)				92%

**Note:**

- (1) 34% of enterprises were preparing to restructure their labour force, 45% have developed and were developing strategies on technical standardization of entire production chains, 20% of enterprises said they would be implement technology for connecting, managing all activities of units.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (3) 10% of enterprises did not share information with the concerned parties.
- (4) Among 40% of enterprises using digital models: 25% used CAD, 19% ERP, 14% PDA and only 4% SCM.



- (5) 61% of enterprises could not control equipment through IT or connect to other technology, and 53% said they could not upgrade equipment to inter-connect or with systems.
- (6) Of 92% of enterprises that have equipped themselves with knowledge, the majority self-assessed the level of equipment as inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 36% of enterprises have equipped, but not sufficiently, with 2% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 25% and 2%, (iii) Security techniques: 19% and 2%, (iv) Automation technology: 24% and 0%, (v) Data analysis techniques: 12% and 0%, (vi) Techniques for developing, applying support systems: 9% and 0% and (vii) Thinking, understanding of systems: 85% and 1%.

**Survey samples:** 144 enterprises responded, including 26 large and 118 medium-sized and small enterprises, of which five were SOEs, 88 non-State enterprises and 51 foreign-invested enterprises.



## 9. PAPER PRODUCTS: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 9/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.56, at "outsider" level. The labour restructuring and technical standardization of the entire production-product chain is currently and will be implemented by many enterprises with the percentage of enterprises having responded (52% and 36%). The percentage of enterprises that are and will inter-connect equipment is 23%, of which 18% have inter-connected equipment and 5% planned to, but enterprises faced infrastructure-related problems implementing this plan. Some 62% of enterprises could not control equipment through IT or connect to other technology, 52% said they could not upgrade equipment to inter-connect it and with systems - the biggest obstacle for subsector readiness. Some 72% of enterprises did not use a digital model, 14% used ERP model and 6% used SCM model. The majority of data was manually collected, 97% of enterprises could not provide product data through IT, 88% did not share data with customers and partners and 59% did not have services integrating production data and product use. Notably, 8% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0. Several private and foreign-invested enterprises are prepared to meet requirements of IR4.0.

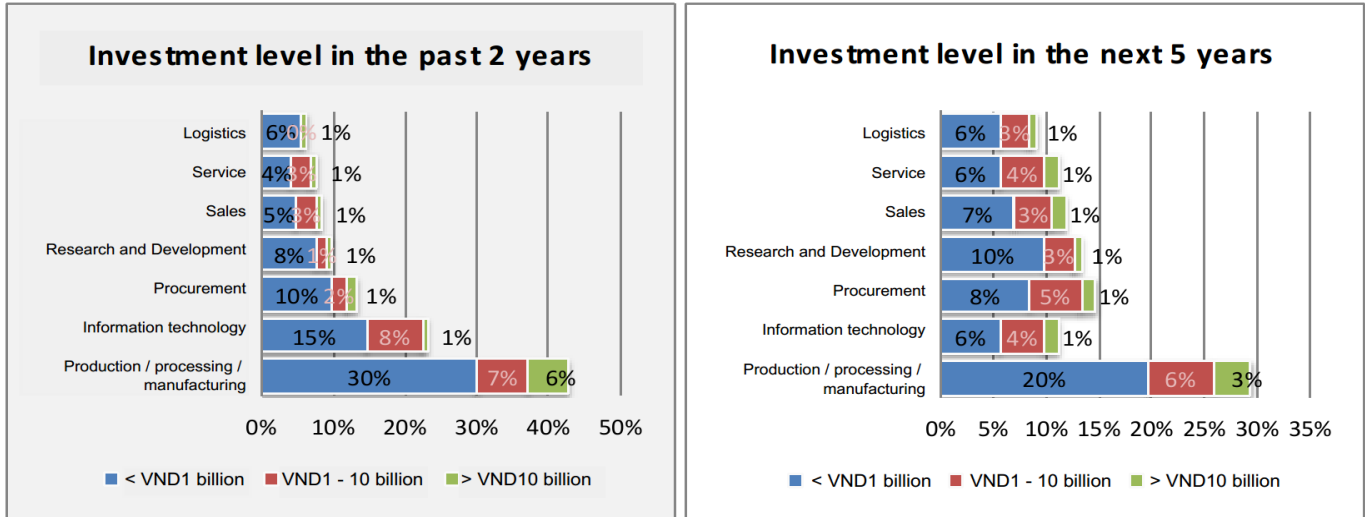
The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with support for application of ERP model, SCM model and enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products could only be achieved when replacement investments were made in 52% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 92%.

Readiness score of <i>Paper products</i> subsector (Industry sector's average)				0.56 (0.53)		Rank			9/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>	
				89%	8%	3%	0	0	0
Pillar B: Strategy and Organization									
Readiness score of <i>Paper products</i> subsector (Industry sector's average)				0.13 (0.14)		Rank			11/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>	
				90%	8%	1%	0	1%	0
<i>B1 - Develop and implement strategy</i>		<i>Share of enterprises that have issued/is issuing strategy (1)</i>						13%	
		<i>Share of enterprises that have no plan to develop strategy</i>						87%	
<i>B2 - Completeness of indicators measuring results</i>		<i>Share of enterprises that have issued/used sets of indicators</i>						4%	
		<i>Completeness of sets of indicators (which have been issued/used)</i>						Incomplete	
<i>B3 - Investment in technology applications</i>		<i>Share of enterprises that have invested in science and technology (2)</i>						46%	
		<i>Share of enterprises that will continue investing in science and technology for production/ processing/ manufacturing</i>						29%	
<i>B4 - Innovation management</i>		<i>Share of enterprises implementing innovation activities for production management</i>						44%	
		<i>Share of enterprises implementing innovation activities for IT management and general management</i>						15%	
		<i>Share of enterprises implementing innovation activities for product development management</i>						6%	
Pillar C: Smart Factory									
Readiness score of <i>Paper products</i> subsector (Industry sector's average)				0.42 (0.35)		Rank			10/17

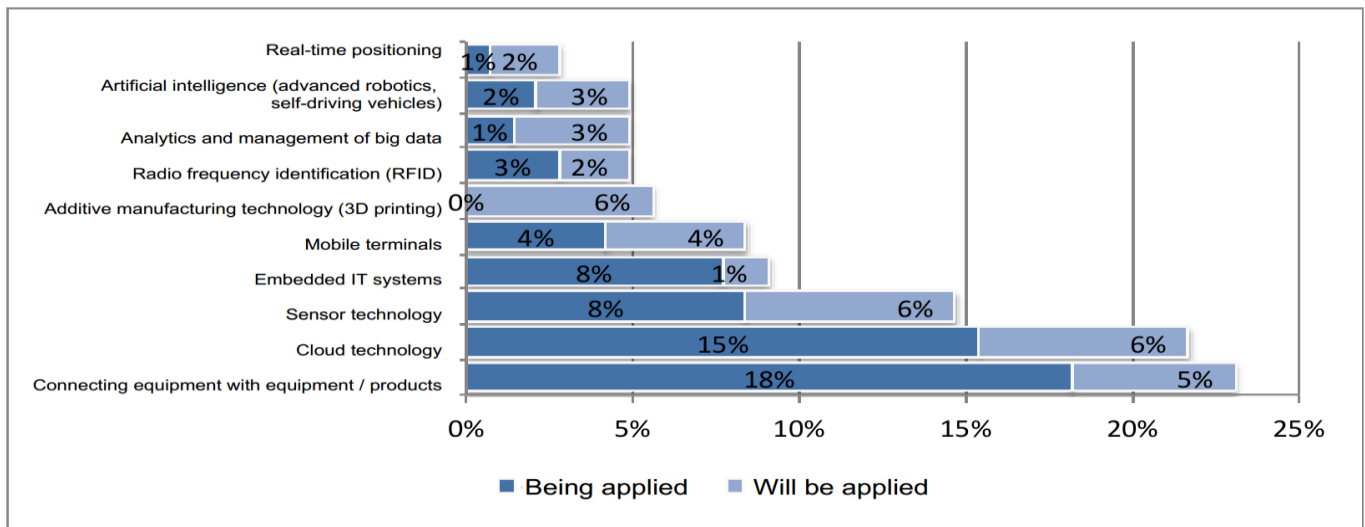
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			65%	20.2%	10.6%	1.4%	2.8%	0
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					48%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					62%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					72%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					95%
Pillar D: Smart Operations								
Readiness score of Paper products subsector (Industry sector's average)			1.49 (1.47)		Rank			9/17
Readiness level	Beginner	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			14%	24%	59%	2%	1%	0
D1 - Information sharing			Share of enterprises sharing information (5)					89%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					13%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					14%
D4 - IT security			Share of enterprises having information security plan					92%
D5 - Cloud usage			Share of enterprises using cloud computing					26%
Pillar E: Smart Products								
Readiness score of Paper products subsector (Industry sector's average)			0.06 (0.08)		Rank			13/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			97%	1%	1%	0	1%	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/will have products, which can provide data through IT					3%
E2 - Use of product data			Share of enterprises that have collected and used product data					41%
Pillar F: Data-driven Services								
Readiness score of Paper products subsector (Industry sector's average)			0.47 (0.43)		Rank			7/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			59%	36%	2%	0	3%	0
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					59%
F3 - Level of using data collected			Share of enterprises that don't use production and product data					88%
Pillar G: Employees								
Readiness score of Paper products subsector (Industry sector's average)			1.32 (1.24)		Rank			8/17
Readiness level	Beginner	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			8%	50%	39%	0	2	1%
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					92%

**Note:**

- (1) 50% of enterprises were preparing to restructure their labour forces, 35% have developed and were developing strategies on technical standardization of the entire production chain, 21% of enterprises said they would implement technology for connecting, managing all activities of units.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (3) 11% of enterprises did not share information with concerned parties.
- (4) Among 28% of enterprises using digital models: 16% used MDC and 15% PDA, 9% ERP and 4% SCM.
- (5) 62% of enterprises could not control equipment through IT or connect to other technology, and 52% of enterprises said they could not upgrade equipment to inter-connect and with systems.
- (6) Of 92% of enterprises equipped with knowledge, the majority self-assessed the level of equipment as inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 22% of enterprises have equipped, but not sufficiently and 2% equipped sufficiently, similarly in other areas: (ii) IT infrastructure: 29% and 3%, (iii) Security techniques: 24% and 3%, (iv) Automation technology: 23% and 2%, (v) Data analysis

techniques: 9% and 1%, (vi) Techniques for developing, applying support systems: 8% and 1% and (vii) Thinking, understanding of systems: 82% and 3%.

**Survey samples:** 143 enterprises responded, including 26 large and 117 medium-sized and small enterprises, of which two were SOEs, 123 non-State enterprises and 18 foreign-invested enterprises.

## 10. FOOD PROCESSING: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 10/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.55, at 'outsider' level. The technical standardization of the entire production-product chain is and will be implemented by many enterprises, with the percentage of enterprises responded being 47%. The percentage of enterprises that are and will inter-connect equipment was 22%, with 20% of enterprises having inter-connected equipment and 10% planned to, but faced infrastructure-related problems during implementation of this plan. Some 58% of enterprises could not control equipment through IT or connect to other technology, and 43% of enterprises said they could not upgrade equipment to inter-connect and with systems - the biggest obstacle for subsector readiness. Some 73% of enterprises did not use a digital model, 9% used SCM model, of which only 2% used leading interfaces of the model. The majority of data was manually collected, 95% of enterprises could not provide product data through IT, 79% did not share data with customers and partners and 64% did not have services integrating production data and product use. Some 13% of enterprises did not equip employees with knowledge and techniques to prepare them for IR4.0.

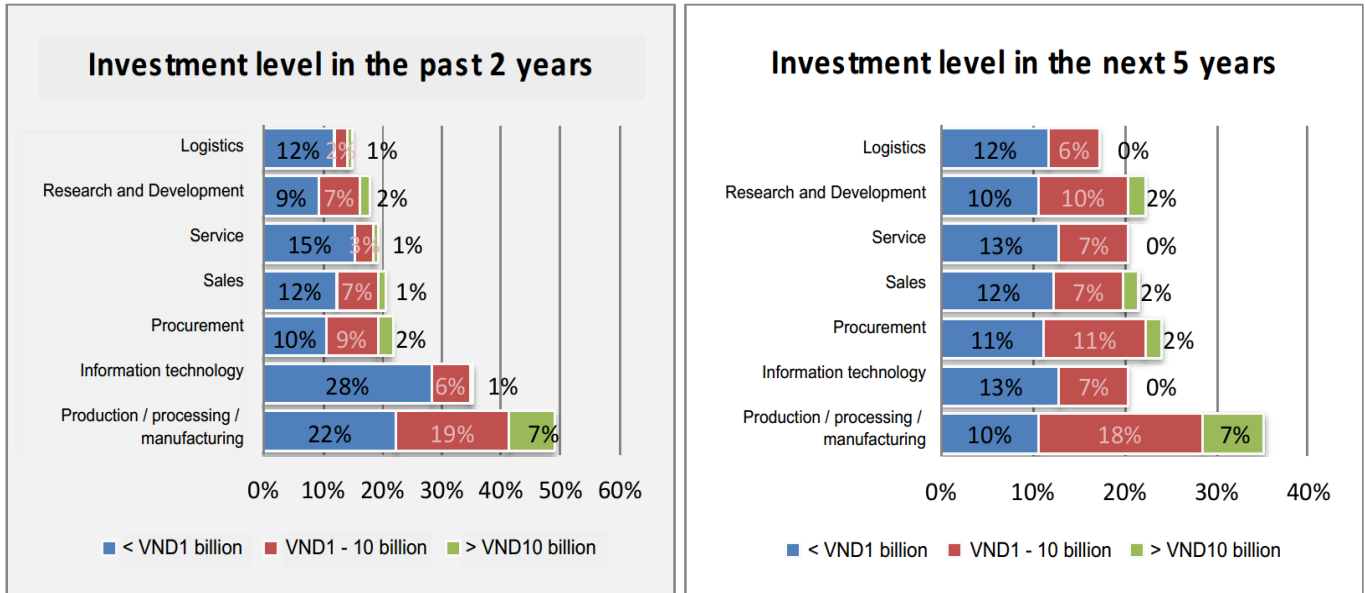
The strategy for technical standardization of the entire production chain should be upgraded to be the food product manufacturing subsector's IR4.0 strategy with support for enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products could only be achieved when replacement investments are made in 43% of firms in the subsector.

Readiness score of <i>Food processing subsector</i> (Industry sector's average)				0.55 (0.53)	Rank			10/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			86%	13%	1%	0	0	0
Pillar B: Strategy and Organization								
Readiness score of <i>Food processing subsector</i> (Industry sector's average)				0.17 (0.14)	Rank			7/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			84%	14%	2%	0	0	0
<i>B1 - Develop and implement strategy</i>		<i>Share of enterprises that have issued/is issuing strategy (1)</i>						18%
		<i>Share of enterprises that have no plan to develop strategy</i>						82%
<i>B2 - Completeness of indicators measuring results</i>		<i>Share of enterprises that have issued/used sets of indicators</i>						4%
		<i>Completeness of sets of indicators (which have been issued/used)</i>						<i>Incomplete</i>
<i>B3 - Investment in technology applications</i>		<i>Share of enterprises that have invested in science and technology (2)</i>						59%
		<i>Share of enterprises that will continue investing in science and technology for production/processing/manufacturing</i>						35%
<i>B4 - Innovation management</i>		<i>Share of enterprises implementing innovation activities for production management</i>						49%
		<i>Share of enterprises implementing innovation activities for IT management and general management</i>						20%
		<i>Share of enterprises implementing innovation activities for product development management</i>						9%
Pillar C: Smart Factory								
Readiness score of <i>Food processing subsector</i> (Industry sector's average)				0.44 (0.35)	Rank			9/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			65%	20%	13%	2%	0	0

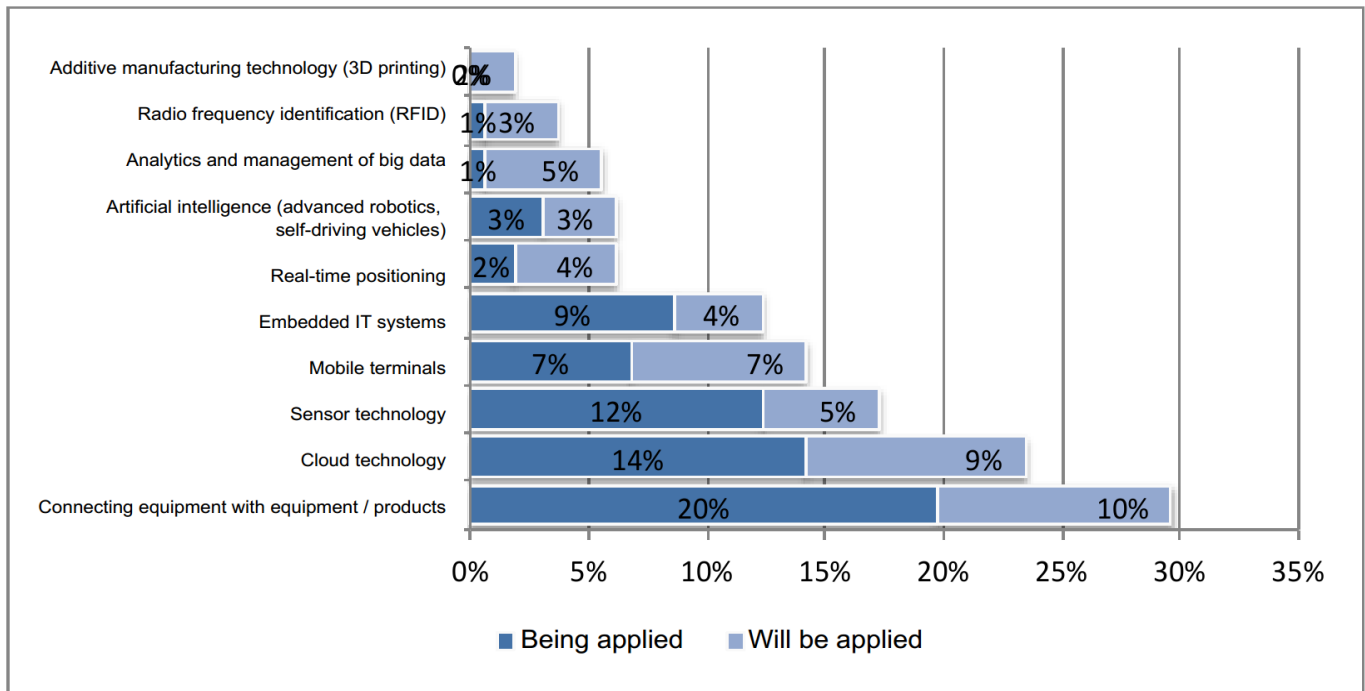
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					57%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					58%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					73%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					92%
Pillar D: Smart Operations								
Readiness score of Food processing subsector (Industry sector's average)			1.47 (1.47)		Rank			11/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			14.2%	24.1%	57.4%	4.3%	0	0
D1 - Information sharing			Share of enterprises sharing information (5)					92%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					15%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					17%
D4 - IT security			Share of enterprises having information security plan					86%
D5 - Cloud usage			Share of enterprises using cloud computing					23%
Pillar E: Smart Products								
Readiness score of Food processing subsector (Industry sector's average)			0.07 (0.08)		Rank			10/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			95%	2%	2%	0	0	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/will have products, which can provide data through IT					5%
E2 - Use of product data			Share of enterprises that have collected and used product data					37%
Pillar F: Data-driven Services								
Readiness score of Food processing subsector (Industry sector's average)			0.43 (0.43)		Rank			13/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			64.2%	29.6%	3.1%	0.6%	1.9%	0.6%
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					64%
F3 - Level of using data collected			Share of enterprises that don't use production and product data					82%
Pillar G: Employees								
Readiness score of Food processing subsector (Industry sector's average)			1.25 (1.24)		Rank			11/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			13%	46.3%	38.3%	0%	1.2%	1.2%
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					87%

**Note:**

- (1) 47% of enterprises have developed and were developing strategies on technical standardization of entire production chains, 4% of enterprises said they were developing strategies for applying IoT technology.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (3) Among 27% of enterprises using digital models, 16% used MES and 9% SCM.
- (4) 8% of enterprises did not share information with concerned parties.
- (5) 58% of enterprises could not control equipment through IT or connect to other technology, and 43% of enterprises said they could not upgrade equipment to inter-connect or with systems.



- (6) Of the 87% of enterprises that equipped themselves with knowledge, the majority self-assessed the level of equipment as inadequate in the seven most surveyed areas: (i) Techniques for using collaborative software: 20% of enterprises have equipped, but not sufficiently, 3% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 27% and 4%, (iii) Security techniques: 22% and 4%, (iv) Automation technology: 27% and 2%, (v) Data analysis techniques: 15% and 3%, (vi) Techniques for developing, applying support systems: 12% and 2% and (vii) Thinking, understanding of systems: 73% and 4%.

**Survey samples:** 162 enterprises responded, including 32 large and 130 medium-sized and small enterprises, of which 147 were non-State enterprises and 15 foreign-invested enterprises.



## 11. MANUFACTURE OF MACHINERY AND EQUIPMENT: (I) "OUTSIDER" (II) RANK: 11/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.53, at "outsider" level. The labour restructuring and technical standardization of the entire production-product chain is and will be implemented by most with the percentage of enterprises responded being 40% and 29%, respectively. The percentage of enterprises that are and will inter-connect equipment was 26%, of which 13% have inter-connected equipment and 13% planned to, but faced infrastructure-related problems implementing this plan. Some 64% of enterprises could not control equipment through IT or connect to other technology, 52% of enterprises said they could not upgrade equipment to inter-connect and to the system, the biggest obstacle for subsector readiness. Some 58% of enterprises did not use a digital model, 18% used ERP model and 4% used SCM model. The majority of data was manually collected, 87% of enterprises could not provide product data through IT, 77% did not share data with customers and partners and 78% did not have services integrating production data and product use. Notably, 13% of enterprises do not equip employees with knowledge and techniques to prepare for IR4.0.

The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with support for application of ERP and SCM models, and enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 52% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 87%.

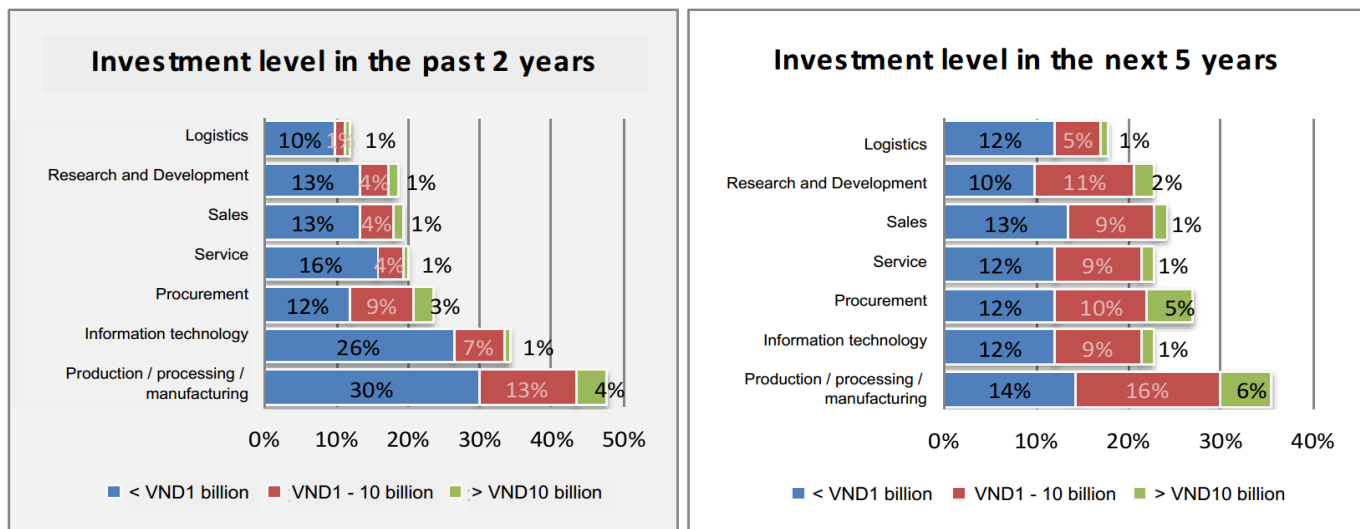
Readiness score of <i>Manufacture of machinery and equipment</i> (Industry sector's average)				0.53 (0.53)	Rank			11/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			84%	13%	4%	0	0	0
Pillar B: Strategy and Organization								
Readiness score of <i>Manufacture of machinery and equipment</i> (Industry sector's average)				0.19 (0.14)	Rank			6/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			77%	18%	2%	3%	0	0
<i>B1 - Develop and implement strategy</i>		<i>Share of enterprises that have issued/is issuing strategy (1)</i>						23%
		<i>Share of enterprises that have no plan to develop strategy</i>						77%
<i>B2 - Completeness of indicators measuring results</i>		<i>Share of enterprises that have issued/used sets of indicators</i>						9%
		<i>Completeness of sets of indicators (which have been issued/used)</i>						Incomplete
<i>B3 - Investment in technology applications</i>		<i>Share of enterprises that have invested in science and technology (2)</i>						52%
		<i>Share of enterprises that will continue investing in science and technology for production/processing/manufacturing</i>						36%
<i>B4 - Innovation management</i>		<i>Share of enterprises implementing innovation activities for production management</i>						46%
		<i>Share of enterprises implementing innovation activities for IT management and general management</i>						15%
		<i>Share of enterprises implementing innovation activities for product development management</i>						14%
Pillar C: Smart Factory								
Readiness score of <i>Manufacture of machinery and equipment</i> (Industry sector's average)				0.32 (0.35)	Rank			13/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			69.5%	14.9%	14.9%	0	0.7%	0

C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					48%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					64%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					58%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					90%
Pillar D: Smart Operations								
Readiness score of Manufacture of machinery and equipment (Industry sector's average)			1.41 (1.47)	Rank				14/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			10%	35%	49%	5%	1%	0
D1 - Information sharing			Share of enterprises sharing information (5)					93%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					15%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					18%
D4 - IT security			Share of enterprises having information security plan					94%
D5 - Cloud usage			Share of enterprises using cloud computing					22%
Pillar E: Smart Products								
Readiness score of Manufacture of machinery and equipment (Industry sector's average)			0.2 (0.08)	Rank				5/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			87%	8%	2%	2%	1%	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/will have products, which can provide data through IT					13%
E2 - Use of product data			Share of enterprises that have collected and used product data					26%
Pillar F: Data-driven Services								
Readiness score of Manufacture of machinery and equipment (Industry sector's average)			0.28 (0.43)	Rank				16/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			78%	18%	0	1	0	3%
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					78%
F3 - Level of using data collected			Share of enterprises that don't use production and product data					77%
Pillar G: Employees								
Readiness score of Manufacture of machinery and equipment (Industry sector's average)			1.2 (1.24)	Rank				13/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			43%	49%	36%	0	0	2%
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					87%

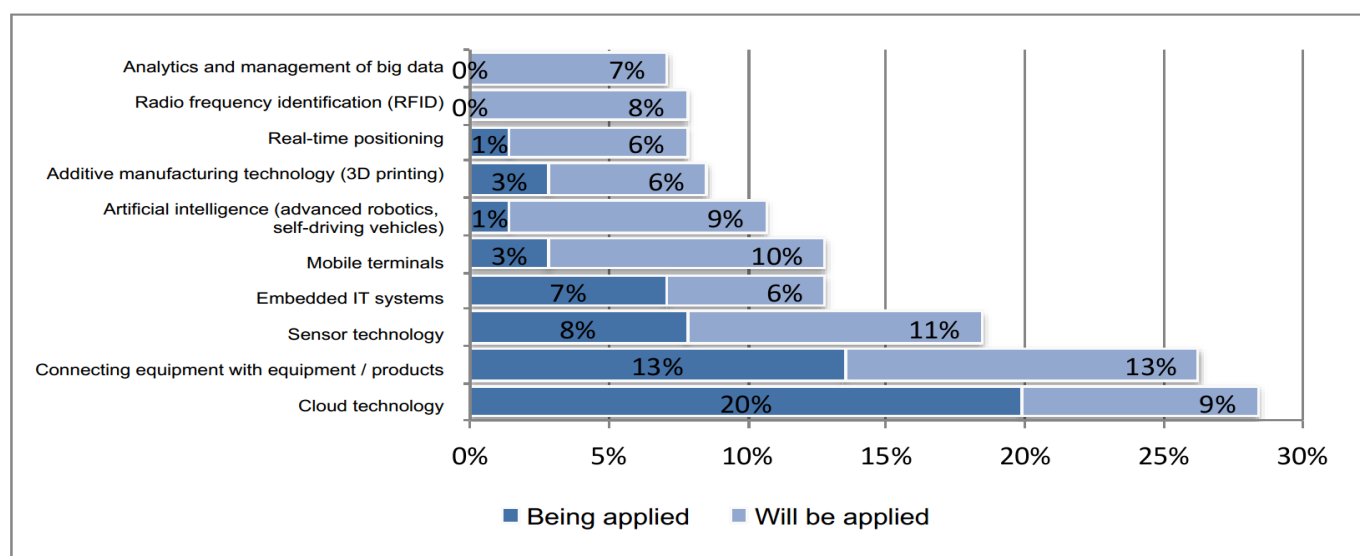
**Note:**

(1) 40% of enterprises were implementing strategies to build new labour structures, 29% of enterprises for technical standardization of the entire production chain, 27% of enterprises had and are deploying strategies for connecting, managing units' activities.

(2) Share of enterprises investing in technology in the surveyed areas:



### TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE



- (3) Among 42% of enterprises using digital models: 34% used CAD, 13% PDA, 12% ERP and 2% SCM.
- (4) 7% of enterprises did not share information with concerned parties.
- (5) 64% of enterprises could not control equipment through IT or connect to other technology, and 52% of enterprises said they could not upgrade equipment to inter-connect and with systems.
- (6) Of the 87% of enterprises that equipped themselves with knowledge, the majority self-assessed the level of equipment as inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 23% of enterprises equipped but not sufficiently, 4% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 28% and 4%, (iii) Security techniques: 26% and 3%, (iv) Automation technology: 26% and 3%, (v) Data analysis techniques: 16% and 2%, (vi) Techniques for developing, applying support systems: 14% and 2% and (vii) Thinking, understanding of systems: 77% and 4%.

**Survey samples:** 141 enterprises responded, including 20 large and 121 medium-sized and small enterprises, of which three were SOEs, 106 non-State enterprises and 32 foreign-invested enterprises.

## 12. RUBBER AND PLASTICS: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 12/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.53, at "outsider" level. The labour restructuring and technical standardization of the entire production-product chain is currently and will be implemented the most with the percentage of enterprises responded being 47% and 44%, respectively. The percentage of enterprises that are and will inter-connect equipment was 22%, of which 17% have inter-connected equipment and 5% planned to, but faced infrastructure-related problems. Some 64% of enterprises could not control equipment through IT or connect to other technology and 55% of enterprises said they could not upgrade equipment to inter-connect and to systems - the biggest obstacle for subsector readiness. Some 63% of enterprises do not use any digital model, 25% of enterprises used ERP model and 3% used SCM model. The majority of data was manually collected, 98% of enterprises could not provide product data through IT, 84% did not share data with customers and partners and 64% did not have services integrating production data and product use. Notably, 10% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with support for application of ERP and SCM models, with enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 55% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 90%.

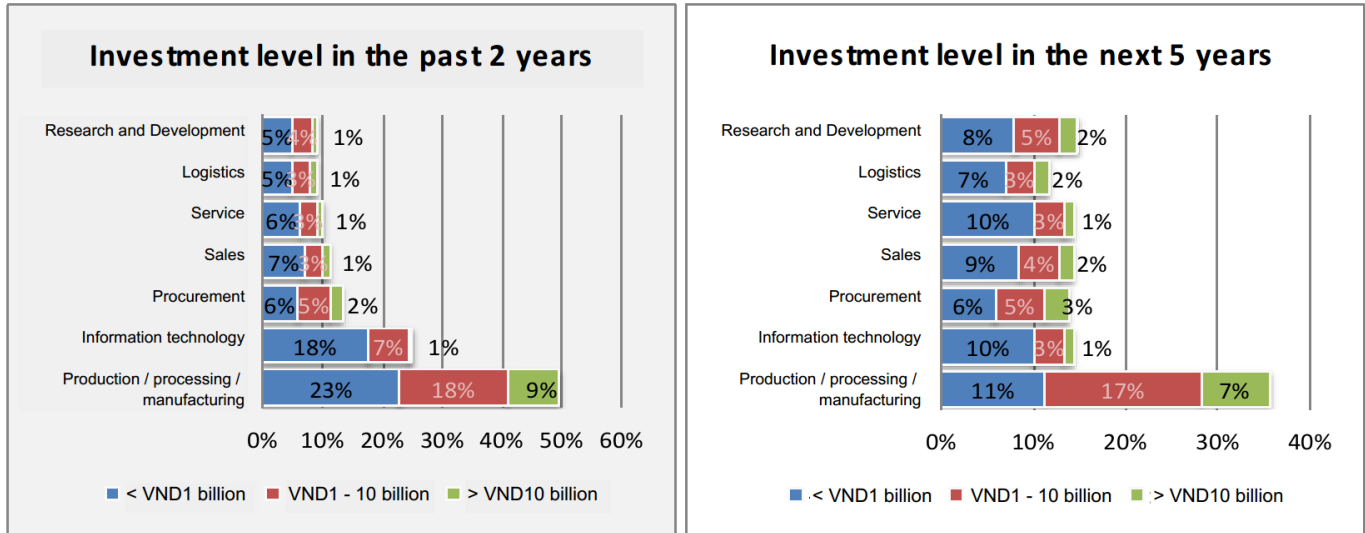
Readiness score of <i>Rubber and plastics</i> subsector (Industry sector's average)				0.53 (0.53)	Rank			12/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			94%	5%	1%	0	0	0
Pillar B: Strategy and Organization								
Readiness score of <i>Rubber and plastics</i> subsector (Industry sector's average)				0.08 (0.14)	Rank			15/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			91%	7%	1%	1%	0	0
<i>B1 - Develop and implement strategy</i>		<i>Share of enterprises that have issued/is issuing strategy (1)</i>						12%
		<i>Share of enterprises that have no plan to develop strategy</i>						88%
<i>B2 - Completeness of indicators measuring results</i>		<i>Share of enterprises that have issued/used sets of indicators</i>						2%
		<i>Completeness of sets of indicators (which have been issued/used)</i>						Incomplete
<i>B3 - Investment in technology applications</i>		<i>Share of enterprises that have invested in science and technology (2)</i>						54%
		<i>Share of enterprises that will continue investing in science and technology for production/ processing/ manufacturing</i>						35%
<i>B4 - Innovation management</i>		<i>Share of enterprises implementing innovation activities for production management</i>						44%
		<i>Share of enterprises implementing innovation activities for IT management and general management</i>						18%
		<i>Share of enterprises implementing innovation activities for product development management</i>						6%
Pillar C: Smart Factory								
Readiness score of <i>Rubber and plastics</i> subsector (Industry sector's average)				0.35 (0.35)	Rank			11/17

Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			72%	16%	11%	1%	0	0
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					45%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					64%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					63%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					96%
Pillar D: Smart Operations								
Readiness score of Rubber and plastics subsector (Industry sector's average)				1.55 (1.47)		Rank		6/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			12%	22%	61%	4%	1%	0
D1 - Information sharing			Share of enterprises sharing information (5)					91%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					7%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					13%
D4 - IT security			Share of enterprises having information security plan					91%
D5 - Cloud usage			Share of enterprises using cloud computing					21%
Pillar E: Smart Products								
Readiness score of Rubber and plastics subsector (Industry sector's average)				0.01 (0.08)		Rank		17/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			98%	1%	1%	0	0	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/will have products, which can provide data through IT					2%
E2 - Use of product data			Share of enterprises that have collected and used product data					38%
Pillar F: Data-driven Services								
Readiness score of Rubber and plastics subsector (Industry sector's average)				0.44 (0.43)		Rank		12/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			64%	31%	3%	1%	1%	0
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					64%
F3 - Level of using data collected			Share of enterprises that don't use production and product data					84%
Pillar G: Employees								
Readiness score of Rubber and plastics subsector (Industry sector's average)				1.31 (1.24)		Rank		9/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			9.6%	47.9%	41%	0	0.5%	1.0%
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					90%

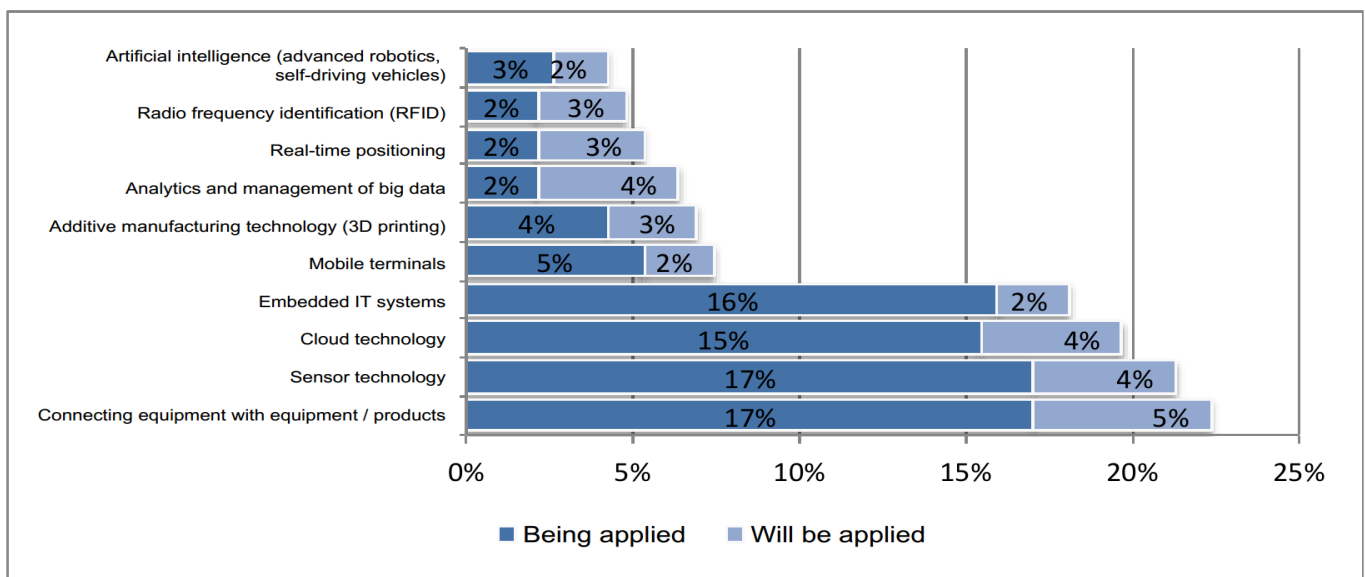


**Note:**

- (1) 48% of enterprises were implementing strategies for building new labour structures, 44% of enterprises for technical standardization of the entire production chains, 24% of enterprises deployed and are deploying strategies for connecting, managing units' activities.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (3) Among 37% of enterprises using digital models: 17% used CAD, 15% ERP, 14% MDC, 11% PDA and 3% SCM.
- (4) 9% of enterprises did not share information with concerned parties.
- (5) 64% of enterprises could not control equipment through IT or connect to other technology, and 55% said they could not upgrade equipment to inter-connect it and with systems.
- (6) Of 90% of enterprises that have equipped employees with knowledge and techniques, the majority self-assessed the level of equipment as inadequate in the seven most surveyed areas:
  - (i) Techniques for using collaborative software: 23% of enterprises have equipped, but not sufficiently, while 2% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 29% and 3%, (iii) Security techniques: 23% and 3%, (iv) Automation technology: 28% and

2%, (v) Data analysis techniques: 14% and 3%, (vi) Techniques for developing, applying support systems: 11% and 2% and (vii) Thinking, understanding of systems: 80% and 2%.

**Survey samples:** 188 enterprises responded, including 45 large and 143 medium-sized and small enterprises, of which three were SOEs, 125 non-State enterprises and 60 foreign-invested enterprises.

### 13. BEVERAGES: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 13/17

**Summary:** Enterprises in this sub-sector have not prepared for IR4.0: the readiness score was 0.52, at "outsider" level. However, some large, private enterprises were at "expert" readiness level in all pillars. The technical standardization of the entire production-product chain is and will be implemented by many enterprises, with the percentage of enterprises having responded was 47%. Some 25% of enterprises are and will use sensor technologies. The percentage of enterprises that are and will inter-connect equipment was 24%, with 17% of enterprises having inter-connected equipment and 7% planning to, but facing infrastructure-related problems in implementing this plan. Some 63% of enterprises could not control equipment through IT or connect to other technology and 54% of enterprises said they could not upgrade equipment to inter-connect and to the system - the biggest obstacle for subsector readiness. Some 77% of enterprises did not use a digital model, 6% used SCM model, of which none used leading interfaces of the model. The majority of data was manually collected, 94% of enterprises could not provide product data through IT, 81% did not share data with customers and partners, 69% did not have services integrating production data and product use and 8% did not equip employees with knowledge and techniques to prepare for IR4.0.

The recommendation for the beverages subsector is similar to that for the food processing sub-sector with an additional suggestion to study and replicate preparedness activities of large private enterprises at "expert" level. The strategy for technical standardization of the entire production chain should be upgraded to be the beverage subsector's IR4.0 strategy with support for enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 54% of firms in the subsector.

Readiness score of <i>beverages sub-sector</i> (Industry sector's average)				0.52 (0.53)		Rank			13/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer	
			86%	12%	1%	0	1%	0	
<b>Pillar B: Strategy and Organization</b>									
Readiness score of <i>beverages sub-sector</i> (Industry sector's average)				0.12 (0.14)		Rank			13/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer	
			83%	14%	1%	1%	1%	0	
B1 - Develop and implement strategy		Share of enterprises that have issued/is issuing strategy (1)							17%
		Share of enterprises that have no plan to develop strategy							83%
B2 - Completeness of indicators measuring results		Share of enterprises that have issued/used sets of indicators							6%
		Completeness of sets of indicators (which have been issued/used)							Incomplete
B3 - Investment in technology applications		Share of enterprises that have invested in science and technology (2)							48%
		Share of enterprises that will continue investing in science and technology for production/processing/manufacturing							32%
B4 - Innovation management		Share of enterprises implementing innovation activities for production management							45%

			Share of enterprises implementing innovation activities for IT management and general management					17%
			Share of enterprises implementing innovation activities for product development management					8%
Pillar C: Smart Factory								
Readiness score of <i>beverages sub-sector</i> (Industry sector's average)			0.34 (0.35)		Rank			12/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			69.6%	18.1%	9.7%	0	2.6%	0
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					46%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					63%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					77%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					95%
Pillar D: Smart Operations								
Readiness score of <i>beverages sub-sector</i> (Industry sector's average)			1.35 (1.47)		Rank			15/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			11%	40.6%	44.5%	3.9%	0	0
D1 - Information sharing			Share of enterprises sharing information (5)					93%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					17%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					17%
D4 - IT security			Share of enterprises having information security plan					91%
D5 - Cloud usage			Share of enterprises using cloud computing					14%
Pillar E: Smart Products								
Readiness score of <i>beverages sub-sector</i> (Industry sector's average)			0.08 (0.08)		Rank			9/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			93.5%	2.6%	2%	1.9%	0	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/ will have products, which can provide data through IT					6%
E2 - Use of product data			Share of enterprises that have collected and used product data					34%
Pillar F: Data-driven Services								
Readiness score of <i>beverages sub-sector</i> (Industry sector's average)			0.45 (0.43)		Rank			10/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			69%	23.1%	3.2%	0	0.6%	3.9%
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					69%
F3 - Level of using data collected			Share of enterprises that don't use production and product data					87%
Pillar G: Employees								
Readiness score of <i>beverages sub-sector</i> (Industry sector's average)			1.26 (1.24)		Rank			10/17
Readiness level	Beginner		Outsider	Beginner	Intermediate	Experienced	Expert	Top performer

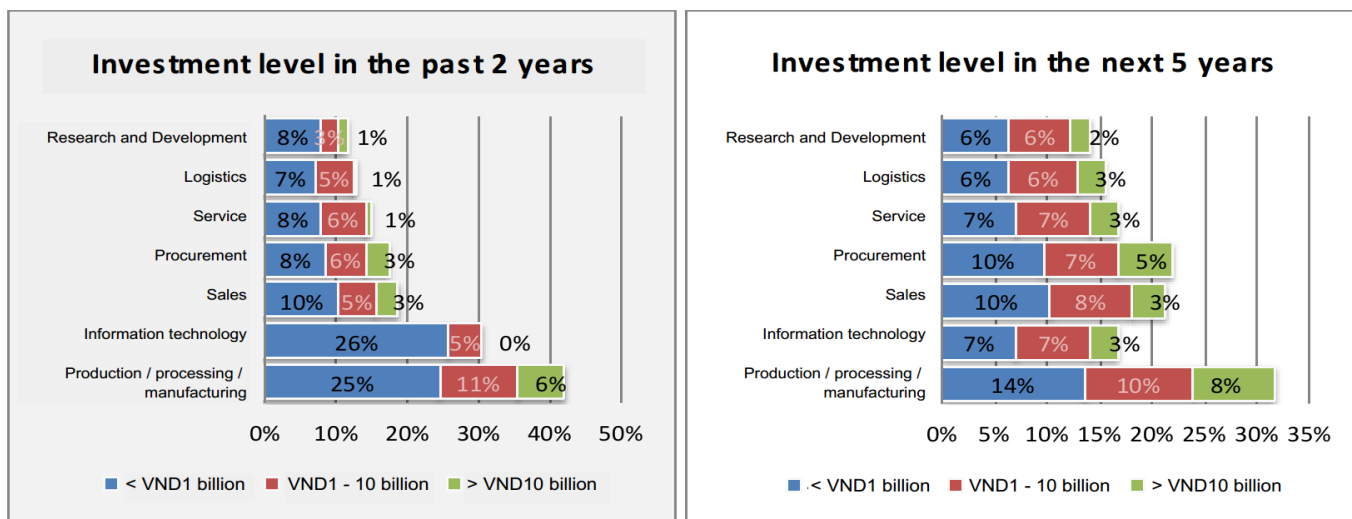


		Share of enterprises by readiness level	7.7%	54.8%	36.1%	0	0.6%	0.6%
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					92%

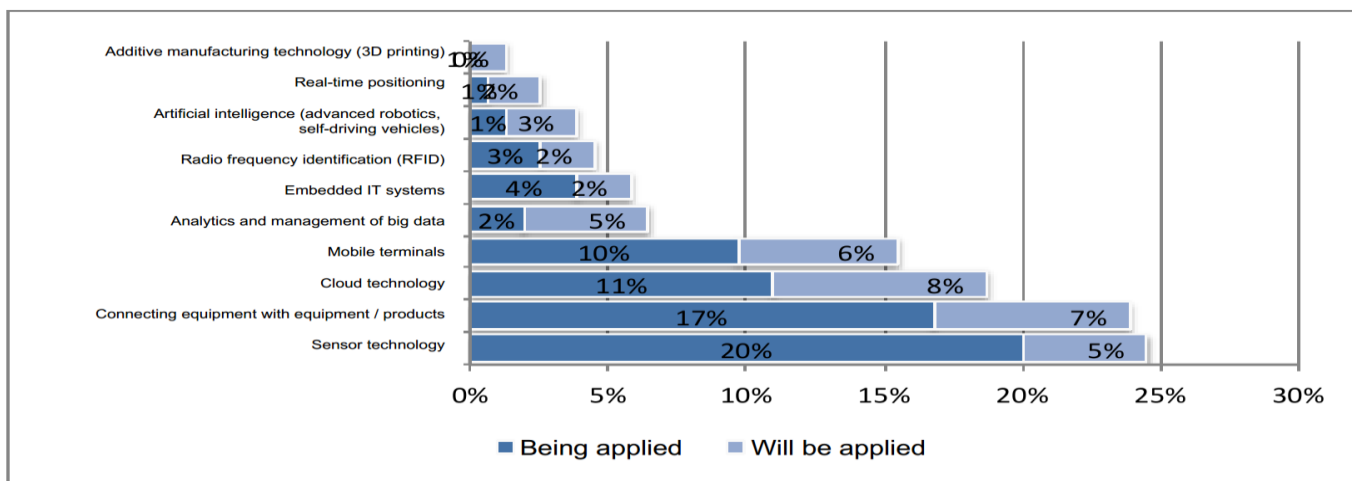
**Note:**

(1) 47% of enterprises have developed and were developing strategies on technical standardization of the entire production chains, 35% of enterprises were developing new labour force structures, 16% of enterprises were working to connect and, manage all activities of units and 3% of enterprises said they were developing strategies for application of IoT technology.

(2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



(3) Among 23% of enterprises using digital models: 13% used PDA, 12% MES, 9% MDC and 6% SCM, of which no business used leading interfaces of the model.

(4) 7% of enterprises did not share information with concerned parties.

(5) 63% of enterprises could not control equipment through IT or connect to other technology, and 54% of enterprises said they could not upgrade equipment to inter-connect and with systems.

- (6) Of the 78% of enterprises to have equipped employees with knowledge and techniques, the majority self-assessed the level of equipment was inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 22% of enterprises have equipped, but not sufficiently and 4% equipped sufficiently, similarly in other areas: (ii) IT infrastructure: 27% and 5%, (iii) Security techniques: 21% and 6%, (iv) Automation technology: 28% and 2%, (v) Data analysis techniques: 15% and 2%, (vi) Techniques for developing, applying support systems: 12% and 3% and (vii) Thinking, understanding of systems: 81% and 6%.

**Survey samples:** 155 enterprises responded, including 18 large and 137 medium-sized and small enterprises, of which five were SOEs, 141 non-State enterprises and nine foreign-invested enterprises.

#### 14. LEATHER AND FOOTWEAR: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 14/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.50, at "outsider" level. The technical standardization of the entire production-product chain is and will be implemented the most by many enterprises, with the percentage of enterprises having responded being 36%. The percentage of enterprises that are and will inter-connect equipment was 16%, with 8% of enterprises having inter-connected equipment and 8% planned to, but enterprises faced infrastructure-related problems in implementing this plan. Some 70% of enterprises could not control equipment through IT or connect to other technology, 52% of enterprises said they could not upgrade equipment to inter-connect and to the system - the biggest obstacle for subsector readiness. Some 75% of enterprises did not use a digital model and 6% used SCM model, of which 2% used leading interfaces of the model. The majority of data was manually collected, 96% of enterprises could not provide product data through IT, 81% did not share data with customers and partners and 73% did not have services integrating production data and product use. Notably, 22% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

The strategy for technical standardization of the entire production chain should be upgraded to be the leather and footwear subsector's IR4.0 strategy with support for enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 52% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 78%. It is advisable to study and replicate preparedness activities for the Smart Products pillar at large private enterprises.

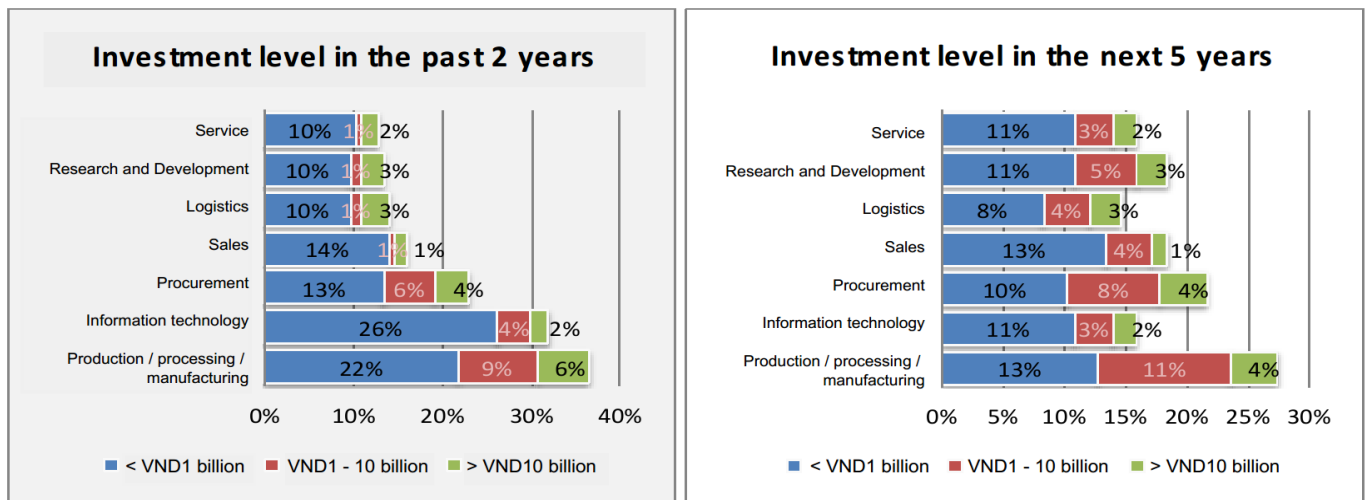
Readiness score of <i>Leather and footwear subsector</i> (Industry sector's average)				0.5 (0.53)		Rank			14/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	by	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				92%	6%	1%	0	0	0
<b>Pillar B: Strategy and Organization</b>									
Readiness score of <i>Leather and footwear subsector</i> (Industry sector's average)				0.12 (0.14)		Rank			12/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	by	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
				90%	8%	1%	1%	0	0

B1 - Develop and implement strategy	Share of enterprises that have issued/is issuing strategy (1)							10%
	Share of enterprises that have no plan to develop strategy							90%
B2 - Completeness of indicators measuring results	Share of enterprises that have issued/used sets of indicators							2%
	Completeness of sets of indicators (which have been issued/used)							Incomplete
B3 - Investment in technology applications	Share of enterprises that have invested in science and technology (2)							50%
	Share of enterprises that will continue investing in science and technology for production/processing/manufacturing							28%
B4 - Innovation management	Share of enterprises implementing innovation activities for production management							41%
	Share of enterprises implementing innovation activities for IT management and general management							15%
	Share of enterprises implementing innovation activities for product development management							8%
Pillar C: Smart Factory								
Readiness score of Leather and footwear subsector (Industry sector's average)				0.31 (0.35)		Rank		14/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			76%	17%	6%	1%	0	0
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					48%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					70%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					75%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					90%
Pillar D: Smart Operations								
Readiness score of Leather and footwear subsector (Industry sector's average)				1.44 (1.47)		Rank		12/17
Readiness level	Beginner	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			17%	25%	54%	4%	0	0
D1 - Information sharing			Share of enterprises sharing information (5)					88%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					11%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					14%
D4 - IT security			Share of enterprises having information security plan					87%
D5 - Cloud usage			Share of enterprises using cloud computing					27%
Pillar E: Smart Products								
Readiness score of Leather and footwear subsector (Industry sector's average)				0.07 (0.08)		Rank		11/17
Readiness level	Outsider	Share of enterprises by readiness level	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			96%	2%	1%	0	1%	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/will have products, which can provide data through IT					4%
E2 - Use of product data			Share of enterprises that have collected and used product data					29%
Pillar F: Data-driven Services								

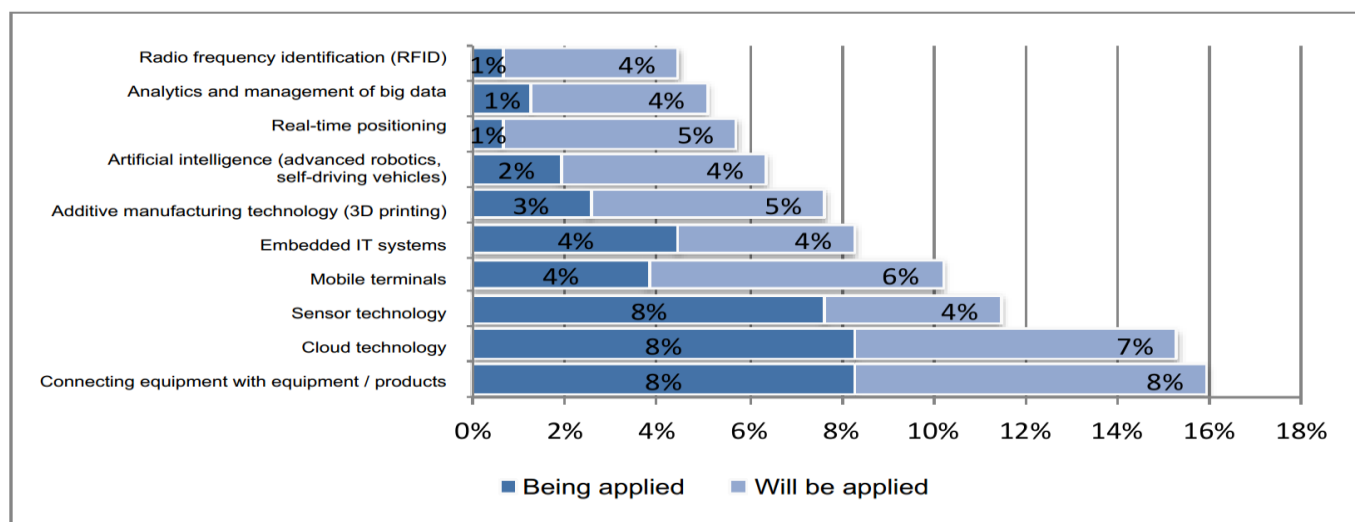
Readiness score of <i>Leather and footwear subsector</i> (Industry sector's average)				0.44 (0.43)		Rank			11/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>	
				73%	20%	3%	0	1%	3%
<i>F1 - Integrating production and product data</i>				<i>Share of enterprises that don't have services for integrating production and product data</i>					73%
<i>F3 - Level of using data collected</i>				<i>Share of enterprises that don't use production and product data</i>					84%
Pillar G: Employees									
Readiness score of <i>Leather and footwear subsector</i> (Industry sector's average)				1.12 (1.24)		Rank			17/17
Readiness level	<i>Beginner</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>	
				21.7%	47.8%	29.3%	0	0.7%	0.6%
<i>G1 - Employees skills</i>				<i>Share of enterprises having equipped employees with 4.0 skills (6)</i>					78%

**Note:**

- (1) 13% of enterprises have developed and were developing strategies on technical standardization of the entire production chains, 13% of enterprises said they would implement technology for connecting, managing all activities of division, and 4% said they were developing strategies for application of IoT technology.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (3) Among 25% of enterprises using digital models: 13% used PDA, 10% CAD, 9% used ERP, PPS and MES, 7% PDM and MDC, 6% SCM, of which 2% of enterprises used leading interfaces of the model.
- (4) 12% of enterprises did not share information with the concerned parties.
- (5) 70% of enterprises could not control equipment through IT or connect to other technology, and 52% of enterprises said they could not upgrade equipment to inter-connect and with systems.
- (6) Of the 79% of enterprises that have equipped employees with knowledge and techniques on systems, the majority self-assessed the level of equipment as inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 18% of enterprises have equipped but not sufficiently, 1% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 22% and 3%, (iii) Security techniques: 18% and 2%, (iv) Automation technology: 15% and 1%, (v) Data analysis techniques: 12% and 1%, (vi) Techniques for developing, applying support systems: 8% and 1% and (vii) Thinking, understanding of systems: 71% and 2%.

**Survey samples:** 157 enterprises responded, including 39 large and 118 medium-sized and small enterprises, of which 110 were non-State enterprises and 47 foreign-invested enterprises.

## 15. GARMENTS: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 15/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.49, at "outsider" level. However, unlike textile enterprises, some garment enterprises have exhibited preparedness above "intermediate" readiness level. The labour restructuring and technical standardization of the entire production-product chain is and will be implemented the most with the percentage of enterprises having responded being 49% and 27%, respectively. The percentage of enterprises that are and will inter-connect equipment is 16%, with 11% having inter-connected equipment and 5% planned it, yet enterprises faced infrastructure-related problems in implementing this plan. Some 73% of enterprises could not control equipment through IT or connect to other technology, 50% of enterprises said they could not upgrade equipment to inter-connect and to systems - the biggest obstacle for subsector readiness. Some 73% of enterprises did not use a digital model, 7% used ERP model and 1% used SCM model. The majority of data was manually collected, 95% of enterprises could not provide product data through IT, 82% did not share data with customers and partners and 80% did not have services integrating production data and product use. Notably, 19% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

Similar to the textile subsector, the strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the garment subsector's IR4.0 strategy with support for application of ERP model and enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 50% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 81%. Business models deployed at high readiness levels ("leaders" group) in each pillar should be studied, disseminated and replicated.

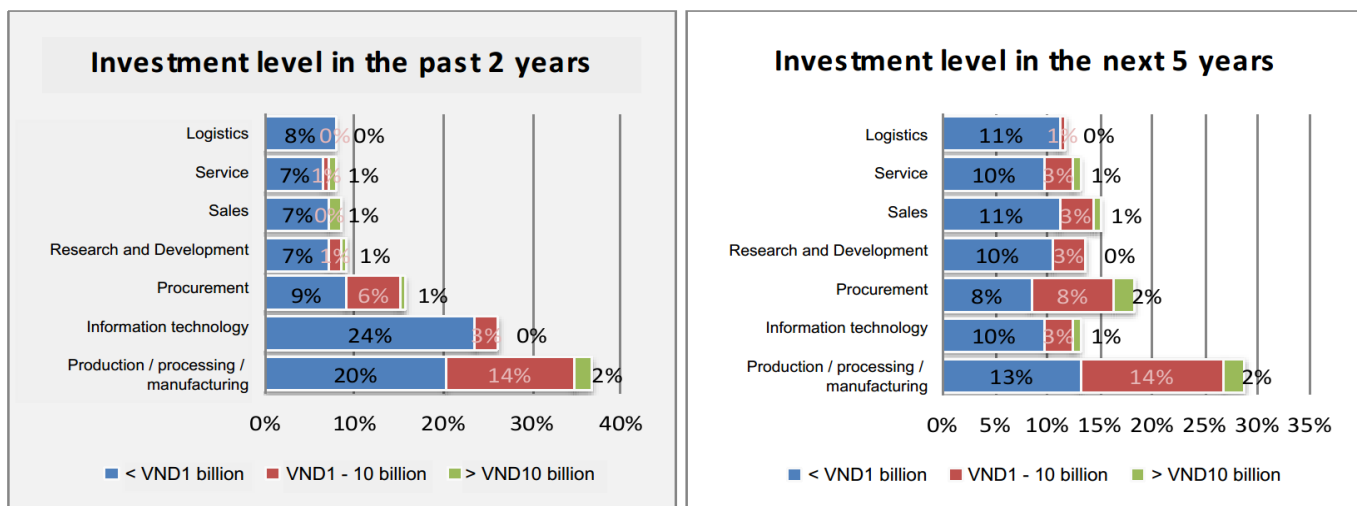
Readiness score of <i>Garments subsector</i> (Industry sector's average)				0.49 (0.53)	Rank			15/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			90%	10%	0	0	0	0
Pillar B: Strategy and Organization								
Readiness score of <i>Garments subsector</i> (Industry sector's average)				0.16 (0.14)	Rank			8/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			88%	9%	1%	1%	1%	0
<i>B1 - Develop and implement strategy</i>		<i>Share of enterprises that have issued/ is issuing strategy (1)</i>						16%
		<i>Share of enterprises that have no plan to develop strategy</i>						84%
<i>B2 - Completeness of indicators measuring results</i>		<i>Share of enterprises that have issued/ used sets of indicators</i>						5%
		<i>Completeness of sets of indicators (which have been issued/ used)</i>						Incomplete
<i>B3 - Investment in technology applications</i>		<i>Share of enterprises that have invested in science and technology (2)</i>						43%
		<i>Share of enterprises that will continue investing in science and technology for production/ processing/ manufacturing</i>						28%
<i>B4 - Innovation management</i>		<i>Share of enterprises implementing innovation activities for production management</i>						37%
		<i>Share of enterprises implementing innovation activities for IT management and general management</i>						15%
		<i>Share of enterprises implementing innovation activities for product development management</i>						5%
Pillar C: Smart Factory								
Readiness score of <i>Garments subsector</i> (Industry sector's average)				0.23 (0.35)	Rank			17/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			78%	16%	6%	0	0	0
<i>C1 - Feature for controlling, connecting equipment</i>		<i>Share of enterprises that have upgradable equipment for connections (3)</i>						50%
<i>C2 - Level of meeting equipment connectivity demand</i>		<i>Share of enterprises that can't control equipment through IT (3)</i>						73%
<i>C3 - Digital management model</i>		<i>Share of enterprises that don't have any digital model (4)</i>						73%
<i>C4 - Data collection method</i>		<i>Share of enterprises collecting data</i>						100%
<i>C5 - Purpose of data usage</i>		<i>Share of enterprises using information</i>						92%
Pillar D: Smart Operations								
Readiness score of <i>Garments subsector</i> (Industry sector's average)				1.54 (1.47)	Rank			7/17



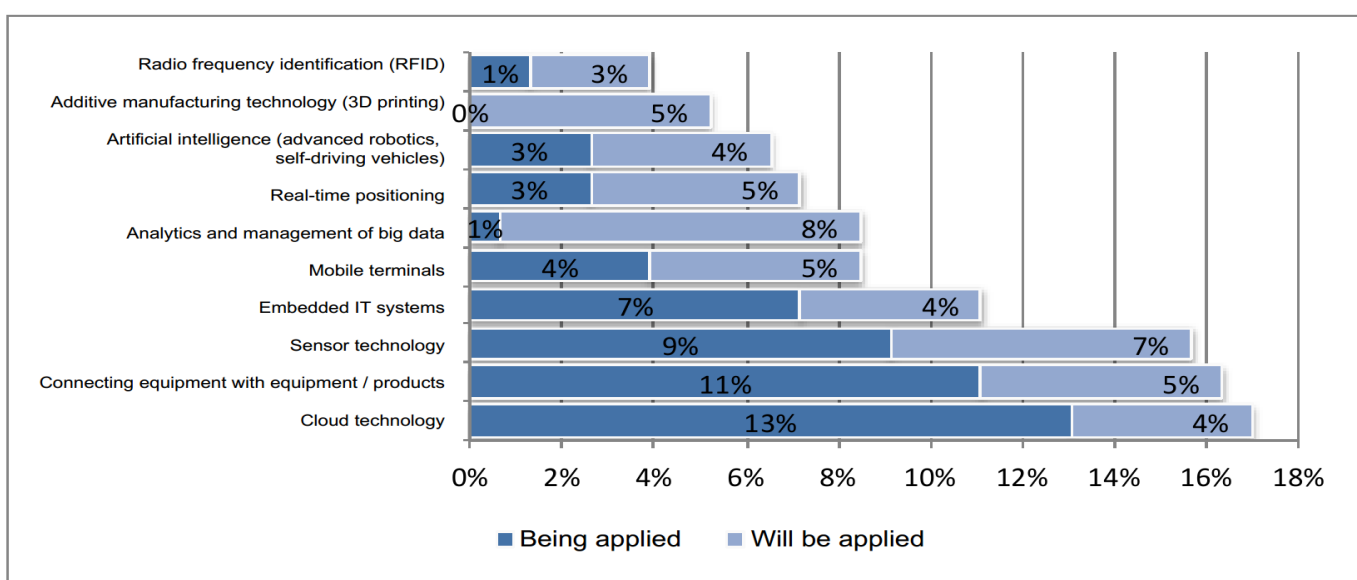
Readiness level	Beginner	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				16%	20%	59%	5%	0	0
D1 - Information sharing				Share of enterprises sharing information (5)					90%
D2 - Automation				Share of enterprises having system autonomously responding to changes (some units)					10%
D3 - Autonomous processes				Share of enterprises having autonomous system (some units)					13%
D4 - IT security				Share of enterprises having information security plan					87%
D5 - Cloud usage				Share of enterprises using cloud computing					18%
Pillar E: Smart Products									
Readiness score of Garments subsector (Industry sector's average)				0.06 (0.08)		Rank			12/17
Readiness level	Outsider	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				95%	3%	1%	0	1%	0
E1 - Products' capability to provide data through IT				Share of enterprises that have/ will have products, which can provide data through IT					5%
E2 - Use of product data				Share of enterprises that have collected and used product data					20%
Pillar F: Data-driven Services									
Readiness score of Garments subsector (Industry sector's average)				0.32 (0.43)		Rank			15/17
Readiness level	Outsider	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				80%	14%	2%	3%	0	1%
F1 - Integrating production and product data				Share of enterprises that don't have services for integrating production and product data					80%
F3 - Level of using data collected				Share of enterprises that don't use production and product data					87%
Pillar G: Employees									
Readiness score of Garments subsector (Industry sector's average)				1.14 (1.24)		Rank			16/17
Readiness level	Beginner	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
				19%	49.6%	30.7%	0	0.7%	0
G1 - Employees skills				Share of enterprises having equipped employees with 4.0 skills (6)					81%

**Note:**

- (1) 44% of enterprises were preparing to restructure their labour force, 34% have developed and were developing strategies on technical standardization of entire production chains, 16% said they would implement technology for connecting, managing all activities of units and 3% said they were developing strategies for application of IoT technology.
- (2) Share of enterprises investing in technology in the surveyed areas:



### TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE



- (3) Among 27% of enterprises using digital models: 19% used CAD, 10% PDA, 7% MES and ERP and management model, and 1% of enterprises used SCM model.
- (4) 10% of enterprises did not share information with concerned parties.
- (5) 73% of enterprises could not control equipment through IT or connect to other technology, and 50% of enterprises said they could not upgrade equipment to inter-connect and with systems.
- (6) Of the 81% of enterprises that have equipped themselves with knowledge, the majority self-assessed the level of equipment as inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 16% of enterprises have equipped but not sufficiently, 1% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 21% and 3%, (iii) Security techniques: 16% and 1%, (iv) Automation technology: 21% and 0%, (v) Data analysis techniques: 13% and 1%, (vi) Techniques for developing, applying support systems: 10% and 0% and (vii) Thinking, understanding of systems: 73% and 1%.

**Survey samples:** 153 enterprises responded, including 32 large and 121 medium-sized and small enterprises, of which two were SOEs, 122 non-State enterprises and 29 foreign-invested enterprises.



## 16. TEXTILES: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 16/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.45, at "outsider" level. The labour restructuring and technical standardization of the entire production-product chain is and will be implemented the most with the percentage of enterprises responded being 44% and 38%, respectively. The percentage of enterprises that are and will inter-connect equipment is 24%. Some 10% of enterprises have inter-connected equipment, while 7% planned it, but enterprises faced infrastructure-related problems in implementing this plan. Some 67% of enterprises could not control equipment through IT or connect to other technology, 62% of enterprises said they could not upgrade equipment to inter-connect and with the system - the biggest obstacle for subsector readiness. Some 74% of enterprises did not use a digital model, 9% used ERP model and 2% used SCM model. The majority of data was manually collected, 98% of enterprises could not provide product data through IT, 85% did not share data with customers and partners and 73% did not have services integrating production data and product use. Notably, 13% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the textile subsector's IR4.0 strategy with support for application of ERP model and enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 62% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 87%.

Readiness score of <i>Textiles subsector</i> (Industry sector's average)				0.45 (0.53)	Rank			16 /17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			92%	8%	1%	0	0	0
Pillar B: Strategy and Organization								
Readiness score of <i>Textiles subsector</i> (Industry sector's average)				0.08 (0.14)	Rank			16/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			88.7%	9.5%	0.6%	0.6%	0.6%	0
<i>B1 - Develop and implement strategy</i>		<i>Share of enterprises that have issued/is issuing strategy (1)</i>						13%
		<i>Share of enterprises that have no plan to develop strategy</i>						87%
<i>B2 - Completeness of indicators measuring results</i>		<i>Share of enterprises that have issued/used sets of indicators</i>						5%
		<i>Completeness of sets of indicators (which have been issued/used)</i>						Incomplete
<i>B3 - Investment in technology applications</i>		<i>Share of enterprises that have invested in science and technology (2)</i>						54%
		<i>Share of enterprises that will continue investing in science and technology for production/processing/manufacturing</i>						34%
<i>B4 - Innovation management</i>		<i>Share of enterprises implementing innovation activities for production management</i>						46%
		<i>Share of enterprises implementing innovation activities for IT management and general management</i>						17%
		<i>Share of enterprises implementing innovation activities for product development management</i>						6%
Pillar C: Smart Factory								
Readiness score of <i>Textiles subsector</i> (Industry sector's average)				0.23 (0.35)	Rank			16/17
Readiness level	<i>Outsider</i>	Share of enterprises by readiness level	<i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>
			75%	14%	8%	2%	1%	0

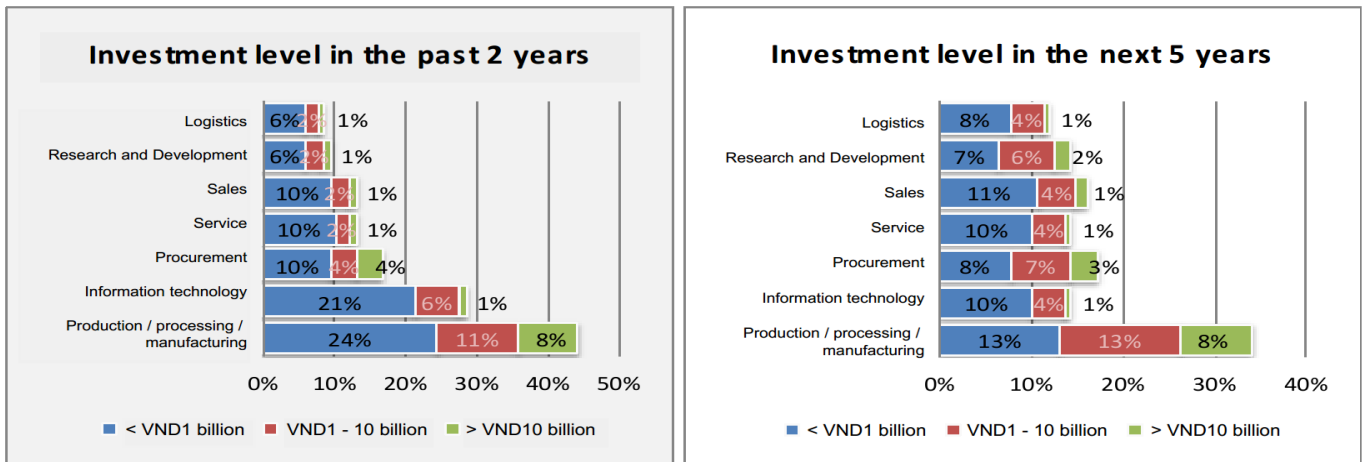
C1 - Feature for controlling, connecting equipment			Share of enterprises that have upgradable equipment for connections (3)					38%
C2 - Level of meeting equipment connectivity demand			Share of enterprises that can't control equipment through IT (3)					67%
C3 - Digital management model			Share of enterprises that don't have any digital model (4)					74%
C4 - Data collection method			Share of enterprises collecting data					100%
C5 - Purpose of data usage			Share of enterprises using information					95%
Pillar D: Smart Operations								
Readiness score of Textiles subsector (Industry sector's average)			1.43 (1.47)		Rank			13/17
Readiness level	Beginner	Share of enterprises readiness level	by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			13%	31%	52%	2%	1%	1%
D1 - Information sharing			Share of enterprises sharing information (5)					90%
D2 - Automation			Share of enterprises having system autonomously responding to changes (some units)					11%
D3 - Autonomous processes			Share of enterprises having autonomous system (some units)					15%
D4 - IT security			Share of enterprises having information security plan					90%
D5 - Cloud usage			Share of enterprises using cloud computing					15%
Pillar E: Smart Products								
Readiness score of Textiles subsector (Industry sector's average)			0.02 (0.08)		Rank			15/17
Readiness level	Outsider	Share of enterprises readiness level	by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			97.6%	1.2%	0	0.6%	0.6%	0
E1 - Products' capability to provide data through IT			Share of enterprises that have/ will have products, which can provide data through IT					2%
E2 - Use of product data			Share of enterprises that have collected and used product data					26%
Pillar F: Data-driven Services								
Readiness score of Textiles subsector (Industry sector's average)			0.33 (0.43)		Rank			14/17
Readiness level	Outsider	Share of enterprises readiness level	by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			72.6%	25%	1.2%	0	0.6%	0.6%
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					73%
F3 - Level of using data collected			Share of enterprises that don't use production and product data					87%
Pillar G: Employees								
Readiness score of Textiles subsector (Industry sector's average)			1.16 (1.24)		Rank			15/17
Readiness level	Beginner	Share of enterprises readiness level	by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			13%	49%	38%	0	0	0
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					87%

**Note:**

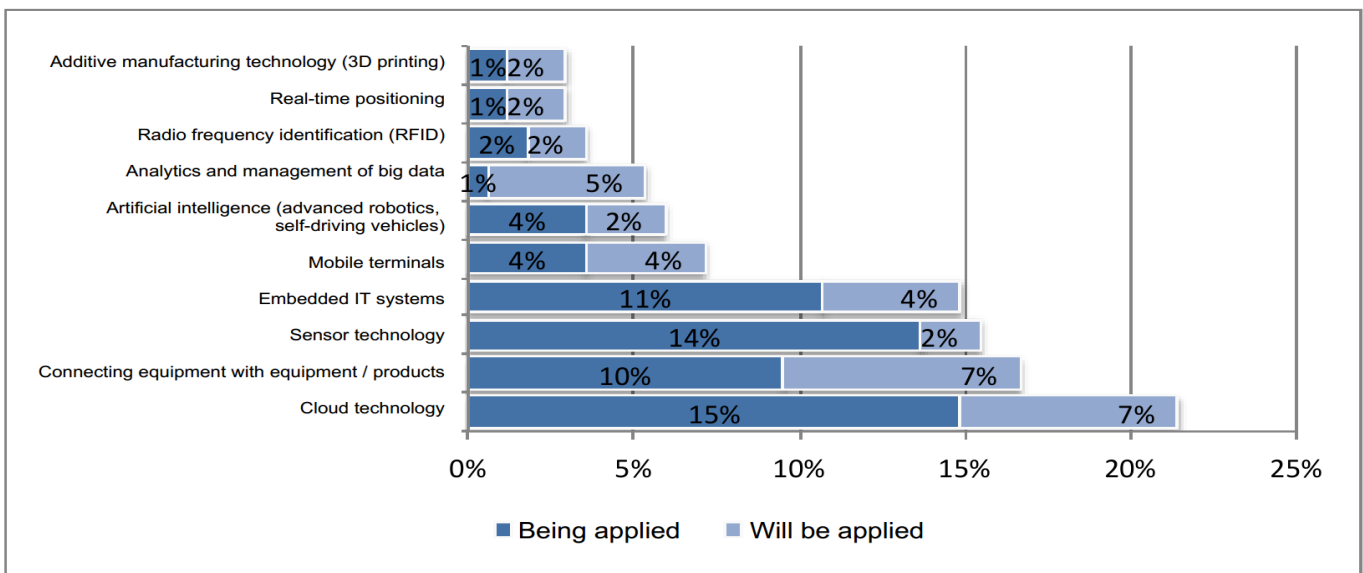
- (1) 37% of enterprises were preparing to restructure labour forces, 38% of enterprises have developed and were developing strategies on technical standardization of entire production chains, 11% of enterprises said they would implement technology for connecting, managing all

activities of units and 4% of enterprises said they were developing strategies for application of IoT technology.

(2) Share of enterprises investing in technology in the surveyed areas:



### TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE



(3) Among 26% of enterprises using digital models: 12% used CAD, 10% PDA, 9% ERP and MES, and 2% of enterprises used SCM model.

(4) 10% of enterprises did not share information with concerned parties.

(5) 67% of enterprises could not control equipment through IT or connect to other technology, and 62% of enterprises said they could not upgrade equipment to inter-connect and with systems.

(6) Of 87% of enterprises that have equipped employees with knowledge and techniques, the majority of enterprises self-assessed the level of equipment was inadequate in the seven most surveyed areas: (i) Techniques for using collaborative software: 24% of enterprises have equipped but not sufficiently, 0% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 27% and 1%, (iii) Security techniques: 23% and 1%, (iv) Automation technology: 24% and 1%, (v) Data analysis techniques: 7% and 1%, (vi) Techniques for developing, applying support systems: 8% and 1% and (vii) Thinking, understanding of systems: 79% and 1%.

**Survey samples:** 168 enterprises responded, including 36 large and 132 medium-sized and small enterprises, of which three were SOEs, 116 non-State enterprises, and 49 foreign-invested enterprises.

## 17. METAL PRODUCT MANUFACTURING: (I) READINESS LEVEL: "OUTSIDER" (II) RANK: 17/17

**Summary:** Enterprises in this subsector have not prepared for IR4.0: the readiness score was 0.43, at "outsider" level. The labour restructuring and technical standardization of the entire production-product chain is and will be implemented the most with the percentage of enterprises having responded being 31% and 23%, respectively. The percentage of enterprises that are and will inter-connect equipment was 21%, of which 15% of enterprises have inter-connected equipment and 6% plan to, yet enterprises are facing infrastructure-related problems in implementing this plan. Some 66% of enterprises could not control equipment through IT or connect to other technology and 57% of enterprises said they could not upgrade equipment to inter-connect and with systems - the biggest obstacle for subsector readiness. Some 70% of enterprises did not use a digital model, 11% used ERP model and 3% used SCM model. The majority of data was manually collected, 96% of enterprises could not provide product data through IT, 89% of enterprises did not share data with customers and partners and 81% did not have services integrating production data and product use. Notably, 6% of enterprises did not equip employees with knowledge and techniques to prepare for IR4.0.

The strategy for labour restructuring and technical standardization of the entire production chain should be upgraded to be the subsector's IR4.0 strategy with support for application of ERP model, SCM model and enhanced collection and exchanges of information on production processes and products. The readiness level for inter-connecting equipment/systems/products can only be achieved when replacement investments are made in 57% of firms in the subsector. The proportion of enterprises equipping workers with knowledge and techniques should increase higher than the current level of 94%.

Readiness score of <i>Metal product manufacturing</i> (Industry sector's average)				0.43 (0.53)		Rank			17/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>	
				92.2%	16.5%	1.3%	0	0	0
Pillar B: Strategy and Organization									
Readiness score of <i>Metal product manufacturing</i> (Industry sector's average)				0.07 (0.14)		Rank			17/17
Readiness level	<i>Outsider</i>	Share of enterprises readiness level	of by <i>Outsider</i>	<i>Beginner</i>	<i>Intermediate</i>	<i>Experienced</i>	<i>Expert</i>	<i>Top performer</i>	
				89%	10%	0	1	0	0
<i>B1 - Develop and implement strategy</i>		<i>Share of enterprises that have issued/is issuing strategy (1)</i>							13%
		<i>Share of enterprises that have no plan to develop strategy</i>							87%
<i>B2 - Completeness of indicators measuring results</i>		<i>Share of enterprises that have issued/used sets of indicators</i>							2%
		<i>Completeness of sets of indicators (which have been issued/used)</i>							Incomplete
<i>B3 - Investment in technology applications</i>		<i>Share of enterprises that have invested in science and technology (2)</i>							61%

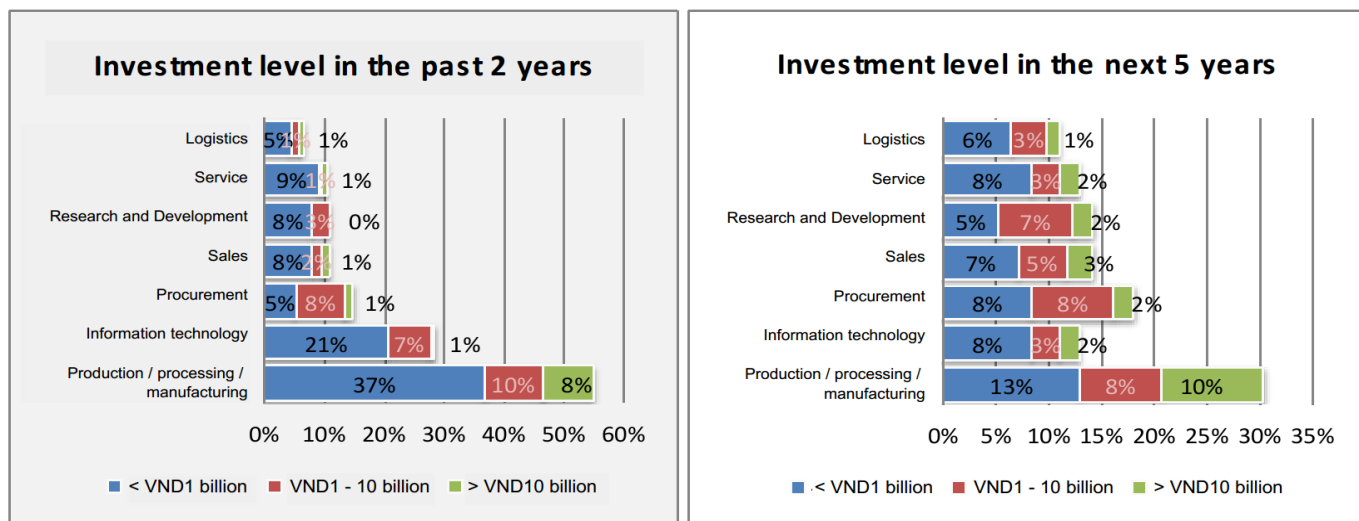
		Share of enterprises that will continue investing in science and technology for production/ processing/ manufacturing						31%
B4 - Innovation management		Share of enterprises implementing innovation activities for production management						58%
		Share of enterprises implementing innovation activities for IT management and general management						17%
		Share of enterprises implementing innovation activities for product development management						5%
Pillar C: Smart Factory								
Readiness score of Metal product manufacturing (Industry sector's average)		0.26 (0.35)		Rank				15/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			73.4%	12.3%	11.6%	2.6%	0	0
C1 - Feature for controlling, connecting equipment		Share of enterprises that have upgradable equipment for connections (3)						43%
C2 - Level of meeting equipment connectivity demand		Share of enterprises that can't control equipment through IT (3)						66%
C3 - Digital management model		Share of enterprises that don't have any digital model (4)						74%
C4 - Data collection method		Share of enterprises collecting data						100%
C5 - Purpose of data usage		Share of enterprises using information						90%
Pillar D: Smart Operations								
Readiness score of Metal product manufacturing (Industry sector's average)		1.33 (1.47)		Rank				17/17
Readiness level	Beginner	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			10%	38%	49%	2%	1%	0
D1 - Information sharing		Share of enterprises sharing information (5)						92%
D2 - Automation		Share of enterprises having system autonomously responding to changes (some units)						11%
D3 - Autonomous processes		Share of enterprises having autonomous system (some units)						12%
D4 - IT security		Share of enterprises having information security plan						95%
D5 - Cloud usage		Share of enterprises using cloud computing						20%
Pillar E: Smart Products								
Readiness score of Metal product manufacturing (Industry sector's average)		0.01 (0.08)		Rank				16/17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			96%	3%	0	1%	0	0
E1 - Products' capability to provide data through IT		Share of enterprises that have/ will have products, which can provide data through IT						4%
E2 - Use of product data		Share of enterprises that have collected and used product data						19%
Pillar F: Data-driven Services								
Readiness score of Metal product manufacturing (Industry sector's average)		0.14 (0.43)		Rank				17 / 17
Readiness level	Outsider	Share of enterprises readiness level	of by Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			81%	16%	0	1%	1%	1%



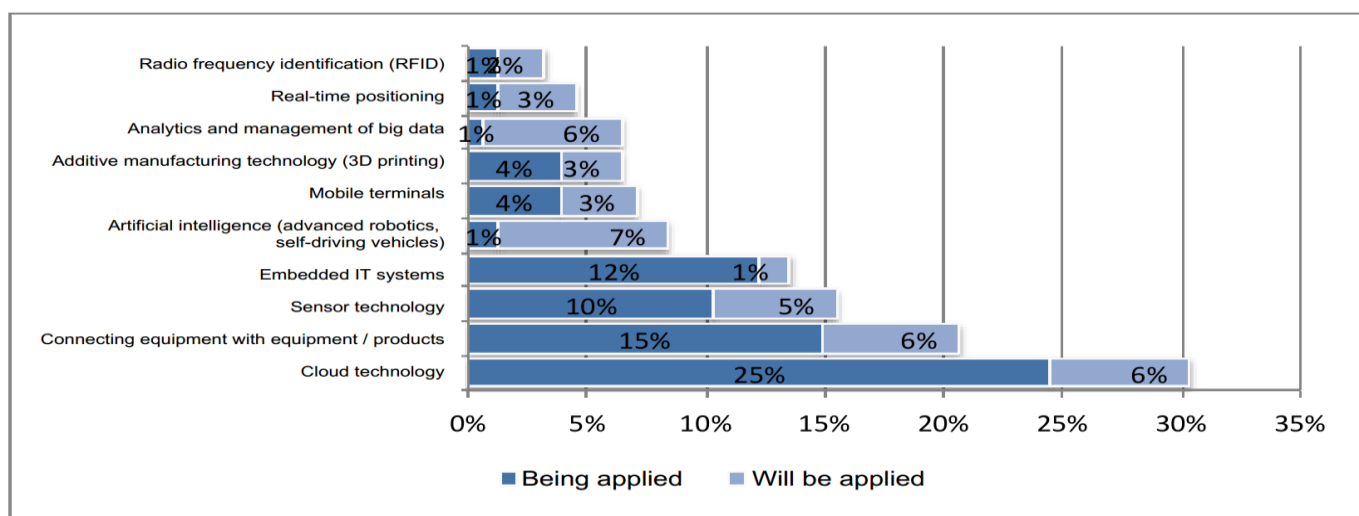
F1 - Integrating production and product data			Share of enterprises that don't have services for integrating production and product data					81%	
F3 - Level of using data collected			Share of enterprises that don't use production and product data					89%	
Pillar G: Employees									
Readiness score of Metal product manufacturing (Industry sector's average)			1.22 (1.24)		Rank			12/17	
Readiness level	Beginner	Share of enterprises readiness level	of by	Outsider	Beginner	Intermediate	Experienced	Expert	Top performer
			6%	59%	35%	0	0	0	
G1 - Employees skills			Share of enterprises having equipped employees with 4.0 skills (6)					94%	

**Note:**

- (1) 29% of enterprises were preparing to restructure labour forces, 24% of enterprises have developed and were developing strategies on technical standardization of entire production chains, 22% of enterprises said they would implement technology for connecting, managing all activities of units.
- (2) Share of enterprises investing in technology in the surveyed areas:



**TECHNOLOGY RELATED TO IR4.0 CURRENTLY IN USE**



- (3) Among 26% of enterprises using digital models: 18% used CAD, 10% PDA, 8% MES and PDM, 7% PLM, MDC, PPS and ERP and 2% SCM.
- (4) 8% of enterprises did not share information with concerned parties.
- (5) 66% of enterprises could not control equipment through IT or connect to other technology, and 57% of enterprises said they could not upgrade equipment to inter-connect and with systems.
- (6) Of 94% of enterprises that have equipped employees with knowledge and techniques, the majority of enterprises self-assessed the level of equipment as inadequate in most of the seven surveyed areas: (i) Techniques for using collaborative software: 18% of enterprises have equipped but not sufficiently, 1% equipped sufficiently and similarly in other areas: (ii) IT infrastructure: 24% and 5%, (iii) Security techniques: 15% and 1%, (iv) Automation technology: 23% and 1%, (v) Data analysis techniques: 12% and 2%, (vi) Techniques for developing, applying support systems: 11% and 1% and (vii) Thinking, understanding of systems: 85% and 1%.

**Survey samples:** 155 enterprises responded, including 38 large and 117 medium-sized and small enterprises, of which one was a SOE, 127 non-State enterprises and 27 are foreign-invested enterprises.

## 4. RESULTS OF IN-DEPTH INTERVIEWS

In order to assist with analyzing quantitative data from the survey and identifying a number of areas that require significant improvements to strengthen the capacity of enterprises in Viet Nam to access IR4.0, in-depth interviews with 25 surveyed enterprises were designed and conducted (after survey data were initially processed, subjects and content of in-depth interviews are presented in Appendix 7). Potential impediments to accessing IR4.0, as viewed by enterprises, are summarized as follows:

### 4.1. INFRASTRUCTURE

- Improved telecommunications infrastructure: Several inadequacies remain apparent, as the speed of internet connections in Viet Nam is sub-optimal and cable breakages on international telecommunications routes severely affect enterprises applying technologies and working with foreign partners. Especially with the proliferation of more services and transactions of enterprises applying cloud computing technology, the dependence of enterprises on internet connections is greater than ever. Interviewed enterprises recommended the government have mechanisms to encourage enterprises to participate in development of telecommunications infrastructure and directly participate in construction of the national telecommunications network, independent of foreign suppliers. In addition, the government should have measures to quickly handle fiber optic cable incidents at sea, assigned to a telecommunications company capable of completing such tasks. Moreover, the government could build a spare cable line to prevent transmission interruptions. Upgrading the 4G transmission system to 5G for faster access speed was also urged.
- Network and data security: Interviewed enterprises recommended the government have more stringent and punitive sanctions against hackers acting within the territory of Viet Nam (and beyond). Many enterprises faced increased threats of attack from hackers in country and abroad, while the law did not have specific measures to protect rights nor has adequate sanctions against unauthorized data infringements. One interviewed enterprise reported it had suffered major losses due to data hacking, resulting in data and financial losses, with six months needed to address the problem. Interviewed enterprises also encouraged the State to establish sanctions for the protection of internet information and data, to protect the interests of enterprises as well as consumers. At a foreign-invested enterprise (SD Viet Nam), the Japan-based parent company anticipated the danger of corporate data being compromised, so from the outset it built an internal IT system with the server designed and located inside the corporate premises to limit reliance on external server systems. Network security measures such as firewalls, limited internet access from within the company and creation of internal IT systems (corporate email) were also established. Enterprises also said the application of cloud computing technology was ideal, yet increased dependency on network transmission lines and network security risks needed to be assessed.
- Infrastructure (such as electricity and water): These utilities must be upgraded in the age of IR4.0. The supply of electricity and water for production needed to be stable, adequate and regular, as power outages and water shortages have large impacts on business production processes as they slow the completion of orders and compliance with contract delivery times. The higher technology applied by enterprises means greater damage is caused by the stopping of machines (and related stagnation of production and business systems). The quality of industrial zones varied and State management agencies have not fulfilled their roles, responsibilities and management functions to ensure operation



standards in industrial zones. This is also reflected in the planning of industrial parks, rarely connected to transport links or appropriate labour resources. In addition, land and land ownership of enterprises is also a focus, as they covet the right to own and use land guaranteed by the State to assure long-term investments. Investment costs for plants remain significantly large, hence mechanisms are necessary to protect the interests of enterprises when investing in real estate to ensure and stabilize production (advocated by Vietstar - a joint stock company with private capital, operating in the field of chemicals, waterproof materials).

- Upgrading the Data Centre of the Viet Nam Road Administration (Ministry of Transport) is recommended due to overloading. At present, the collected data volume exceeded storage capacity by more than half, often causing communication bottlenecks in transmission lines that provide information from enterprises. About 20 companies in the Viet Nam Automobile Transport Association provide equipment for itinerary tracking and vehicle information transmission to the Viet Nam Road Administration, at a frequency of 10 seconds/report/vehicle of 800,000 vehicles operating in the transportation business. This scale is expected to increase to two million vehicles by the end of 2018 and storage capacity should be upgraded. While this data system can solve many problems, from which data can be extracted for agencies responsible for managing traffic and tax for example, the servers have yet to be upgraded despite the relatively small cost. According to internal information, this centre was originally a VND 200 billion investment made by Hanel Joint Stock Company for the Ministry of Transport, but was not transferred as due payment was not made.

#### 4.2. ACCESS TO FINANCING

- Improve disbursement procedures: Most enterprises viewed government incentive packages for preferential credit or financial support (technology upgrading, R&D and application of IR4.0 technologies) as ineffective. The main reason cited was difficult disbursement procedures that turned off capable, qualified enterprises from tapping such financing sources as the opportunity costs were too high compared to preferential benefits received.
- Enterprises recommended a tax incentives policy for the import of high-tech machinery for production.
- A concessional lending policy for enterprises investing in IR4.0 technologies was recommended, as large investments usually entailed great risks. This is not just a matter for SMEs, but even corporations and conglomerates felt investing in high technology and IR4.0 was potentially very risky. As such, it is possible technology invested in a factory could become obsolete in just a few years and all risks sat with enterprises and leadership (if State shares were involved, it could raise criminal liability concerns).

#### 4.3. HUMAN RESOURCE TRAINING

- Employee skills training: Industrial Revolution 4.0 is an inevitable technology trend that Viet Nam must catch up on with other countries. Human resources in Viet Nam are largely not equipped with technology knowledge to work in enterprises with application of IR4.0 technologies. Therefore, the government should have policies to train students with skills and knowledge based on technology from schooling to easily enter the workforce and access new machinery and technologies. In addition, a strategy is necessary to train students majoring in computer science, IT and robotics engineering in line with the rapid progress of technology.
- Support access to information: Interviewed enterprises encouraged the government and research institutions, pioneering in the field of technology, to organize seminars and training courses to improve knowledge on technologies and share experiences from enterprises on

the difficulties and challenges faced when applying IR4.0 technologies and how enterprises can overcome such difficulties.

- Organization of training courses, skills coaching: Most interviewed enterprises highly valued the capabilities of Vietnamese workers, but due to limitations in accessing high technology machinery and equipment, it is necessary to create conditions for experts, engineers and users of technology to be exposed to advanced technologies and participate in short-term, yet effective and practical training courses.
- Clear policy orientation to encourage and facilitate enterprises to penetrate more deeply into the global value chain is required: Government and State governing agencies should be more active in guiding and supporting enterprises to convert from low value processing to higher value business forms.

#### 4.4 OTHER RECOMMENDATIONS

- Interviewed enterprises encouraged the government to develop a policy to promote and implement e-commerce activities for enterprises in the field of production supply. Viet Nam's garment subsector is one of its leading exporters, however, production machinery and materials such as fabrics, yarns or decorative accessories are imported from abroad and mainly from China. Enterprises heavily depend on materials and equipment from China, because the domestic market is unable to meet demand in terms of quantity, quality or design (The Parosy Company - garments for export and domestic markets). Industrial development in the product/value chain may not only solve the garment subsector's problems, it may also facilitate the development of other subsectors such as mechanical engineering, machinery and production of other raw and auxiliary materials, especially in the context of higher international trade demand for traceability and the rate of domestic production.
- Some interviewed enterprises proposed to build an e-commerce transaction platform for domestic and international enterprises operating in Viet Nam, capable of ensuring quality for sellers and buyers in the same way Alibaba supports many Chinese enterprises reaching out to customers and partners globally.
- Thoroughly implement electronic administrative procedures (typically Customs and taxation) as well as harmonize and integrate them with international electronic systems (such as international Customs systems) were recommended. Electronic signatures are currently being developed in the field of e-commerce through transactions with customers, which should be applied more widely. In corporations and conglomerates with State shares, management responsibilities of top leaders is high, yet administrative and management procedures remain cumbersome. For example, if a leader is absent on a business trip, his/her electronic signature is not accepted, so all official documents must be done in parallel (reporting, approval made by email, with signatures of official letters when returning to the office).
- Standardization of international technical standards: Technical and environmental standards promulgated by the Ministry of Science and Technology greatly differ from international technical standards, while enterprises (eg: Vinacomin - Viet Nam National Coal and Mineral Industries Holding Corporation Ltd.) are required to import machinery to support production, as the domestic market is unable to meet demand for such equipment. This has led to a situation where corporation technical experts need more time and efforts to reprogramme machinery, equipment and software to be compliant with Vietnamese standards.

## 5. CONCLUSIONS AND POLICY IMPLICATIONS

The Fourth Industrial Revolution (IR4.0) is accelerating on a global scale and significantly changing every aspect of economic and social life. In this context, strengthening the capacity of enterprises in Viet Nam to access IR4.0 has become an important policy objective. To provide the first evidence to underpin the design of an appropriate support policy for Viet Nam's industry sector, this study was conducted to determine the sector's IR4.0 readiness through a survey of 2,659 industrial enterprises in Viet Nam.

### 5.1. KEY FINDINGS

- Analysis results showed the overwhelming majority of Viet Nam's industrial enterprises were at "outsider" level from IR4.0. In the six areas related to IR4.0 readiness, enterprises had the highest readiness level for "Smart Operations", followed by "Employees" capabilities, "Strategy and Organization", "Smart Factory", "Data-driven Services" and, finally, "Smart Products" as the area with the lowest readiness level.
- The scale, ownership and nature of industry made a significant difference to IR4.0 readiness levels. In particular, the larger the size of the enterprise, the higher the rate of participation in IR4.0. SOEs, with higher levels of capital equipment, scale, level of technological capabilities, concentration of manufacturing subsectors, level of technology usage compared to foreign-invested enterprises and non-State enterprises, have a pioneering role in terms of readiness level to participate in IR4.0.
- Of the 17 priority subsectors, oil and gas and the electronics products had the highest IR4.0 readiness levels, followed by electricity-gas-water, motor vehicles and chemicals. The mechanical engineering, textiles, leather and footwear subsectors had the lowest readiness levels. The percentage of enterprises applying advanced technologies is still very low.
- About four-in-five surveyed enterprises did not have plans to make significant adjustments in the context of IR4.0, with more than one-third admitted they were not even cognizant of this game-changing trend. One-fifth of enterprises planned to change investment options in equipment, plant and IT. With these change alternatives, more than half of enterprises were confident they could respond to change and only less than 30% needed support.

### 5.2. POLICY IMPLICATIONS

The findings of this study should be placed and considered in the overall context of some key economic characteristics of Viet Nam, including: (i) the private sector remains relatively small and undeveloped, (ii) micro, small and medium-sized enterprises make up a very high and growing proportion in the economy<sup>29</sup>, (iii) a large share (more than 70%) of employees work in the informal

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<sup>29</sup> According to data from the Viet Nam Enterprise Census (UNDP-VASS study on productivity and competition - forthcoming): among registered enterprises (formal sector): 65.4% of enterprises had less than 10 employees, 19.3% had 10-24 employees, 7.1% had 25-49 employees, 6.7% had 50-299 employees, 1.1% had 300-999 employees and only 0.4% had more than 1,000 employees. Despite the significant increase in the number of newly registered enterprises, the number of employees as well as total capital in 2007-2015 (VCCI, 2016), the proportion of small and micro enterprises rapidly increased, while the share of medium-sized and large enterprises fell. The average number of employees in medium-sized and small enterprises in Viet Nam decreased from 126 and 76 in 2006 to approximately 35 and 26 in 2015, respectively, and the capital of micro and small enterprises accounted for a large proportion, up to 80% of total capital of formal enterprises by 2014.

sector and (iv) the industrial base is developing, yet labour productivity is low<sup>30</sup> as it moves from low productivity sectors (such as agriculture) to services and industry to increase labour productivity, contributions of intra-industry productivity growth to overall productivity gains remain modest<sup>31</sup> and the added value and competitiveness of enterprises are not high<sup>32</sup>. On the other hand, although SMEs are the driving force behind economic development in Viet Nam - contributing 40% of GDP and accounting for more than 20% of total export value (Yoshino, Naoyuki et al., 2015), a recent study by the Japan External Trade Organization (JETRO, 2017) found that SMEs in Viet Nam faced a number of barriers, with four major obstacles: (i) lack of capability to access financial resources, (ii) limited participation in domestic and international value chains, (iii) ineffective government support and (iv) limited business capacity. In addition, business investment in technology innovation and government spending on science, research and development (0.2% of GDP per annum from 2011-2015 - source: *Financial assessment for development in Viet Nam - UNDP 2018, forthcoming*) is modest.

The findings of this study on the correlation between labour force sizes, levels of concentration, capital sizes, current technology levels and IR4.0 readiness levels of firms were relatively similar to those found in the (forthcoming) study by UNDP and VASS on productivity and competitiveness of Vietnamese enterprises. The latter study also illustrated the close relationship between labour productivity, value added, market share as well as labour force and capital sizes, indicating the very low capability of SMEs, especially small and micro, to invest in technology innovation, human resources training, research and deployment as well as networking with other enterprises in the value chain.

The important policy implications of such findings are: *efforts to enhance the readiness level of enterprises for IR4.0 must be an inseparable part of industry policy and development of domestic enterprises, reforms of SOEs and FDI attraction.*

Effort is required to help *all domestic enterprises of different types of ownership* (particularly medium-sized, small and micro enterprises) grow in scale, levels of capital equipment, increase the concentration index and apply advanced technologies, improve R&D capabilities and conduct skills training for workers. These factors are not only decisive for enterprises to develop, improve productivity and competitiveness, but also to enhance readiness levels for IR4.0 (determinants of competitiveness and productivity of business in the future). Priority must be given to multi-disciplinary solutions, the "whole of government" approach (cross-sectoral), to build a "innovative network" with participation from all stakeholders (government, enterprises, social organizations and investors) in applying IR4.0 technologies, with high spillover effects. This is essential to support the important goals of industrial development, labour productivity and competitiveness, as well as the competitiveness and connectivity of Vietnamese enterprises in domestic and global value

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<sup>30</sup> In 2016, labour productivity in the surveyed subsectors: garments and footwear (nearly VND 82 million and VND 87 million) and metals reached more than VND 2 billion. The average for the remainder (except for oil and gas as well as electricity-gas-water) was VND 372 million.

<sup>31</sup> Source: Viet Nam Human Development Report 2015, UNDP's Productivity and Competitiveness Study (forthcoming).

<sup>32</sup> Textile, leather and footwear and metals have a share of value added on revenue of 45%-52%, rubber and plastics (36%). In the remaining subsectors these shares only ranged from 16%-30%. Except for textiles, electronics and metal-based products have RCA > 1, RCA of all the remaining industries is <1. (source: *Enterprise Census 2017*).

chains. Successful experiences of other countries should be examined and applied in Viet Nam (see Box 5-1).

#### BOX 5-1: INTERNATIONAL EXPERIENCES IN BUSINESS DEVELOPMENT AND IMPROVEMENTS IN READINESS LEVELS FOR IR4.0

*India's e-identity programme:* The Government of India, in partnership with the private sector, developed and implemented an e-identity programme through which citizens' fingerprints are digitalized, which not only serves citizen management work and provision of administrative services, but is also applied for transactions in banking, tax and social security related services. Tax policies (such as tax deductible if taxpayers are linked via e-tax and e-identity and unipay) are linked to the State support policy for making social insurance contributions through use of an e-identity system. This contributed to the rapid increase in the number of formal sector enterprises (defined as having a tax code/tax payment, a labour contract, and social insurance contributions for employees), and has helped create a level playing field: competing for efficiency (not about tax evasion), increasing coverage of social insurance and hence the resilience of the economy/society (source: Santosh Mehrotra - Indian expert and IR4.0 Summit panelist).

*E-commerce and e-payment development in China:* Alibaba is known not only as the largest e-commerce site in the world, it also supports Chinese enterprises in reaching out to customers and partners all over the world and contributes to participation of Chinese (including small and medium-sized) enterprises in domestic and global value chains. Developing e-payments - such as using QR codes - on a large scale and everywhere in China (also with the major role of Alibaba) does not only help develop e-commerce, it supports the banking system to develop its customer base, enabling enterprises (including small and micro enterprises) to improve the efficiency and access to services of the formal banking system. Note: the applications by governments of e-payments for social security, pension and other government payments will help not only improve transparency and efficiency (reducing administrative costs), but also the banking system increase its customer base, helping the vulnerable (unbanked) groups, especially the poor, women and small/micro enterprises, access the banking system and official capital sources, and creating demand for IT enterprises/e-payment/e-banking solutions to develop (source: UNCDF: Financial inclusion notes).

*Non-profit research and consulting organizations (e.g., Fraunhofer) of Germany in supporting enterprises (especially SMEs) in renovation and innovation:* Fraunhofer, established in 1949, plays a central role in promoting the strengths of German SMEs in global markets. The Fraunhofer Research Institute is dedicated to providing results of direct applications of R&D to support small and medium-sized enterprises in Germany. Fraunhofer's research offices regularly work with companies on short-term projects, in order to improve production processes or to improve the quality and features of products, so they remain competitive in the global manufacturing and processing industry. (source: "Differentials in market constraints and value addition among micro, small, and medium enterprises in Viet Nam" (WIDER Working Paper March 2017).

For SOEs, due to the current status/starting point, there are a number of advantages (size of labour force, capital, technology capability, level of concentration), greater than for other types of ownership to increase readiness levels (as well as labour productivity and competitiveness). Therefore, reform of SOEs must focus<sup>33</sup> on: (i) application of IR4.0 technologies to promote these relative strengths, improve determinants of readiness levels for IR4.0, labour productivity and competitiveness of these enterprises and (ii) create linkages between SOEs and enterprises with other types of ownership, especially domestic private enterprises with limited size and low capacity

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<sup>33</sup> Instead of setting the focus on equitization of SOEs (changing ownership form from SOEs to private): The analyses of this study have shown that "ownership" does not have a statistically significant effect on the readiness level of enterprises for IR4.0, but other determinants such as size of labour force and capital, concentration level, nature of a subsector and technology capabilities.

to increase spillover effects, to enhance the ability of SOEs to lead improvements in sector's readiness level for IR4.0.

Similarly, efforts to develop SMEs in the country should prioritize the application of Industry 4.0 technologies to improve the key factors: size, level of capital equipment, concentration index and application of the high technology, R&D capability and skills training for employees, increased connectivity and spillover effects, rather than focusing on volume growth.

It is necessary to shift focus in attracting FDI from quantity to quality, by gradually applying: (i) international technology standards to attract FDI, (ii) requirements for "local components" and linkages with technology transfers to domestic companies, (iii) more stringent standards on efficient energy use and environmental safety and (iv) strengthening institutional capacity and more rigorous review systems, thorough appraisals and approvals of FDI projects to ensure compliance with such standards. In addition, measures to encourage, attract FDI by tax reductions/extensions and granting of other privileges (by central and local governments) must be phased out. Instead, efforts should be made to improve the business environment, infrastructure, utilities and trained labour supply - basic factors for investors to make decisions whether to invest or not - as key instruments to attract quality FDI (*source: Financial Assessment for Development in Viet Nam and productivity and competitiveness - UNDP 2018, forthcoming*).

To increase the IR4.0 readiness of Viet Nam's industry sector, the study found that while the readiness score for the *Strategy and Organization* pillar of the entire sector and each industry was low, many enterprises were formulating a strategy to restructure labour forces, standardize techniques throughout the production chain and linkages, governance in some units and adoption of some ERP and management models, SCM and enhance the collection and exchanges of information on production processes and products. The research team recommends the industry sector, two-digit subsectors and enterprises upgrade existing strategies to a IR4.0 strategy for the sector and enterprises, to elevate connections in some units to connections of all activities in all units. In addition, support for investment in technology innovation should be prioritized (upgrades, application of technologies with high spillover effects, relatively simple and low costs, such as applying cloud technology, digitalization).

In respect to the *Smart Products* pillar, enterprises must focus on equipping the manufacturing process and especially products (suitable for integrating IT for product data) with IT features to collect and analyze data gathered to optimize the manufacturing process and product development, sales and after-sales supports.

In the area of *Smart Factory* pillar, enterprises at "outsider" or "beginner" levels must collect and process data to increase efficiency in planning and monitoring, with adjustments and optimization of enterprises' production and business processes. At the same time, it is necessary to apply solutions to connect infrastructure, machinery and equipment with IT systems to automate procedures to fine-tune processes in a timely and flexible manner.

Regarding the *Data-driven Services* pillar, enterprises at "outsider" or "beginner" levels must implement data-driven services or integrate them to improve benefits to customers. The group of "experienced" enterprises should digitize integration of services with benefits to customers.

For areas where enterprises have attained higher readiness levels, such as the *Smart Operations* and *Employees* pillars, improvements at a higher level can help increase the readiness

level for these areas. In *Smart Operations*, enterprises should foster integrating of systems with outside and automated control procedures.

The readiness level for *Employees* will be improved if enterprises place due emphasis on equipping employees with necessary skills for aspects related to access to IR4.0, achieved not only by the efforts of each enterprise - but also implemented through linkages with "*top performer*" companies ("*top performer*" companies may assign experts to deliver support or provide internships and practice opportunities for enterprises at lower readiness levels), and with government support (organization of joint trainings, standard setting, lesson plans) at the sector and each industry levels.

However, it should be noted that: (i) the readiness level to connect equipment with devices/systems/products can only be improved with investments for renovation in 47% of enterprises in the sector, requiring large investment that usually entail high risks, (ii) not all enterprises would need to meet all requirements for IR4.0, as it would depend on IR4.0's impact on production and business processes and enterprise determination of the appropriate level of participation in each particular field and/or companies selecting advanced technologies with low costs and wide applicability, such as cloud technology<sup>34</sup>. To arrive at such a selection, as proposed by international experts in the Forum IR4.0 organized by the Central Economic Commission and the Government of Viet Nam in July 2018, there should be further studies on the challenges, impacts and opportunities for each industry/enterprise to be used as the basis for formulation of action plans for each industry/enterprise and sector/government policy to help enterprises and subsectors minimize negative impacts, leverage opportunities and meet challenges brought about by IR4.0, to grow faster and more sustainably.

Finally, "measures" and their use to assess readiness levels (pillars, dimensions of each pillar, weights and scoring methods) applied in the VDMA method for this study need to be "calibrated" in future surveys/research. The pillars and dimensions of each pillar and questionnaires should be developed through several rounds of consultations with experts and enterprises of different subsectors, with weights developed based on evidence-based studies. Since IR4.0 impacts all sectors and many fields, meeting IR4.0 requirements necessitates increased linkages between sectors. Future surveys/evaluations should be conducted for enterprises in all sectors (not only the industry sector).

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<sup>34</sup> For enterprises at "*beginner*" level and above, there should be a mechanism to encourage the application of pilot models to develop and implement a linkage strategy, management of the product value chain. For enterprises at "*intermediate*" level and above, it is necessary to consider the development and deployment of IoT technology.



## APPENDIX 1: VDMA SCORING METHOD

The model offers six levels of IR4.0 deployment.

The six levels describing the readiness levels of an enterprise are detailed as follows:

### **Readiness level 0:** *Outsider Group*

Enterprises at this level do not meet any criterion of IR4.0. Readiness level 0 is also automatically classified for enterprises that say they are unclear about IR4.0, or it does not make sense for the business.

### **Readiness level 1:** *Beginner Group*

Enterprises at this level have participated in IR4.0 through pilot programmes deployed in some sections and invested in a certain field. Only a part of the production process has applied IT system, and the current infrastructure and equipment only partially meet the requirements of integration and exchange of information in the future. Internal and homogeneous information sharing is only deployed in certain areas. IT security solutions are still in the research or pilot for deployment phase. In the manufacturing environment, enterprises in this group are producing products with first steps towards additional functions based on IT platform. The capacities required to replicate IR4.0 is only recognized in some areas of the enterprise.

### **Readiness level 2:** *Intermediate Group*

Enterprises in the *Intermediate* group have integrated IR4.0 into the strategic orientation of the enterprise. Enterprises are studying to develop a strategy for implementing IR4.0 and suitable indicators to assess the level of deployment. Enterprises have invested in IR4.0 in certain areas. Some parts of the production data have been collected automatically and used in certain scopes. The condition of the machinery and equipment infrastructure does not yet meet the requirements of future development. To some extent, internal information sharing has been incorporated into the system, and enterprises have also step by step deployed sharing of information with external partners. A number of appropriate integrated security solutions have also been in part deployed. In this manufacturing environment, enterprises are operating based on some of the added features based on IT platform. In some areas, employees adequately have the necessary skills to develop the IR4.0.

### **Readiness level 3:** *Experienced Group*

Firms in this group have formed an IR4.0. The enterprise has been implementing some investment categories in the field of IR4.0 and continue to accelerate the deployment of IR4.0 through the management innovation of each department of enterprise. IT systems in production are tied to interfaces and support production process, with data in some fields collected automatically. Infrastructure, equipment and machinery can be upgraded to meet future development needs. The sharing of information is implemented internally and with partners that have been integrated into the system. The necessary network security solutions have been deployed. Measures based on cloud computing are also being studied for business development purposes. In this environment, enterprises are producing products with many additional interoperability features based on IT platform. These products create the premise for the first basic *data-driven services*, but the business still does not really connect with its customers. New data-driven services account for just a very small share of total revenue. The company has worked hard to develop the skills of the employees to achieve the set goals.

#### **Readiness level 4: *Expert* Group**

Enterprises in the *Expert* group have deployed the IR4.0 strategy and monitored the roadmap with suitable sets of indicators. Enterprises have also invested in most of the priority categories, and this process is supported by innovative management methods throughout the units. IT systems support most stages of production and collect a large amount of information and data, which are then used to optimize processes. Enterprises can continue to expand and develop, as equipment and machinery adequately meet the integration criteria of the future. Information sharing within and with external business partners has largely been integrated into the system. Network security solutions have been deployed in priority areas, and IT has been developed based on solutions using cloud computing technology. Enterprises in the expert group are beginning to explore some of the self-operating and self-regulating procedures in the production process. Production stages and final products are built based on the enhanced features of IT, enabling data collection and in-depth analysis in the usage phases. This facilitates *data-driven services* that customers have started using, and the percentage of revenue from these types of services constitutes a small portion of total revenues. The data-driven services also have live connections features between customers and manufacturers. In a number of priority categories, the business has the necessary in-house skills to achieve this level of development and continue to further develop IR4.0.

#### **Readiness Level 5: *Top Performer* Group**

Enterprises in this group have deployed the IR4.0 strategy and regularly monitored the deployment progress of other projects. This is supported by investments in various parts of the business. The enterprise has established a method of managing innovation at a full scale. The enterprise has implemented an IT support system for the whole production process, and the collection of important information and data has now been automated. Machinery and equipment meet all requirements for the unification and integration of information throughout the system. This leads to system-wide information being shared internally and with external partners. Comprehensive IT security solutions have also been deployed, and the cloud computing technology based solutions allow for a flexible IT architecture design. Some manufacturing fields have deployed autonomous operations and processing stages. The stages and products are integrated with many IT features, and data and information collected in this way during the usage phase are used in various stages such as product development, remote maintenance, and sales support. *Data-driven services* for customers account for a significant share of revenues. The producer is integrated with the customer. The enterprise has the necessary in-house expertise in all critical areas and can continue to develop further with IR4.0.

The six readiness levels can be grouped into three types of company, which makes it possible to better summarize the results. This grouping also makes it easier to draw conclusions about progress and conditions relating to the implementation of IR4.0 and identify specific action items based on the level of implementation (Figure 2-2):

- Newcomers group (readiness levels 0 and 1): The Newcomers group includes those companies that have done either nothing or very little to deal with IR4.0 and are therefore assigned to levels 0 or 1 in the readiness level measurement.
- Learners group (readiness level 2): The Learners group is for companies that are at level 2 and have thus already taken their first steps in implementing IR4.0.
- Leaders group (readiness level 3 and up): The Leaders group includes companies that have reached at least level 3 in the readiness level measurement model. They are already well on the way to implementing IR4.0 and are therefore far ahead of most companies in Germany's mechanical engineering industry. They represent the benchmark group.

Each enterprise is ranked with a readiness level in each dimension based on the lowest score in any single field within the given dimension: If under *Smart Operations*, for example, an enterprise reaches level 5 in three fields and level 1 in one field, the readiness level for this dimension is 1. The six *dimension-level readiness scores* are then consolidated through a weighted average to produce a *total readiness score*. The formula for weighting the dimension scores was determined in the survey by asking the firms to assess the relative importance of each dimension in the implementation of IR4.0. From a total of 100 possible points, the dimensions are weighted as follows: *Strategy and organization* – 25; *Smart factory* – 14; *Smart products* – 19; *Data-driven services* – 14; *Smart operations* – 10; and *Employees* – 18. These calculations were used to assign every enterprise a readiness level of 0 to 5.

### Actual calculations

To measure readiness level, the study has defined criteria to be satisfied with for each area. These criteria have to be met by an enterprise so as to move up to the next readiness level. Some companies do not provide all the necessary information on the important, relevant criteria, leading to three possible scenarios, which can be illustrated using the following an example in Table PL1-1 as follows:

**TABLE PL1- 1: EXAMPLE OF CALCULATION PERFORMED ON SIX AREAS**

	Satisfaction of one or more criteria ...						Result
	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	
<b>A</b>	Yes	Yes	No	No	No	No	Level 1
<b>B</b>	Yes	Missing values	Yes	No	No	No	Level 2
<b>C</b>	Yes	Missing values	No	No	No	No	Level 0

- In scenario A, the enterprise has provided the necessary information and meets the criteria for readiness level 1. The criteria for readiness levels 2 to 5 have not been met. The enterprise is therefore assigned to readiness level 1.
- In scenario B, it is not possible to determine whether the criteria for level 1 have been met, since the enterprise did not provide any information on the corresponding indicators (missing values). Since the criteria to reach level 2 have been met, however, the missing values from level 1 are interpreted as meeting the criteria for level 1. The enterprise is therefore assigned to readiness level 2.
- In scenario C, no information is available to determine whether the criteria for level 1 have been met. Since the criteria for level 2 have not been met, the missing values for level 1 are interpreted as not meeting the criteria. The enterprise is therefore assigned to readiness level 0.

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**QUESTIONNAIRE FOR ENTERPRISE SURVEY**  
**On the Impact and Readiness Level for the**  
**Fourth Industrial Revolution, Industry and Trade Sector**

**A. GENERAL INFORMATION**

A.1	Enterprise's name*				
A.2	Address*				
A.3	Year established		Tax Identification Number		
A.4	No. of Employees	<input type="checkbox"/> > 300	<input type="checkbox"/> 200 - 300 employees	<input type="checkbox"/> 10 - 200 employees	<input type="checkbox"/> ≤ 10 employees
A.5	Capital size	<input type="checkbox"/> > 100 billion	<input type="checkbox"/> 20 - 100 billion	<input type="checkbox"/> ≤ 20 billion	
A.6	Telephone		Email		Website
A.7	Industry of operation	<input type="checkbox"/> Oil & gas extraction	<input type="checkbox"/> Manufacture of food products	<input type="checkbox"/> Manufacture of beverages	<input type="checkbox"/> Leather - Footwear
		<input type="checkbox"/> Textile	<input type="checkbox"/> Garment	<input type="checkbox"/> Paper and paper products	<input type="checkbox"/> Chemicals and chemical products
		<input type="checkbox"/> Rubber, plastics	<input type="checkbox"/> Metal Manufacturing	<input type="checkbox"/> Metal Product Manufacturing	<input type="checkbox"/> Electrical equipment
		<input type="checkbox"/> Machinery and equipment	<input type="checkbox"/> Ships, boats, trains	<input type="checkbox"/> Manufacture of motor vehicles	<input type="checkbox"/> SP electronics, informatics
		<input type="checkbox"/> Electricity, gas, water	<input type="checkbox"/> Other (specify)		
	Main product*				
A.8	Business type	<input type="checkbox"/> Manufacturing	<input type="checkbox"/> Trade	<input type="checkbox"/> Import and Export	<input type="checkbox"/> Other
A.9	Type according to capital	<input type="checkbox"/> State-owned, State-invested capital ratio (%)			

		<input type="checkbox"/> Non-state	<input type="checkbox"/> Private	<input type="checkbox"/> Partnerships	<input type="checkbox"/> Limited liability
			<input type="checkbox"/> Joint stock company with state-invested capital	<input type="checkbox"/> Joint stock company with no state-invested capital	
		<input type="checkbox"/> Foreign-invested capital	<input type="checkbox"/> 100% foreign-invested capital		<input type="checkbox"/> Joint venture
A.10	Main activities	<input type="checkbox"/> Design, research and development		<input type="checkbox"/> Raw material supply	
		<input type="checkbox"/> Supplying semi-finished products, supporting industry		<input type="checkbox"/> Outsourcing, processing, producing industrial products	
		<input type="checkbox"/> Industrial products distribution and trading services		<input type="checkbox"/> Industrial products distribution and trading	

#### B. STRATEGY AND ORGANIZATIONS RELATED TO I4.0

*I4.0 improves not only the current products or processes through digital technologies, but I4.0 also opens up the opportunity to develop new overall business models*

B. STRATEGY AND ORGANIZATION	<b>Strategy Implementation</b> (scoring as per numerical order of selected cells)		<b>B.1 How does the enterprise describe the degree of formulation and implementation of its I4.0 strategy?</b>		
	Degree of I4.0 strategy implementation		<input type="checkbox"/> 0 No strategy	<input type="checkbox"/> 1 Having a trial initiative	<input type="checkbox"/> 2 Being formulated
			<input type="checkbox"/> 3 Having been formed	<input type="checkbox"/> 4 Being implemented	<input type="checkbox"/> 5 Completed
	<b>Set of Assessment Indicators</b> (scoring as per numerical order of selected cells)		<b>Availability of performance assessment indicators</b>		
			<input type="checkbox"/> 5 Full set of indicators	<input type="checkbox"/> 4 Set of oriented indicators	<input type="checkbox"/> 1 Not available
	<b>B.2 What policies does the enterprise have for the following activities?</b>				
	Connecting, managing operations of product value chain	<input type="checkbox"/> Issued	<input type="checkbox"/> Being formulated	<input type="checkbox"/> Not available	<input type="checkbox"/> Irrelevant
	Connecting, managing all activities in enterprise's divisions	<input type="checkbox"/> Issued	<input type="checkbox"/> Being formulated	<input type="checkbox"/> Not available	<input type="checkbox"/> Irrelevant
	Applications of the Internet of Things (IOT) technology	<input type="checkbox"/> Issued	<input type="checkbox"/> Being formulated	<input type="checkbox"/> Not available	<input type="checkbox"/> Irrelevant
	Standardization of production techniques for the entire product chain	<input type="checkbox"/> Issued	<input type="checkbox"/> Being formulated	<input type="checkbox"/> Not available	<input type="checkbox"/> Irrelevant
	Building new structure of the labor force	<input type="checkbox"/> Issued	<input type="checkbox"/> Being formulated	<input type="checkbox"/> Not available	<input type="checkbox"/> Irrelevant
	<b>B.3 Which of the following technologies is the enterprise applying?</b>				
	Artificial intelligence (advanced robotics, self-driving vehicles)	<input type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant

Analytics and management of big data	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant
Cloud technology	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant
Connecting equipment with equipment / products	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant
Additive manufacturing technology (3D printing)	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant
Sensor technology	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant
Mobile terminals	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant
Radio frequency identification (RFID)	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant
Real-time positioning	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant
Embedded IT systems	<input checked="" type="checkbox"/> Being applied	<input type="checkbox"/> Will be applied	<input type="checkbox"/> No plan to apply	<input type="checkbox"/> Irrelevant

**B.4** What was the estimated investment level of the enterprise for application and technology innovation following the I4.0 trends in the past 2 years?

Investment in research and development	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/>
Investment in production / processing / manufacturing	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment
Investment for procurement	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment
Investment in logistics	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment
Investment for sales	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment
Investment for services	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment
Investment in information technology	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment

**B.5** What is the estimated investment level of the enterprise for application and technology innovation following the I4.0 trends in the next 5 years?

Investment in research and development	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment
Investment in production / processing / manufacturing	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment
Investment for procurement	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment

	Investment in logistics	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment	
	Investment for sales	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment	
	Investment for services	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment	
	Investment in information technology	<input type="checkbox"/> > 10 billion	<input type="checkbox"/> 1 - 10 billion	<input type="checkbox"/> < 1 billion	<input type="checkbox"/> No investment	
<b>Innovation management</b>	<b>B.6</b> In which areas has the enterprise systematically implemented management of innovation and technology?					
2 - Select cell 6 3 - Select any cell except cell 6 4 - Select 3 cells except cell 6 5 - Select all cells except cell 6	<input type="checkbox"/> 1 Information Technology <input type="checkbox"/> 2 Production technology <input type="checkbox"/> 3 Product development					
	<input type="checkbox"/> 4 Service <input type="checkbox"/> 5 Overall management <input type="checkbox"/> 6 No area identified					
<b>C. SMART FACTORY</b> <i>Smart factory is a working environment where production / processing / manufacturing processes and administrative support processes are proactively organized without much human involvement. The Smart factory is based on the connections of Cyber - Physical Systems (CPS) by exchanging information through the global Internet of Things (IoT) technology systems. Smart factory is engaged in the data management model, encompassing smart data collection, storage and processing. The Smart factory model ensures data is transmitted and resources are used more efficiently, requiring continuous data collection and coordination across the entire enterprise from production to information and people.</i>						
<b>C. SMART FACTORY</b>	<b>Machinery, equipment, infrastructure (existing)</b>	<b>C.1</b> What features are included in the equipment currently in use?				
		Enabling control through information technology	<input type="checkbox"/> 1 Completely feasible	<input type="checkbox"/> 2 Partially feasible	<input type="checkbox"/> 3 Completely not feasible	
		Enabling connection, communication between equipment and equipment	<input type="checkbox"/> 1 Completely feasible	<input type="checkbox"/> 2 Partially feasible	<input type="checkbox"/> 3 Completely not feasible	
		Enabling integration and coordination with other systems	<input type="checkbox"/> 1 Completely feasible	<input type="checkbox"/> 2 Partially feasible	<input type="checkbox"/> 3 Completely not feasible	
	0 - Select 3 for all 3 lines 1 - Select 2 for 1 of 3 lines 2 - Select 2 for all 3 lines 3 - Select 1 for line 1, 2 for line 2, and 3 for line 3 4 - Select 1 for line 1, 2 for line 2, and 2 for line 3 5 - Select 1 for all 3 lines					
	<b>Machinery, equipment, infrastructure (planned)</b>	<b>C.2</b> What is the level of response of the equipment currently in use to the following requirements below?				
		Requirement for connection, communication between equipment and equipment	<input type="checkbox"/> 1 Features included	<input type="checkbox"/> 2 Need to upgrade	<input type="checkbox"/> 3 Non-upgradable	<input type="checkbox"/> 4 Irrelevant
		Requirement for integration, coordination with other systems	<input type="checkbox"/> 1 Features included	<input type="checkbox"/> 2 Need to upgrade	<input type="checkbox"/> 3 Non-upgradable	<input type="checkbox"/> 4 Irrelevant
	0 - Select 4 for both lines 1 - Select 3 for both lines 2 - Select 2 for 1 line and 3 for the remaining line 3 - Select 2 for both lines 4 - Select 1 for 1 line and 2 for the remaining line 5 - Select 1 for both lines					
	<b>Data collection</b>	<b>C.3</b> What data does the enterprise collect in the process of production / processing / manufacturing?				
	Current operating status of the equipment	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected		
	Mobilized capacity of the equipment	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected		
	Overall Equipment Effectiveness (OEE)	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected		
1 - Select 3 for all lines 2 - Select 2 for any 11-12 lines and 3 for the remaining 1-2 lines 3 - Select 1 for any 2-3 lines and 2 for the remaining 10-11 lines 4 - Select 1 for 4-6 lines and 2 for the remaining 7-9 lines 5 - Select 1 for all lines						



Volume of raw materials, products in inventory	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
Location of raw materials, fuel, products	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
Production output over time	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
Product quantity being completed	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
Product defects	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
Waste generated	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
Transition time between stages, divisions	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
Use of labor	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
Other parameters (specify)	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected
C.3.3 Collection method of other data	<input type="checkbox"/> 1 Online collection	<input type="checkbox"/> 2 Manual collection	<input type="checkbox"/> 3 Not collected

#### Use of data

- 1 - Do not select any purpose  
2 - Select only any 2 cells  
3 - Select any 3-4 cells  
4 - Select Yes for any 5 items and No for the remaining item  
5 - Select Yes for all purposes

#### C.4 What purposes does the enterprise use the data collected for?

- ☐ 1 Maintenance of equipment ☐ 2 Process optimization ☐ 3 Information transparency  
☐ 4 Quality management ☐ 5 Resource optimization ☐ 6 Automated control  
☐ In Google only option box ☐ Other purposes (specify)

#### IT system

- 0 - Select 2 for all lines of Section A  
1 - Select 1 for any line in Section A, and 2 for all remaining lines in Sections A and B  
2 - Select 1 for any 2-3 lines in Section A, and 2 for all lines of in Sections A and B  
3 - Select 1 for any 2-3 lines in Section A and corresponding line in Section B, and 2 for all remaining lines (Sections A and B)  
4 - Select 1 for all lines in Section A and 2 for all lines in Section B  
5 - Select 1 for all lines in Section A and Section B

#### C.5 Which of the following systems is the enterprise using?

Surveyed Systems	A. Use		B. Interface of the leading system	
MES - Manufacturing Execution System	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No
ERP - Enterprise Resource Planning	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No
PLM - Product Lifecycle Management	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No
PDM - Product Data Management	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No
PPS - Production Planning System	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No

	PDA - Production Data Collection	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No
	MDC - Machine Data Collection	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No
	CAD - Computer Aided Design	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No
	SCM - Supply Chain Management	<input type="checkbox"/> 1 Yes	<input type="checkbox"/> 2 No	<input type="checkbox"/> 3 Yes	<input type="checkbox"/> 4 No

D. SMART OPERATIONS

*Signs demonstrating the implementation of I4.0 are the vertical and horizontal integration of the cyber - physical systems across the entire enterprise. Digitalization and the sufficient availability or redundancy of the data will enable the implementation of new forms and approaches for Production Planning System (PPS) and Supply Chain Management (SCM).*

**D.1 What information is the enterprise sharing with the stakeholders?**

**Sharing information**

0 - Select 2 for all lines in Section A

1 - Select 1 for any line and 2 for all remaining lines in Section A, and 2 for all lines in Section B

2 - Select 1 for any 2-3 lines and 2 for all remaining lines in Section A, and 2 for all lines in Section B

3 - Select 1 for any 4-5 lines and 2 for all remaining lines in Section A, and 1 for any line and 2 for all remaining lines in Section B

4 - Select 1 for any 6-7 lines and 2 for all remaining lines in Section A, and 1 for any 2-3 lines and 2 for all remaining lines in Section B

5 - Select 1 for all the remaining lines in Section A, and 1 for any 4-5 lines and 2 for all remaining lines in Section B

**Type of information**

**A. Internal sharing (with enterprise's divisions)**

**B. External sharing (with customers / partners)**

Information on research and development

Information on the process of production / processing / manufacturing

Information on orders

Information on logistics operations

Information about sales

Information on financial management / accounting

Information about the operations and results of services

Information on the application of information technology

☐ 1 Yes

☐ 2 No

☐ 1 Yes

☐ 2 No

☐ 1 Yes

☐ 2 No

☐ 1 Yes

☐ 2 No

☐ 1 Yes

☐ 2 No

☐ 1 Yes

☐ 2 No

☐ 1 Yes

☐ 2 No

☐ 1 Yes

☐ 2 No

**Automated process**

3 - Select 4 for all lines

4 - Select 3 for all lines

5 - Select 1 or 2 for all lines

**D.2 What is the level of automation in the enterprise at the present?**

**Autonomous governance**

**Autonomous operations responding to changes**

☐ 1 Enterprise-wide

☐ 2 Some areas

☐ 3 Examination, testing

☐ 4 None / not applicable

☐ 1 Enterprise-wide

☐ 2 Some areas

☐ 3 Examination, testing

☐ 4 None / not applicable

**D.3 Does the enterprise have an IT department and how is it organized?**

☐ Expert(s) available for each division

☐ IT department established for each division

		<input type="checkbox"/> IT department established for the entire enterprise	<input type="checkbox"/> No IT department established (outsourced)			
<b>IT Security</b> 0 - Select 4 for all lines 1 - Select 3 for any 1-2 lines, and 4 for all remaining lines 2 - Select 2 for any 1-2 lines, and 3 for all remaining lines 3 - Select 1 for any 1-2 lines, and 2 or 3 for remaining lines 4 - Select 1 for 3-4 lines, and 2 for remaining lines 5 - Select 1 for all lines	<b>D.4 How are the information security solutions deployed in the enterprise?</b>					
	Data storage security	<input type="checkbox"/> 1 Implemented	<input type="checkbox"/> 2 Being developed	<input type="checkbox"/> 3 Will be implemented	<input type="checkbox"/> 4 Irrelevant	
	Data security through cloud services	<input type="checkbox"/> 1 Implemented	<input type="checkbox"/> 2 Being developed	<input type="checkbox"/> 3 Will be implemented	<input type="checkbox"/> 4 Irrelevant	
	Data storage security	<input type="checkbox"/> 1 Implemented	<input type="checkbox"/> 2 Being developed	<input type="checkbox"/> 3 Will be implemented	<input type="checkbox"/> 4 Irrelevant	
	Security for data shared internally	<input type="checkbox"/> 1 Implemented	<input type="checkbox"/> 2 Being developed	<input type="checkbox"/> 3 Will be implemented	<input type="checkbox"/> 4 Irrelevant	
	Security for data shared externally with partners	<input type="checkbox"/> 1 Implemented	<input type="checkbox"/> 2 Being developed	<input type="checkbox"/> 3 Will be implemented	<input type="checkbox"/> 4 Irrelevant	
	<b>Using cloud computing technology</b> 0-2 - Select 4 for all lines 3 - Select 2 for line 1, 3 for line 2, and 3 for line 3 4 - Select 1 for line 1, or 2 for line 2, or 2 for line 3, and 3 to 4 for remaining lines 5 - Select 1 for all lines	<b>D.5 Does the enterprise have any activity or use any service related to cloud computing?</b>				
		Using software with cloud platform	<input type="checkbox"/> 1 Have used	<input type="checkbox"/> 2 Will use	<input type="checkbox"/> 3 Do not use	<input type="checkbox"/> 4 Irrelevant
		Using data analytics service	<input type="checkbox"/> 1 Have implemented	<input type="checkbox"/> 2 Are implementing	<input type="checkbox"/> 3 Have a plan to implement	<input type="checkbox"/> 4 Irrelevant
		Using data storage service	<input type="checkbox"/> 1 Have implemented	<input type="checkbox"/> 2 Are developing	<input type="checkbox"/> 3 Will implement	<input type="checkbox"/> 4 Irrelevant
<b>E. SMART PRODUCTS</b> <i>Smart products (SPs) are equipped with information technology components (such as sensors, RFID, communication interfaces, etc.) to collect data on the current state of the environment and the product itself. Only when the product receives information, knows how to go through the production process and exchange information with high-level systems, then the production process can be improved and operate according to real time data continuously. SPs enables monitoring and optimization of the production conditions of each individual product and potential applications beyond the manufacturing process.</i>	<b>E.1 What additional functions of information and communication technology do the enterprise's products have?</b>					
	Product contains memory	<input type="checkbox"/> 1 Included	<input type="checkbox"/> 2 Will be included	<input type="checkbox"/> 3 Not included	<input type="checkbox"/> 4 Irrelevant	
	Product includes self-reporting function	<input type="checkbox"/> 1 Included	<input type="checkbox"/> 2 Will be included	<input type="checkbox"/> 3 Not included	<input type="checkbox"/> 4 Irrelevant	
	Product includes functions integrated with other features	<input type="checkbox"/> 1 Included	<input type="checkbox"/> 2 Will be included	<input type="checkbox"/> 3 Not included	<input type="checkbox"/> 4 Irrelevant	
	Products contains localized functionality	<input type="checkbox"/> 1 Included	<input type="checkbox"/> 2 Will be included	<input type="checkbox"/> 3 Not included	<input type="checkbox"/> 4 Irrelevant	
	Products are integrated with a support system	<input type="checkbox"/> 1 Included	<input type="checkbox"/> 2 Will be included	<input type="checkbox"/> 3 Not included	<input type="checkbox"/> 4 Irrelevant	
	Products includes monitoring function	<input type="checkbox"/> 1 Included	<input type="checkbox"/> 2 Will be included	<input type="checkbox"/> 3 Not included	<input type="checkbox"/> 4 Irrelevant	
	<b>Additional IT features</b> 0 - Select 3 or 4 for all lines 1 - Select 2 for any line and 3 for remaining lines 2 - Select 1 for any line and 2 for remaining lines 3 - Select 1 for any 2-4 lines and 3 for remaining lines 4 - Select 1 for any 5-6 lines and 3 for remaining lines 5 - Select 1 for all lines					

	Product contains information on production process	<input type="checkbox"/> 1 Included	<input type="checkbox"/> 2 Will be included	<input type="checkbox"/> 3 Not included	<input type="checkbox"/> 4 Irrelevant
	Products includes automatic identification function	<input type="checkbox"/> 1 Included	<input type="checkbox"/> 2 Will be included	<input type="checkbox"/> 3 Not included	<input type="checkbox"/> 4 Irrelevant
	Product includes other functions (specify)				

F. DATA-DRIVEN SERVICES	<b>F. DATA-DRIVEN SERVICES</b>				
	<i>Data-driven services help to streamline business models that bring more benefits to customers. Post-sales services will be conducted based on the results of the analysis and assessment of the data collected and the size of the integration of the business. The physical product of the enterprise itself should be equipped with information technology components to be able to receive, send and process data, thereby aiding the operations process. This means that a product will consist of two parts, namely, physical and information technology, and this forms the basis for digital services during the product use phase.</i>				
	Analysis of data during use	F.1 How does the enterprise integrate production data with data during product use / product consumption?			
	0 - Select cell 3 2 - Select cell 2 5 - Select cell 1	Data on product use phase	<input type="checkbox"/> 1 Collected, analyzed	<input type="checkbox"/> 2 Collected, not analyzed	<input type="checkbox"/> 3 Not collected
	Data-driven services	Services integrating data on production and product use	<input type="checkbox"/> 1 Yes, with customers	<input type="checkbox"/> 2 Yes, not with customers	<input type="checkbox"/> 3 No services available

G. EMPLOYEES	<b>G. EMPLOYEES</b>					
	<i>Employees help the enterprise implement digitization process and are the people most affected by this process. The immediate working environment of employees is changed and requires them to acquire new skills and competencies.</i>					
	Employees 0 - Select 3 or 4 for all lines 1 - Select 2 for any line and 3 or 4 for remaining lines 2 - Select 2 for 2-3 lines and 3 or 4 for remaining lines 3 - Select 1 for 2-3 lines and 2 or 3 or 4 for remaining lines 4 - Select 1 for 4-5 lines and 2 or 3 or 4 for remaining lines 5 - Select 1 for all lines	G.1 What skills do employees at the enterprise have?				
		Information technology infrastructure	<input type="checkbox"/> 1 Fully equipped	<input type="checkbox"/> 2 Equipped, not sufficiently	<input type="checkbox"/> 3 Not equipped	<input type="checkbox"/> 4 Irrelevant
		Automation technology	<input type="checkbox"/> 1 Fully equipped	<input type="checkbox"/> 2 Equipped, not sufficiently	<input type="checkbox"/> 3 Not equipped	<input type="checkbox"/> 4 Irrelevant
		Data analytics techniques	<input type="checkbox"/> 1 Fully equipped	<input type="checkbox"/> 2 Equipped, not sufficiently	<input type="checkbox"/> 3 Not equipped	<input type="checkbox"/> 4 Irrelevant
		Techniques for information / communication security	<input type="checkbox"/> 1 Fully equipped	<input type="checkbox"/> 2 Equipped, not sufficiently	<input type="checkbox"/> 3 Not equipped	<input type="checkbox"/> 4 Irrelevant
		Techniques for support system development / application	<input type="checkbox"/> 1 Fully equipped	<input type="checkbox"/> 2 Equipped, not sufficiently	<input type="checkbox"/> 3 Not equipped	<input type="checkbox"/> 4 Irrelevant
		Techniques for collaborative software use	<input type="checkbox"/> 1 Fully equipped	<input type="checkbox"/> 2 Equipped, not sufficiently	<input type="checkbox"/> 3 Not equipped	<input type="checkbox"/> 4 Irrelevant
		Thinking, understanding of the system	<input type="checkbox"/> 1 Fully equipped	<input type="checkbox"/> 2 Equipped, not sufficiently	<input type="checkbox"/> 3 Not equipped	<input type="checkbox"/> 4 Irrelevant

#### H. FORECAST OF THE IMPACTS OF I4.0

##### H.1 What changes in the future does the enterprise forecast?

Impact of I4.0 on the enterprise	<input type="checkbox"/> Do not know what to do	<input type="checkbox"/> Big change will take place	<input type="checkbox"/> Change will be made to adapt	<input type="checkbox"/> Insignificant
Structure of labor force	<input type="checkbox"/> New investment	<input type="checkbox"/> Adjustment	<input type="checkbox"/> No change	<input type="checkbox"/> Do not know
Methods of marketing, sales	<input type="checkbox"/> New investment	<input type="checkbox"/> Adjustment	<input type="checkbox"/> No change	<input type="checkbox"/> Do not know
Internal management methods	<input type="checkbox"/> New investment	<input type="checkbox"/> Adjustment	<input type="checkbox"/> No change	<input type="checkbox"/> Do not know
Partners, customers management methods	<input type="checkbox"/> New investment	<input type="checkbox"/> Adjustment	<input type="checkbox"/> No change	<input type="checkbox"/> Do not know
Equipment, plant	<input type="checkbox"/> New investment	<input type="checkbox"/> Adjustment	<input type="checkbox"/> No change	<input type="checkbox"/> Do not know
Information Technology	<input type="checkbox"/> New investment	<input type="checkbox"/> Adjustment	<input type="checkbox"/> No change	<input type="checkbox"/> Do not know

##### H.2 What change is the most important to the development and existence of the business?

Building new structure of the labor force	<input type="checkbox"/> Very important	<input type="checkbox"/> Important	<input type="checkbox"/> May be needed	<input type="checkbox"/> Do not know
Developing new methods for marketing, sales	<input type="checkbox"/> Very important	<input type="checkbox"/> Important	<input type="checkbox"/> May be needed	<input type="checkbox"/> Do not know
Developing new methods for internal management	<input type="checkbox"/> Very important	<input type="checkbox"/> Important	<input type="checkbox"/> May be needed	<input type="checkbox"/> Do not know
Developing new methods for partners, customers management	<input type="checkbox"/> Very important	<input type="checkbox"/> Important	<input type="checkbox"/> May be needed	<input type="checkbox"/> Do not know
Investment in new equipment, plants	<input type="checkbox"/> Very important	<input type="checkbox"/> Important	<input type="checkbox"/> May be needed	<input type="checkbox"/> Do not know
Investments in new information technologies	<input type="checkbox"/> Very important	<input type="checkbox"/> Important	<input type="checkbox"/> May be needed	<input type="checkbox"/> Do not know

##### H.3 What is the enterprise's capability to meet the above mentioned changes?

Building new structure of the labor force	<input type="checkbox"/> Adequate capacity	<input type="checkbox"/> Need more support	<input type="checkbox"/> Cannot do anything	<input type="checkbox"/> Irrelevant
Developing new methods for marketing, sales	<input type="checkbox"/> Adequate capacity	<input type="checkbox"/> Need more support	<input type="checkbox"/> Cannot do anything	<input type="checkbox"/> Irrelevant
Developing new methods for internal management	<input type="checkbox"/> Adequate capacity	<input type="checkbox"/> Need more support	<input type="checkbox"/> Cannot do anything	<input type="checkbox"/> Irrelevant
Developing new methods for partners, customers management	<input type="checkbox"/> Adequate capacity	<input type="checkbox"/> Need more support	<input type="checkbox"/> Cannot do anything	<input type="checkbox"/> Irrelevant

Investment in new equipment, plants ☐ Adequate capacity ☐ Need more support ☐ Cannot do anything ☐ Irrelevant

Investments in new information technologies ☐ Adequate capacity ☐ Need more support ☐ Cannot do anything ☐ Irrelevant

H.4 *The biggest concern of the enterprise with I4.0 for business operations, sustainability and development*

H.5 *What should the State focus on for implementation to help enterprises respond to I4.0?*

*Information,  
training, and  
investment*

*Policies and  
infrastructure*

**Preparer**

**Enterprise's representative (signed and stamped)**

Name  
Position  
Telephone  
Email  
Province  
Signature

### APPENDIX 3: SAMPLE SELECTION

- **Sample selection strategy:** Stratified random sampling<sup>35</sup> by industry (18 industries, including 17 priority industries of MOIT, and the other industries), and by scale (small enterprise: less than 200 employees; medium-sized enterprise: 200-300 employees; large enterprise: the remaining)<sup>36</sup>.
- **Determination of sample size:**

Sample size needed for an industry to ensure the representativeness of the results for the surveyed industry:  $n = (z^2 * p.q) / (e^2)$ ,

Where:

$n$  = sample size

$z$  = distribution value corresponding to the confidence level selected (if the confidence level is 95%, the  $z$  value is 1.96)

$e$  = permissible error (+-3%; +-4%; +-5%)

$p$  = is the estimate percentage of the overall

$q = 1-p$

With this survey, a large proportion of enterprises do not have access to the technology of IR4.0 and, therefore, to the majority of questions in the questionnaire, the answer will be zero. Therefore, a conservative estimate will be that about 90% of enterprises say "No", i.e.,  $q = 0.9$  and  $p = 0.1$ .

Therefore, if the permissible error is + -5%, and the confidence level is 95% (parameters commonly used in sample selection in the surveys) then

$$n = (1.96^2 * 0.1 * 0.9) / (0.05^2) = 138$$

The sample size of the whole survey including 18 industries is:  $138 * 18 = 2,484$

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<sup>35</sup> Stratifying plays an important role in ensuring the homogeneity of the enterprises in a group, thereby reducing the sampling error (sampling error =  $\frac{\sigma}{\sqrt{n}}$ ), by reducing the numerator. According to this formula, the accuracy of the calculations depends not only on the sample size ( $n$ , i.e., the denominator) but also on the standard deviation (numerator).

<sup>36</sup> This is the size classification according to Viet Nam's regulations. It can be classified by form of ownership. However, if the criterion is added, it will reduce the number in each subgroup, while there is a certain correlation between ownership and size (SOEs and foreign-invested enterprises usually are larger scale enterprises).



With a 20% response rate expected, the sample size will be:  $n_{tt} = 2,484 / 0.2 = 12,420$

Details of the selected sample are given in Table 3.

- **Creating cross-tabulation for grouping (see Table 1): *industry and scale*** (there is the high correlation between scale and ownership). It's arguable that SMEs are mainly in the Industry 2.0<sup>37</sup>; while large enterprises are in the Industry 2.0 - Industry 3.0; a few FDI enterprises and start-ups started to implement Industry 4.0<sup>38</sup>.

The fact that enterprises are at the different technological development stages has important implications for sample selection, just as the questionnaire design does, because if the focus is placed only on the technologies of Industry 4.0, the answer basically is not, since not only in Viet Nam but also in the world only some enterprises in some industries can leapfrog into Industry 4.0 (see Table 2). In this table, the percentage of enterprises in the 32 developed countries actually using the digital technologies of Industry 4.0, such as cloud computing is about 10%, RFID (Radio Frequency Identification Technologies - an important component for connecting M2M objects - machine to machine via the internet) is only about 4%. These figures show that this ratio is much lower in Vietnamese enterprises, especially in domestic ones it's even much lower.

Furthermore, other than "participation in Industry 4.0," the "readiness to participate in Industry 4.0" is essentially the process of creating an ecosystem in which enterprises can cut short the time for moving forward from Industry 2.0 through Industry 3.0 to Industry 4.0.

***FDI enterprises have also been selected*** to conduct surveys because of the spillover ability through demonstration effects, labour turnover as well as forward and backward linkages in the vertical integration<sup>39</sup>.

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<sup>37</sup> It can be generalized that Industry 1.0 is mechanization; Industry 2.0 is electrification and mass production; Industry 3.0 is computer and automation; and Industry 4.0 is digitization at the peak phase based on the three pillars: (i) Internet; (ii) computing; and (iii) sensors, which create a close connection between physical systems and cyber space.

<sup>38</sup> According to some assessments, the majority of Vietnam's industries are in the Industry 2.0 (Source: Grant Thornton, Confederation of Indian Industry, 2017. "India's Readiness for Industry 4.0", p. 16. In short to medium term, only a few highly developed countries can migrate to Industry 4.0, while countries at a lower development level keep continuing to compete on the basis of Industry 2.0 (but need to accelerate the digitization process to quickly move up to Industry 3.0), yet it's very difficult to leapfrog to Industry 4.0 due to the lack of many important components of the ecosystems for Industry 4.0 (Source: World Bank, 2017. "Trouble in the Making?: The Future of Manufacturing-Led Development. Overview Report, p. 18.)

<sup>39</sup> In the Questionnaire of Enterprise Census 2016, there is a section on forward linkages and backward linkages.

**TABLE PL3-1: CLASSIFICATION OF ENTERPRISES BY INDUSTRY AND SIZE OF LABOUR FORCE**

	VSIC2	Enterprise size		Total
		Large	SME	
<b>Priority industries</b>		<b>3,070</b>	<b>49,345</b>	<b>52,415</b>
Oil and gas	06	3	11	14
1.1.1. Food processing	10	380	6,673	7,053
Beverages	11	29	2,201	2,230
Textiles	13	190	2,967	3,157
Garments	14	937	5,432	6,369
Leather and footwear	15	371	1,478	1,849
Paper products	17	60	2,369	2,429
Chemicals	20	74	3,231	3,305
Rubber and plastics	22	206	4,761	4,967
Basic metals	24	55	1,093	1,148
Fabricated metals	25	146	12,502	12,648
Electronic products	26	261	1,114	1,375
Electrical equipment	27	113	1,236	1,349
Machinery and equipment n.e.c	28	33	1,680	1,713
Motor vehicles	29	84	397	481
Other transport equipment	30	73	634	707
Electricity-gas-water	35	55	1,566	1,621
<b>Remaining industries</b>		<b>474</b>	<b>15,234</b>	<b>15,708</b>
<b>Total</b>		<b>3,544</b>	<b>64,579</b>	<b>68,123</b>

\* It was decided to **over-sample** 10 priority industries and large enterprises (because of the small number of such enterprises in Viet Nam). Including the group of medium-sized enterprises and group of small enterprises into the group of SMEs due to the relatively small number of medium-sized enterprises. For priority industries, 150 enterprises were selected, of which 25 were large enterprises (equivalent to 16.7%) and 125 SMEs (equivalent to 83.3%). Particularly for the two industries No.15 and No.26, where the proportion of large enterprises is higher (nearly 20%), 30 large enterprises were selected. For the 15 remaining industries, 500 enterprises were randomly selected, of which 100 were large enterprises (20%) and 400 were SMEs (80%). Selected samples were allocated by industry, size and forms of ownership as follows:

**TABLE PL3-2: SAMPLE DISTRIBUTION BY SUBSECTOR AND SIZE OF LABOUR FORCE**

	VSIC2	Tổng	Phân theo mô DN	
			Lớn	SME
1 <b>Priority industries</b>				
2 Oil and gas	6	15	2	13
3 Food processing	10	918	147	771
4 Beverages	11	781	31	750
5 Textiles	13	910	155	755
6 Garments	14	902	153	749
7 Leather and footwear	15	902	180	722
8 Paper products	17	814	57	757
9 Chemicals	20	830	75	755
10 Rubber and plastics	22	904	145	759
11 Basic metals	24	812	57	755
12 Fabricated metals	25	904	136	768
13 Electronics	26	903	163	740
14 Electrical equipment	27	867	113	754
15 Machinery and equipment n.e.c	28	786	31	755
16 Motor vehicles	29	490	83	407
17 Other transport equipment	30	708	71	637
18 Electricity-gas-water	35	884	124	760
19 <b>Remaining industries</b>		1,514	288	1,226

<b>Total</b>	<b>14,844</b>	<b>2,009</b>	<b>12,835</b>
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**\* Sample weights:**

*For 17 priority industries:*

- Industry with Code 06: Due to the small number of enterprises (only 14 enterprises), all will be selected and weight assigned for each enterprise will be equal to 1.

*For other industries:*

- Large Enterprise: Probability of a large enterprise in industry  $i$  be selected is:  $p_{Li} = a_{Li} / N_{Li}$ , where  $N_{Li}$  is the total number of large firms in industry  $i$ , and  $a_i$  is the total number of large firms in industry  $i$  being selected as a sample ( $a_i = 30$  with  $i = \{15; 26; 29\}$ , and  $a_i = 25$  with the other industries). In turn, the weight assigned to a large business in industry  $i$  is  $W_{Li} = 1 / p_{Li} = N_{Li} / a_{Li}$

- Similarly, the weight assigned to an SME in industry  $i$  is  $W_{SMEi} = N_{SMEi} / a_{SMEi}$ , where  $N_{SMEi}$  is the total number of SMEs in industry  $i$ , and  $a_{SMEi}$  is the number of SMEs in the industry  $i$  being selected as a sample ( $a_{SMEi} = 120$  with  $i = \{15; 26; 29\}$ , and  $a_{SMEi} = 125$  with the other industries).

*For the remaining industries:*

Large firms in the remaining industries have a weight of  $W_{Lj} = N_{Lj} / a_{Lj}$ , where  $N_{Lj}$  is the total number of large firms in these industries, and  $a_{Lj}$  is the number of large firms in these industries being chosen as a sample ( $a_{Lj} = 50$ ).

- SMEs of the remaining industries have a weight of  $W_{SMEj} = N_{SMEj} / a_{SMEj}$ , of which  $N_{SMEj}$  is the total number of SMEs in these sectors, and  $a_{SMEj}$  is the number of SMEs in these sectors selected ( $a_{SMEj} = 200$ ).

**\* It is necessary to keep the codes of the enterprises on the list so that they can be linked** to the data of Enterprise Census 2016, with a lot of important information that can be very useful for more in-depth analyses related to the readiness of Vietnamese enterprises for Industry 4.0, not only for use in common tables.

#### APPENDIX 4: CLASSIFICATION OF INDUSTRIES BY TECHNOLOGY LEVEL (NACE)

Industries are classified according to the European Commission's Economic Activity Statistics System (NACE) as follows:

**TABLE PL4-1: CLASSIFICATION OF INDUSTRIES BY TECHNOLOGY LEVEL (NACE)**

Industry group	Industry name
Agriculture, Forestry and Fishing	Agriculture and related service activities
	Forestry and related service activities
	Fishing and aquaculture
Mining and Quarrying, Electricity, water	Mining of hard coal and lignite
	Extraction of crude petroleum and natural gas
	Mining of metal ores
	Other mining and quarrying
	Mining support service activities
	Manufacture and distribution of electricity, gas, hot water, steam and air conditioning
	Water collection, treatment and supply
	Water drainage and wastewater treatment
	Waste collection, treatment and disposal activities; materials recovery
	Remediation activities and other waste management services
Construction	Construction of buildings
	Civil engineering
	Specialized construction activities
High technology manufacturing industry	Manufacture of pharmaceuticals, medicinal chemical and botanical products

Industry group	Industry name
	Manufacture of computer, electronic and optical products
	Manufacture of chemicals and chemical products
	Manufacture of electrical equipment
	Manufacture of machinery and equipment n.e.c.
	Manufacture of motor vehicles, trailers
	Manufacture of other transport equipment
Medium level technology manufacturing industry	Manufacture of coke and refined petroleum products
	Manufacture of rubber and plastics products
	Manufacture of other non-metallic mineral products
	Manufacture of metals
	Manufacture of metals
	Repair, maintenance and installation of machinery and equipment
Low level technology manufacturing industry	Manufacture of food products
	Manufacture of beverages
	Manufacture of tobacco products
	Manufacture of textiles
	Manufacture of wearing apparel
	Manufacture of leather and related products
	Manufacture of wood and of products of wood and cork, (except furniture); manufacture of products of straw and plaiting materials

Industry group	Industry name
	Manufacture of paper and paper products
	Printing and reproduction of recorded media
	Manufacture of furniture
	Other manufacturing
Knowledge based market services	Water transport
	Air transport
	Legal, accounting and auditing activities
	Activities of head offices; management consultancy activities
	Architectural and engineering activities; technical testing and analysis
	Advertising and market research
	Other professional, scientific and technical activities
	Employment activities
	Security and investigation activities
Knowledge based high technology services	Motion picture, video and television programme production, sound recording and music publishing activities
	Programming and broadcasting activities
	Telecommunications
	Computer programming, consultancy and related activities
	Information service activities
	Scientific research and development

Industry group	Industry name
Knowledge based financial services	Financial service activities (except insurance and social insurance)
	Insurance, reinsurance and social insurance, except compulsory social security)
	Other financial activities
Other knowledge based services	Publishing activities
	Travel agency, tour operator and related activities
	Education and training
	Human health activities
	Residential care and nursing activities
	Creative, arts and entertainment activities
	Libraries, archives, museums and other cultural activities
	Lottery, betting and gambling activities
	Sports activities and amusement and recreation activities
Services with limited knowledge base	Activities of other associations and organizations
	Sales and repair of motor vehicles, motorcycles and other motor vehicles
	Wholesale (except motor vehicles, motorcycles and other motor vehicles)
	Retail trade (except motor vehicles, motorcycles and other motor vehicles)
	Land transport and transport via railways and via pipelines
	Warehousing and support activities for transportation



Industry group	Industry name
	Postal and courier activities
	Accommodation
	Food and beverage service activities
	Real estate activities
	Renting and leasing of machinery and equipment (without operators); of personal and household goods; of non-financial intangible
	Services to buildings and landscape activities
	Office administrative, office support and other business support activities
	Repair of computers, personal and household goods
	Other personal service activities

## APPENDIX 5: ENTERPRISE-LEVEL FACTORS

Information on the enterprise-level factors that may affect IR4.0 readiness is included in the data of Enterprise Census 2017 of the General Statistics Office (GSO), including:

- The level of capital equipment per worker
- Enterprise size: Reference group – Size of 1 - 4 employees

5-9 employees

10-24 employees

25-49 employees

50-99 employees

100-299 employees

300-999 employees

From 1000 employees

- Employee qualifications

Share of employees trained, holding no certificate

Share of employees holding primary vocational certificate

Share of employees holding intermediate or college degrees

Share of employees holding university degree and above

Share of employees holding other certificate

Share of foreign employees

Share of employees aged from 35 to 55 years old

Share of employees aged from 56 years old and above

- Enterprise having export-import activities
- Enterprise having research and deployment activities

- Enterprise setting up own website
- Manager's qualifications: Reference group - Director holding college degree or below

Director holding university degree

Director holding master degree and above

Director age

Director age squared

4.  $\ln(\text{Industry concentration index in district})$
5. Share of employees in industry working for foreign-invested enterprises in district
6. Urbanization index
7. Technology level of an industry by NACE classification: Reference group - Low technology manufacturing industries

Mining and Quarrying, and Electricity, water

Construction

High technology manufacturing industries

Medium level technology manufacturing industries

- Ownership: Reference group: Private enterprise

SOE

Cooperative

Mixed enterprise

Foreign-invested enterprise

- Locality: Reference group: Ho Chi Minh City

Central Highlands

Mekong River Delta

North Central and Central coastal areas

Northern mountain areas

Ha Noi

Red River Delta (except Ha Noi)

South East (except Ho Chi Minh City)

**TABLE PL6-1: DETERMINANTS OF READINESS LEVEL FOR IR4.0, OLS REGRESSION**

<b>Dependent variable: Readiness level score for IR4.0 (Continuous variable)</b>	
Ln(K/L)	0.0480*** (0.0087)
5-9 employees	0.0464 (0.0377)
10-24 employees	0.1164*** (0.0385)
25-49 employees	0.1773*** (0.0426)
50-99 employees	0.1650*** (0.0470)
100-299 employees	0.2381*** (0.0483)
300-999 employees	0.4051*** (0.0508)
From 1000 employees	0.5354*** (0.0659)
Share of female employees	-0.0519 (0.0452)
Share of foreign employees	-0.2068 (0.2867)
Academic qualification of manager	0.0565** (0.0248)
Age of manager	0.0003 (0.0075)
Age of manager squared	-0.0000 (0.0001)
Ln(Concentration index)	0.0122** (0.0062)

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**Dependent variable: Readiness level score for IR4.0 (Continuous variable)**

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Share of employees of foreign-invested enterprises in a district	-0.0307 (0.0400)
High technology manufacturing	0.0472** (0.0240)
Medium level technology manufacturing	-0.0183 (0.0266)
SOE	0.0886* (0.0530)
Cooperative	-0.0575 (0.0674)
Joint venture enterprise	0.2553*** (0.0955)
Foreign-invested enterprise	-0.0180 (0.0404)
Central Highlands	0.1732** (0.0789)
Mekong River Delta	0.1578*** (0.0403)
Central coastal areas	0.1232*** (0.0380)
Northern mountain areas	0.0312 (0.0481)
Ha Noi	0.0825** (0.0346)
Red River Delta, except Ha Noi	0.0893*** (0.0309)
South East, except Ho Chi Minh City	0.0407 (0.0359)
Share of employees using computer	0.0009 (0.0007)
Share of employees using internet	-0.0002 (0.0007)
Enterprise possessing computer	0.0052

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**Dependent variable: Readiness level score for IR4.0 (Continuous variable)**

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	(0.0902)
Enterprise possessing own website	0.0340
	(0.0224)
Enterprise using internet for operations management	0.0444*
	(0.0239)
Enterprise using internet for transactions	-0.0404*
	(0.0244)
Enterprise using internet for financial transactions	0.0222
	(0.0235)
Share of employees trained for less than 3 months	-0.0884**
	(0.0394)
Share of employees holding primary vocational certificate	-0.0096
	(0.0502)
Share of employees holding intermediate vocational certificate	0.0596
	(0.0485)
Share of employees holding university degree and above	0.1298**
	(0.0636)
Share of employees holding other certificates	-0.0946**
	(0.0472)
Share of employees aged from 31 to 45 years old	-0.0500
	(0.0416)
Share of employees aged from 46 to 55 years old	-0.1256*
	(0.0740)
Share of employees aged from 56 to 60 years old	-0.2204
	(0.1506)
Share of employees aged from over 60 years old	-0.0755
	(0.2448)

**Dependent variable: Readiness level score for IR4.0 (Continuous variable)**

Fixed coefficient	0.2805 (0.1973)
Number of observations	2,416
R2 adjustment	0.180

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: Calculated from data of IR4.0 Readiness Survey data

**Table PL6-2: Determinants of technology adoption, logit regression, marginal effect**

<b>Dependent variable: dummy variable = 1 if enterprise applies technology and = 0 if does not apply technology</b>	<b>Technical standardization of entire production chain</b>	<b>Cloud technology</b>	<b>Connecting equipment with equipment/products</b>
Ln(K/L)	0.0245*** (0.0087)	0.0106 (0.0066)	0.0336** * (0.0067)
5-9 employees	0.0351 (0.0382)	0.0568* (0.0307)	0.0712** (0.0347)
10-24 employees	-0.0377 (0.0399)	0.0333 (0.0324)	0.0678* (0.0354)
25-49 employees	-0.0073 (0.0434)	0.0773* * (0.0344)	0.0665* (0.0385)
50-99 employees	-0.0236 (0.0475)	0.0619 (0.0380)	0.1046** * (0.0399)
100-299 employees	0.0181 (0.0481)	0.1206* ** (0.0375)	0.1751** * (0.0392)
300-999 employees	-0.0487	0.1365* **	0.2205** *



<b>Dependent variable: dummy variable = 1 if enterprise and = 0 if does not apply technology</b>	<b>Technical standardization of entire production chain</b>	<b>Cloud technology</b>	<b>Connecting equipment with equipment/products</b>
	(0.0512)	(0.0392)	(0.0406)
From 1000 employees	-0.0181	0.1686* **	0.2483** *
	(0.0651)	(0.0480)	(0.0484)
Share of female employees	0.0261	- 0.1040* **	-0.0493
	(0.0457)	(0.0352)	(0.0362)
Share of foreign employees	-0.3359	- 0.6587* *	-0.2015
	(0.2946)	(0.3045)	(0.2310)
Academic qualification of manager	0.0432*	-0.0080	0.0167
	(0.0252)	(0.0193)	(0.0199)
Age of manager	0.0041	0.0004	- 0.0123**
	(0.0076)	(0.0059)	(0.0055)
Age of manager squared	-0.0000	-0.0000	0.0001**
	(0.0001)	(0.0001)	(0.0001)
Ln(Concentration index)	0.0027	-0.0035	0.0025
	(0.0062)	(0.0048)	(0.0048)
Share of foreign employees of foreign-invested enterprises in a district	0.0064	0.0195	-0.0147
	(0.0405)	(0.0316)	(0.0326)
High technology manufacturing	0.0064	0.0253	0.0147
	(0.0239)	(0.0180)	(0.0179)
Medium level technology manufacturing	-0.0089	0.0129	-0.0083
	(0.0268)	(0.0202)	(0.0203)
SOE	-0.0831	-0.0506	0.0233
	(0.0528)	(0.0361)	(0.0324)
Cooperative	-0.0309	0.0644	-0.0441
	(0.0728)	(0.0530)	(0.0711)
Joint venture enterprise	0.0396	-0.0637	0.0770

<b>Dependent variable: dummy variable = 1 if enterprise and = 0 if does not apply technology</b>	<b>Technical standardization of entire production chain</b>	<b>Cloud technology</b>	<b>Connecting equipment with equipment/products</b>
	(0.0895)	(0.0724)	(0.0571)
Foreign-invested enterprise	0.0128	0.0451	0.0008
	(0.0402)	(0.0312)	(0.0311)
Central Highlands	-0.0830	-0.0785	0.0223
	(0.0876)	(0.0702)	(0.0599)
Mekong River Delta	0.1124***	0.0113	0.0826** *
	(0.0391)	(0.0295)	(0.0300)
Central coastal areas	0.0386	0.0108	0.0480
	(0.0388)	(0.0279)	(0.0299)
Northern mountain areas	0.0128	- 0.1105* **	0.0093
	(0.0487)	(0.0422)	(0.0372)
Ha Noi	0.0950***	-0.0143	0.0520*
	(0.0340)	(0.0256)	(0.0270)
Red River Delta, except Ha Noi	0.0244	-0.0305	0.0283
	(0.0315)	(0.0234)	(0.0245)
South East, except Ho Chi Minh City	0.0104	-0.0466*	0.0352
	(0.0364)	(0.0273)	(0.0276)
Share of employees using computer	-0.0003	0.0014* *	0.0011**
	(0.0007)	(0.0006)	(0.0006)
Share of employees using internet	-0.0001	-0.0010*	-0.0007
	(0.0007)	(0.0005)	(0.0005)
Enterprise possessing computer	-0.0825	-0.0247	-0.0216
	(0.0883)	(0.0687)	(0.0782)
Enterprise possessing own website	0.0369*	-0.0000	-0.0182
	(0.0221)	(0.0167)	(0.0168)
Enterprise using internet for operations management	0.0610***	0.0645* **	0.0148
	(0.0234)	(0.0170)	(0.0172)
Enterprise using internet for transactions	0.0064	0.0021	0.0214

<b>Dependent variable: dummy variable = 1 if enterprise and = 0 if does not apply technology</b>	<b>Technical standardization of entire production chain</b>	<b>Cloud technology</b>	<b>Connecting equipment with equipment/products</b>
	(0.0249)	(0.0194)	(0.0200)
Enterprise using internet for financial transactions	-0.0195	-0.0105	-0.0073
	(0.0234)	(0.0173)	(0.0172)
Share of employees trained for less than 3 months	-0.0919**	-0.0188	-0.0219
	(0.0408)	(0.0319)	(0.0313)
Share of employees holding primary vocational certificate	-0.0251	0.0218	0.0062
	(0.0506)	(0.0373)	(0.0374)
Share of employees holding intermediate vocational certificate	0.0564	-0.0045	-0.0200
	(0.0483)	(0.0382)	(0.0393)
Share of employees holding university degree and above	-0.0204	0.1109*	0.0553
	(0.0641)	(0.0469)	(0.0504)
Share of employees holding other certificates	0.0697	0.0066	-0.0223
	(0.0458)	(0.0358)	(0.0352)
Share of employees aged from 31 to 45 years old	-0.1212***	-0.0477	-0.0703**
	(0.0422)	(0.0324)	(0.0336)
Share of employees aged from 46 to 55 years old	-0.0741	-0.0084	-0.0268
	(0.0760)	(0.0590)	(0.0622)
Share of employees aged from 56 to 60 years old	-0.0833	-0.1206	-0.3744**
	(0.1548)	(0.1369)	(0.1867)
Share of employees aged from over 60 years old	-0.2228	-0.0324	0.0814
	(0.2515)	(0.2088)	(0.1968)
Number of observations	2,416	2,416	2,416

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: Calculated from data of IR4.0 Readiness Survey data

**TABLE PL6-3: DETERMINANTS OF READINESS LEVEL FOR IR4.0, OLS REGRESSION RESULTS**

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: ranking scores from 1 - 5 for each field	Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
Ln(K/L)	0.1684*** (0.0527)	0.2903*** (0.0460)	-0.0126 (0.0387)	0.1874** (0.0938)	0.1587*** (0.0421)	0.2015*** (0.0364)
5-9 employees	0.0798 (0.2807)	0.5060** (0.2337)	0.0171 (0.1617)	-0.4655 (0.6555)	0.5806*** (0.2192)	0.2250 (0.1532)
10-24 employees	0.4922* (0.2693)	0.7196*** (0.2335)	-0.1197 (0.1675)	0.9283* (0.5171)	1.3137*** (0.2152)	0.5313*** (0.1585)
25-49 employees	0.6754** (0.2909)	0.7889*** (0.2541)	0.0381 (0.1857)	1.0420* (0.5520)	1.2361*** (0.2323)	0.6859*** (0.1752)
50-99 employees	0.5075 (0.3205)	1.3345*** (0.2662)	-0.1748 (0.2071)	0.5706 (0.6189)	1.5337*** (0.2460)	0.7536*** (0.1959)
100-299 employees	0.8907*** (0.3137)	1.5648*** (0.2705)	-0.1407 (0.2133)	1.0091* (0.6103)	1.6416*** (0.2523)	1.1067*** (0.1991)
300-999 employees	1.7006*** (0.3178)	2.5445*** (0.2808)	-0.0970 (0.2272)	1.6109*** (0.6076)	1.5829*** (0.2647)	1.7012*** (0.2150)
From 1000 employees	1.9942*** (0.3714)	2.9830*** (0.3407)	0.0954 (0.3064)	2.1340*** (0.6753)	1.7788*** (0.3261)	2.3583*** (0.2838)
Share of female employees	-0.4482 (0.2886)	-0.3473 (0.2440)	-0.1564 (0.1993)	0.4524 (0.5130)	-0.0668 (0.2241)	-0.2435 (0.1873)
Share of foreign employees	2.0408 (1.4161)	1.3818 (1.3138)	-2.2886* (1.2471)	-3.5377 (4.0591)	-1.2010 (1.4102)	0.6921 (1.1797)
Academic qualification of manager	0.0827 (0.1574)	0.2831** (0.1324)	0.0197 (0.1091)	0.5989* (0.3298)	0.2417** (0.1193)	0.2837*** (0.1030)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: ranking scores from 1 - 5 for each field	Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
Age of manager	-0.0233 (0.0461)	-0.0958** (0.0382)	0.0315 (0.0330)	0.0432 (0.0885)	-0.0072 (0.0365)	-0.0108 (0.0311)
Age of manager squared	0.0002 (0.0005)	0.0009** (0.0004)	-0.0004 (0.0003)	-0.0004 (0.0009)	0.0000 (0.0004)	0.0001 (0.0003)
Ln(Concentration index)	0.0590 (0.0380)	0.0876*** (0.0327)	0.0578** (0.0273)	0.0195 (0.0664)	-0.0250 (0.0298)	0.0100 (0.0255)
Share of employees of foreigned-invested enterprises in a district	0.1554 (0.2469)	-0.2066 (0.2146)	-0.3098* (0.1766)	-0.4659 (0.4845)	-0.0488 (0.1935)	0.0944 (0.1665)
High technology manufacturing	-0.0182 (0.1401)	0.1654 (0.1225)	0.1498 (0.1077)	0.7660*** (0.2468)	0.1813 (0.1142)	-0.0598 (0.1000)
Medium level technology manufacturing	-0.3756** (0.1624)	-0.0033 (0.1381)	0.0683 (0.1185)	-0.2770 (0.3288)	0.0275 (0.1272)	-0.0056 (0.1090)
SOE	0.4596* (0.2374)	0.2977 (0.2357)	0.5176** (0.2635)	-0.1129 (0.4138)	-0.1425 (0.2350)	0.0788 (0.2184)
Cooperative	-0.4481 (0.5587)	0.1251 (0.4072)	-0.3111 (0.2918)	-12.0278 (541.7597)	-0.3816 (0.3833)	0.0038 (0.2837)
Joint venture enterprise	0.7414* (0.4307)	1.1382*** (0.4138)	0.3957 (0.4504)	1.4947*** (0.5495)	0.1909 (0.4097)	0.3899 (0.3830)
Foreign-invested enterprise	-0.4534* (0.2420)	0.1375 (0.2052)	0.1485 (0.1806)	0.2565 (0.4724)	-0.0892 (0.1893)	-0.2673 (0.1698)
Central Highlands	1.0445*** (0.3910)	0.5757 (0.3973)	-0.0006 (0.3607)	0.8435 (0.7283)	-0.0351 (0.3911)	0.2678 (0.3307)
Mekong River Delta	0.1790 (0.2537)	0.4879** (0.2112)	0.4428** (0.1800)	1.0928** (0.4331)	0.6809*** (0.1919)	0.3688** (0.1677)
Central coastal areas	0.5899*** (0.2290)	0.3461* (0.2032)	0.1387 (0.1683)	0.5200 (0.4450)	0.4244** (0.1873)	0.4116*** (0.1555)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: ranking scores from 1 - 5 for each field	Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
Northern mountain areas	0.2602 (0.2814)	0.3104 (0.2426)	-0.1438 (0.2164)	0.2147 (0.5222)	0.2425 (0.2326)	0.3049 (0.2022)
Ha Noi	0.3041 (0.2165)	0.2852 (0.1842)	0.2165 (0.1527)	0.5592 (0.3686)	0.4425*** (0.1669)	0.1381 (0.1423)
Red River Delta, except Ha Noi	0.4896*** (0.1885)	0.4110** (0.1631)	0.0876 (0.1377)	0.6544* (0.3443)	0.2485 (0.1519)	0.2589** (0.1289)
South East, except Ho Chi Minh City	0.0962 (0.2239)	0.1281 (0.1897)	0.0780 (0.1586)	0.1684 (0.4294)	0.4569*** (0.1709)	-0.0435 (0.1493)
Share of employees using computer	-0.0054 (0.0041)	0.0066* (0.0038)	0.0046 (0.0032)	-0.0076 (0.0071)	-0.0079** (0.0035)	0.0078** (0.0031)
Share of employees using internet	0.0085** (0.0038)	-0.0015 (0.0036)	-0.0061** (0.0030)	0.0092 (0.0065)	0.0050 (0.0033)	-0.0028 (0.0029)
Enterprise possessing computer	-0.1290 (0.6568)	-0.2776 (0.5354)	0.1718 (0.3802)	12.7692 (703.1379)	0.0362 (0.4843)	0.1675 (0.3670)
Enterprise possessing own website	0.0919 (0.1334)	-0.1609 (0.1149)	0.2446** (0.1003)	0.1861 (0.2327)	0.1429 (0.1056)	0.0947 (0.0934)
Enterprise using internet for operations management	0.1535 (0.1355)	0.1974* (0.1172)	0.1676 (0.1071)	0.0234 (0.2338)	-0.0295 (0.1105)	0.0968 (0.0992)
Enterprise using internet for transactions	-0.2124 (0.1542)	-0.1550 (0.1322)	-0.0068 (0.1073)	-0.1996 (0.2819)	-0.0167 (0.1205)	-0.1811* (0.1013)
Enterprise using internet for financial transactions	0.0414 (0.1349)	0.1671 (0.1172)	-0.0868 (0.1052)	0.1156 (0.2319)	0.0853 (0.1093)	0.1886* (0.0974)
Share of employees trained for less than 3 months	-0.4733* (0.2509)	-0.1455 (0.2065)	-0.0740 (0.1752)	-0.4938 (0.4636)	-0.5831*** (0.1908)	-0.3308** (0.1649)
Share of employees holding primary vocational certificate	-0.1475	-0.1131	-0.0297	-0.1832	-0.2985	-0.0044

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: ranking scores from 1 - 5 for each field	Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
Share of employees holding intermediate vocational certificate	(0.3002) 0.2467 (0.2966)	(0.2554) -0.0863 (0.2655)	(0.2234) 0.0519 (0.2142)	(0.5325) 0.9686* (0.5133)	(0.2378) -0.0783 (0.2407)	(0.2083) 0.0552 (0.2021)
Share of employees holding university degree and above	0.1333 (0.4025)	0.4755 (0.3404)	0.4314 (0.2791)	0.7840 (0.6958)	0.3756 (0.3188)	0.3766 (0.2613)
Share of employees holding other certificates	-0.0803 (0.2785)	-0.7664*** (0.2488)	-0.1716 (0.2107)	-0.8114 (0.5671)	-0.2876 (0.2187)	-0.3188 (0.1985)
Share of employees aged from 31 to 45 years old	-0.5564** (0.2651)	-0.0995 (0.2235)	-0.0708 (0.1833)	-0.1895 (0.4757)	-0.0310 (0.2049)	-0.1900 (0.1729)
Share of employees aged from 46 to 55 years old	-1.0212* (0.5242)	-0.3368 (0.4271)	-0.1601 (0.3216)	-2.5363** (1.2579)	-0.0976 (0.3870)	-0.6141** (0.3039)
Share of employees aged from 56 to 60 years old	-2.4446* (1.3507)	-1.7672 (1.1135)	-0.2152 (0.6538)	-3.9604 (3.5647)	-0.1384 (0.8667)	-0.4549 (0.6098)
Share of employees aged from over 60 years old	2.1633 (1.3737)	1.0803 (1.3761)	-0.9650 (1.0553)	2.9675 (3.0114)	0.0952 (1.3423)	-0.8449 (1.0513)
/cut1	2.5472** (1.2667)	1.6584 (1.0462)	-0.4788 (0.8588)	20.1972 (703.1411)	2.8559*** (0.9917)	-0.0851 (0.8127)
/cut2	4.3812*** (1.2711)	4.8571*** (1.0556)	-0.3836 (0.8588)	20.5445 (703.1411)	5.5415*** (0.9987)	2.5068*** (0.8142)
/cut3	4.8686*** (1.2735)	6.5079*** (1.0783)	2.9227*** (0.8614)	21.4746 (703.1411)		5.1962*** (0.8205)
/cut4	7.4419*** (1.3436)	7.2172*** (1.1070)	4.7169*** (0.8710)	22.5523 (703.1412)		6.4953*** (0.8295)
/cut5		8.6122*** (1.2652)	6.2096*** (0.9073)	23.7418 (703.1413)		7.4226*** (0.8462)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: ranking scores from 1 - 5 for each field	Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
Number of observations	2,416	2,416	2,416	2,416	2,416	2,416
R2 adjustment	0.106	0.167	0.017	0.117	0.064	0.075

Note: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Source: Calculated from data of IR4.0 Readiness Survey data



**TABLE PL6-4: DETERMINANTS OF READINESS LEVEL FOR EACH AREA, ORDER LOGIT, MARGINAL EFFECTS**

Dependent variable: ranking scores from 1 - 5 for each field	Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
Ln(K/L)						
1	-0.0213*** (0.0066)	- 0.0581** *	0.0021 (0.0065)	-0.0032 (0.0487)	- 0.0339** *	- 0.0163** *
2	0.0169*** (0.0053)	0.0537** *	0.0001 (0.0004)	0.0009 (0.0136)	0.0293** *	- 0.0332** *
3	0.0017*** (0.0006)	0.0035** *	-0.0010 (0.0031)	0.0014 (0.0208)	0.0046** *	0.0400** *
4	0.0026*** (0.0009)	0.0004** *	-0.0010 (0.0030)	0.0006 (0.0093)		0.0067** *
5	0.0002* (0.0001)	0.0003** (0.0001)	-0.0002 (0.0006)	0.0002 (0.0034)		0.0017** *
6		0.0001 (0.0001)	-0.0001 (0.0002)	0.0001 (0.0015)		0.0011** *
5-9 employees						
1	-0.0101 (0.0355)	- 0.1012**	-0.0029 (0.0271)	0.0079 (0.1213)	- 0.1240** *	-0.0182 (0.0124)
2	0.0080 (0.0281)	0.0936** (0.0431)	-0.0002 (0.0015)	-0.0023 (0.0338)	0.1073** *	-0.0370 (0.0253)
3	0.0008 (0.0028)	0.0062** (0.0029)	0.0014 (0.0128)	-0.0034 (0.0519)	0.0167** *	0.0447 (0.0304)
4	0.0012 (0.0043)	0.0008* (0.0004)	0.0013 (0.0126)	-0.0015 (0.0233)		0.0075 (0.0051)

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
5	0.0001 (0.0004)	0.0006 (0.0003)	0.0003 (0.0024)	-0.0005 (0.0085)		0.0019 (0.0013)
6		0.0002 (0.0002)	0.0001 (0.0007)	-0.0002 (0.0038)		0.0013 (0.0009)
10-24 employees						
1	-0.0622* (0.0339)	- 0.1440** *	0.0201 (0.0281)	-0.0157 (0.2411)	- 0.2807** *	- 0.0430** *
2	0.0492* (0.0268)	0.1331** *	0.0011 (0.0015)	0.0045 (0.0672)	0.2429** *	- 0.0875** *
3	0.0048* (0.0027)	0.0087** *	-0.0095 (0.0133)	0.0067 (0.1032)	0.0378** *	0.1055** *
4	0.0075* (0.0042)	0.0011** (0.0005)	-0.0093 (0.0131)	0.0030 (0.0463)		0.0177** *
5	0.0006 (0.0004)	0.0008* (0.0004)	-0.0018 (0.0025)	0.0011 (0.0169)		0.0044** *
6		0.0003 (0.0002)	-0.0005 (0.0008)	0.0005 (0.0075)		0.0030** *
25-49 employees						
1	-0.0854** (0.0365)	- 0.1579** *	-0.0064 (0.0311)	-0.0177 (0.2706)	- 0.2641** *	- 0.0555** *
2	0.0676** (0.0290)	0.1459** *	-0.0003 (0.0017)	0.0051 (0.0754)	0.2285** *	- 0.1130** *

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
3	0.0066** (0.0030)	0.0096** * (0.0033)	0.0030 (0.0147)	0.0076 (0.1158)	0.0355** * (0.0073)	0.1362** * (0.0350)
4	0.0103** (0.0046)	0.0012** (0.0006)	0.0030 (0.0145)	0.0033 (0.0520)		0.0228** * (0.0061)
5	0.0009 (0.0005)	0.0009* (0.0005)	0.0006 (0.0028)	0.0012 (0.0190)		0.0057** * (0.0018)
6		0.0003 (0.0002)	0.0002 (0.0008)	0.0005 (0.0084)		0.0038** * (0.0013)
50-99 employees						
1	-0.0642 (0.0404)	- 0.2670** * (0.0527)	0.0293 (0.0347)	-0.0097 (0.1485)	- 0.3277** * (0.0519)	- 0.0610** * (0.0160)
2	0.0508 (0.0320)	0.2468** * (0.0489)	0.0016 (0.0019)	0.0028 (0.0414)	0.2836** * (0.0454)	- 0.1241** * (0.0327)
3	0.0050 (0.0032)	0.0162** * (0.0038)	-0.0138 (0.0165)	0.0041 (0.0636)	0.0441** * (0.0080)	0.1497** * (0.0391)
4	0.0077 (0.0050)	0.0020** (0.0008)	-0.0136 (0.0161)	0.0018 (0.0285)		0.0251** * (0.0069)
5	0.0007 (0.0005)	0.0015** (0.0007)	-0.0026 (0.0032)	0.0007 (0.0104)		0.0062** * (0.0020)
6		0.0005 (0.0004)	-0.0008 (0.0010)	0.0003 (0.0046)		0.0042** * (0.0014)
100-299 employees						

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
1	-0.1126*** (0.0393)	- 0.3131** *	0.0236 (0.0358)	-0.0171 (0.2621)	- 0.3507** *	- 0.0896** *
2	0.0891*** (0.0313)	0.2894** *	0.0013 (0.0020)	0.0049 (0.0731)	0.3035** *	- 0.1823** *
3	0.0088*** (0.0033)	0.0190** *	-0.0111 (0.0169)	0.0073 (0.1122)	0.0472** *	0.2198** *
4	0.0136*** (0.0050)	0.0024** (0.0009)	-0.0110 (0.0166)	0.0032 (0.0503)		0.0368** *
5	0.0012* (0.0007)	0.0017** (0.0008)	-0.0021 (0.0032)	0.0012 (0.0184)		0.0091** *
6		0.0006 (0.0004)	-0.0006 (0.0010)	0.0005 (0.0081)		0.0062** *
300-999 employees						(0.0017)
1	-0.2150*** (0.0396)	- 0.5092** *	0.0163 (0.0381)	-0.0273 (0.4182)	- 0.3382** *	- 0.1378** *
2	0.1701*** (0.0318)	0.4707** *	0.0009 (0.0021)	0.0078 (0.1166)	0.2926** *	- 0.2802** *
3	0.0167*** (0.0040)	0.0309** *	-0.0077 (0.0180)	0.0117 (0.1790)	0.0455** *	0.3378** *
4	0.0259*** (0.0057)	0.0038** *	-0.0076 (0.0177)	0.0051 (0.0803)		0.0566** *

Dependent variable: ranking scores from 1 - 5 for each field	Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
5	0.0022** (0.0011)	0.0028** (0.0012)	-0.0015 (0.0034)	0.0019 (0.0294)		0.0141** * (0.0031)
6		0.0009 (0.0007)	-0.0004 (0.0010)	0.0008 (0.0129)		0.0095** * (0.0024)
From 1000 employees						
1	-0.2521*** (0.0465)	- 0.5969** *	-0.0160 (0.0513)	-0.0362 (0.5540)	- 0.3800** *	- 0.1910** * (0.0243)
2	0.1995*** (0.0374)	0.5518** *	-0.0009 (0.0028)	0.0104 (0.1545)	0.3289** *	- 0.3884** * (0.0495)
3	0.0196*** (0.0047)	0.0363** *	0.0076 (0.0242)	0.0155 (0.2372)	0.0511** *	0.4683** * (0.0584)
4	0.0304*** (0.0067)	0.0045** *	0.0074 (0.0239)	0.0068 (0.1064)		0.0785** * (0.0113)
5	0.0026** (0.0012)	0.0033** (0.0014)	0.0014 (0.0046)	0.0025 (0.0389)		0.0195** * (0.0041)
6		0.0011 (0.0008)	0.0004 (0.0014)	0.0011 (0.0171)		0.0131** * (0.0032)
Share of female employees						
1	0.0567 (0.0364)	0.0695 (0.0488)	0.0262 (0.0334)	-0.0077 (0.1178)	0.0143 (0.0479)	0.0197 (0.0152)
2	-0.0448 (0.0289)	-0.0642 (0.0451)	0.0014 (0.0018)	0.0022 (0.0328)	-0.0123 (0.0414)	0.0401 (0.0309)
3	-0.0044 (0.0029)	-0.0042 (0.0030)	-0.0124 (0.0158)	0.0033 (0.0504)	-0.0019 (0.0064)	-0.0484 (0.0372)

Dependent variable: ranking scores from 1 - 5 for each field		Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
4		-0.0068 (0.0045)	-0.0005 (0.0004)	-0.0122 (0.0155)	0.0014 (0.0226)		-0.0081 (0.0063)
5		-0.0006 (0.0005)	-0.0004 (0.0003)	-0.0024 (0.0030)	0.0005 (0.0083)		-0.0020 (0.0016)
6			-0.0001 (0.0001)	-0.0007 (0.0009)	0.0002 (0.0036)		-0.0014 (0.0011)
Share of foreign employees							
1		-0.2580 (0.1790)	-0.2765 (0.2629)	0.3836* (0.2090)	0.0600 (0.9208)	0.2566 (0.3012)	-0.0561 (0.0956)
2		0.2042 (0.1418)	0.2556 (0.2431)	0.0209* (0.0119)	-0.0172 (0.2568)	-0.2220 (0.2607)	-0.1140 (0.1943)
3		0.0201 (0.0143)	0.0168 (0.0161)	-0.1811* (0.1001)	-0.0257 (0.3942)	-0.0345 (0.0407)	0.1374 (0.2343)
4		0.0311 (0.0219)	0.0021 (0.0021)	-0.1784* (0.0976)	-0.0113 (0.1769)		0.0230 (0.0393)
5		0.0027 (0.0022)	0.0015 (0.0016)	-0.0346* (0.0195)	-0.0041 (0.0646)		0.0057 (0.0098)
6			0.0005 (0.0006)	-0.0104 (0.0064)	-0.0018 (0.0285)		0.0039 (0.0066)
Academic qualification of manager							
1		-0.0105 (0.0199)	-0.0567** (0.0264)	-0.0033 (0.0183)	-0.0102 (0.1555)	-0.0516** (0.0255)	-0.0230** (0.0084)
2		0.0083 (0.0157)	0.0524** (0.0244)	-0.0002 (0.0010)	0.0029 (0.0434)	0.0447** (0.0221)	-0.0467** (0.0171)
3		0.0008 (0.0016)	0.0034** (0.0017)	0.0016 (0.0086)	0.0043 (0.0666)	0.0069** (0.0035)	0.0563** (0.0205)

Dependent variable: ranking scores from 1 - 5 for each field		Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
4		0.0013	0.0004*	0.0015	0.0019		0.0094** *
		(0.0024)	(0.0003)	(0.0085)	(0.0299)		(0.0035)
5		0.0001	0.0003	0.0003	0.0007		0.0023**
		(0.0002)	(0.0002)	(0.0016)	(0.0109)		(0.0010)
6			0.0001	0.0001	0.0003		0.0016**
			(0.0001)	(0.0005)	(0.0048)		(0.0007)
Age manager	of						
1		0.0029	0.0192**	-0.0053	-0.0007	0.0015	0.0009
		(0.0058)	(0.0076)	(0.0055)	(0.0113)	(0.0078)	(0.0025)
2		-0.0023	-0.0177**	-0.0003	0.0002	-0.0013	0.0018
		(0.0046)	(0.0071)	(0.0003)	(0.0032)	(0.0068)	(0.0051)
3		-0.0002	-0.0012**	0.0025	0.0003	-0.0002	-0.0021
		(0.0005)	(0.0005)	(0.0026)	(0.0048)	(0.0010)	(0.0062)
4		-0.0004	-0.0001*	0.0025	0.0001		-0.0004
		(0.0007)	(0.0001)	(0.0026)	(0.0022)		(0.0010)
5		-0.0000	-0.0001*	0.0005	0.0000		-0.0001
		(0.0001)	(0.0001)	(0.0005)	(0.0008)		(0.0003)
6			-0.0000	0.0001	0.0000		-0.0001
			(0.0000)	(0.0002)	(0.0003)		(0.0002)
Age manager squared	of						
1		-0.0000	-0.0002**	0.0001	0.0000	-0.0000	-0.0000
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)
2		0.0000	0.0002**	0.0000	-0.0000	0.0000	-0.0000
		(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
3		0.0000	0.0000**	-0.0000	-0.0000	0.0000	0.0000
		(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0001)
4		0.0000	0.0000*	-0.0000	-0.0000		0.0000
		(0.0000)	(0.0000)	(0.0000)	(0.0000)		(0.0000)

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
5	0.0000 (0.0000)	0.0000* (0.0000)	-0.0000 (0.0000)	-0.0000 (0.0000)		0.0000 (0.0000)
6		0.0000 (0.0000)	-0.0000 (0.0000)	-0.0000 (0.0000)		0.0000 (0.0000)
Ln(Concentration index)						
1	-0.0075 (0.0048)	- 0.0175** *	-0.0097** (0.0046)	-0.0003 (0.0052)	0.0054 (0.0064)	-0.0008 (0.0021)
2	0.0059 (0.0038)	0.0162** *	-0.0005** (0.0003)	0.0001 (0.0015)	-0.0046 (0.0055)	-0.0016 (0.0042)
3	0.0006 (0.0004)	0.0011** (0.0004)	0.0046** (0.0022)	0.0001 (0.0022)	-0.0007 (0.0009)	0.0020 (0.0051)
4	0.0009 (0.0006)	0.0001* (0.0001)	0.0045** (0.0021)	0.0001 (0.0010)		0.0003 (0.0008)
5	0.0001 (0.0001)	0.0001* (0.0001)	0.0009** (0.0004)	0.0000 (0.0004)		0.0001 (0.0002)
6		0.0000 (0.0000)	0.0003* (0.0001)	0.0000 (0.0002)		0.0001 (0.0001)
Share of employees of foreign-invested enterprises in a district						
1	-0.0196 (0.0312)	0.0413 (0.0429)	0.0519* (0.0296)	0.0079 (0.1212)	0.0104 (0.0413)	-0.0076 (0.0135)
2	0.0156 (0.0247)	-0.0382 (0.0397)	0.0028* (0.0017)	-0.0023 (0.0338)	-0.0090 (0.0358)	-0.0155 (0.0274)
3	0.0015 (0.0024)	-0.0025 (0.0026)	-0.0245* (0.0142)	-0.0034 (0.0519)	-0.0014 (0.0056)	0.0187 (0.0331)
4	0.0024 (0.0038)	-0.0003 (0.0003)	-0.0242* (0.0138)	-0.0015 (0.0233)		0.0031 (0.0055)



<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
5	0.0002 (0.0003)	-0.0002 (0.0003)	-0.0047* (0.0028)	-0.0005 (0.0085)		0.0008 (0.0014)
6		-0.0001 (0.0001)	-0.0014 (0.0009)	-0.0002 (0.0037)		0.0005 (0.0009)
High technology manufacturing						
1	0.0023 (0.0177)	-0.0331 (0.0245)	-0.0251 (0.0181)	-0.0130 (0.1989)	-0.0387 (0.0244)	0.0048 (0.0081)
2	-0.0018 (0.0140)	0.0306 (0.0226)	-0.0014 (0.0010)	0.0037 (0.0554)	0.0335 (0.0211)	0.0098 (0.0165)
3	-0.0002 (0.0014)	0.0020 (0.0015)	0.0119 (0.0086)	0.0056 (0.0851)	0.0052 (0.0033)	-0.0119 (0.0199)
4	-0.0003 (0.0021)	0.0002 (0.0002)	0.0117 (0.0084)	0.0024 (0.0382)		-0.0020 (0.0033)
5	-0.0000 (0.0002)	0.0002 (0.0002)	0.0023 (0.0017)	0.0009 (0.0140)		-0.0005 (0.0008)
6		0.0001 (0.0001)	0.0007 (0.0005)	0.0004 (0.0061)		-0.0003 (0.0006)
Medium level technology manufacturing						
1	0.0475** (0.0205)	0.0007 (0.0276)	-0.0114 (0.0199)	0.0047 (0.0721)	-0.0059 (0.0272)	0.0005 (0.0088)
2	-0.0376** (0.0163)	-0.0006 (0.0255)	-0.0006 (0.0011)	-0.0013 (0.0201)	0.0051 (0.0235)	0.0009 (0.0180)
3	-0.0037** (0.0017)	-0.0000 (0.0017)	0.0054 (0.0094)	-0.0020 (0.0309)	0.0008 (0.0037)	-0.0011 (0.0216)
4	-0.0057** (0.0026)	-0.0000 (0.0002)	0.0053 (0.0092)	-0.0009 (0.0138)		-0.0002 (0.0036)
5	-0.0005 (0.0003)	-0.0000 (0.0002)	0.0010 (0.0018)	-0.0003 (0.0051)		-0.0000 (0.0009)
6		-0.0000 (0.0001)	0.0003 (0.0005)	-0.0001 (0.0022)		-0.0000 (0.0006)

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
State-owned enterprise						
1	-0.0581* (0.0301)	-0.0596 (0.0472)	-0.0868** (0.0441)	0.0019 (0.0301)	0.0305 (0.0502)	-0.0064 (0.0177)
2	0.0460* (0.0239)	0.0551 (0.0437)	-0.0047* (0.0025)	-0.0005 (0.0084)	-0.0264 (0.0434)	-0.0130 (0.0360)
3	0.0045* (0.0024)	0.0036 (0.0029)	0.0410* (0.0211)	-0.0008 (0.0129)	-0.0041 (0.0068)	0.0156 (0.0434)
4	0.0070* (0.0037)	0.0004 (0.0004)	0.0404* (0.0207)	-0.0004 (0.0058)		0.0026 (0.0073)
5	0.0006 (0.0004)	0.0003 (0.0003)	0.0078* (0.0041)	-0.0001 (0.0021)		0.0007 (0.0018)
6		0.0001 (0.0001)	0.0024* (0.0014)	-0.0001 (0.0009)		0.0004 (0.0012)
Cooperative						
1	0.0566 (0.0706)	-0.0250 (0.0815)	0.0522 (0.0489)	0.2040 (6.8035)	0.0815 (0.0818)	-0.0003 (0.0230)
2	-0.0448 (0.0559)	0.0231 (0.0753)	0.0028 (0.0027)	-0.0584 (1.9625)	-0.0706 (0.0709)	-0.0006 (0.0467)
3	-0.0044 (0.0055)	0.0015 (0.0050)	-0.0246 (0.0232)	-0.0873 (2.9118)	-0.0110 (0.0111)	0.0008 (0.0563)
4	-0.0068 (0.0085)	0.0002 (0.0006)	-0.0243 (0.0228)	-0.0383 (1.2698)		0.0001 (0.0094)
5	-0.0006 (0.0008)	0.0001 (0.0005)	-0.0047 (0.0045)	-0.0139 (0.4586)		0.0000 (0.0023)
6		0.0000 (0.0002)	-0.0014 (0.0014)	-0.0061 (0.2011)		0.0000 (0.0016)
Joint venture enterprise						
1	-0.0937* (0.0545)	- 0.2277** * (0.0830)	-0.0663 (0.0755)	-0.0253 (0.3881)	-0.0408 (0.0875)	-0.0316 (0.0311)

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
2	0.0742* (0.0432)	0.2105** * (0.0768)	-0.0036 (0.0042)	0.0073 (0.1082)	0.0353 (0.0758)	-0.0642 (0.0631)
3	0.0073* (0.0044)	0.0138** * (0.0053)	0.0313 (0.0358)	0.0108 (0.1661)	0.0055 (0.0118)	0.0774 (0.0761)
4	0.0113* (0.0067)	0.0017** (0.0009)	0.0308 (0.0351)	0.0048 (0.0745)		0.0130 (0.0128)
5	0.0010 (0.0007)	0.0013* (0.0007)	0.0060 (0.0069)	0.0017 (0.0272)		0.0032 (0.0032)
6		0.0004 (0.0003)	0.0018 (0.0021)	0.0008 (0.0120)		0.0022 (0.0022)
Foreign-invested enterprise						
1	0.0573* (0.0306)	-0.0275 (0.0411)	-0.0249 (0.0303)	-0.0043 (0.0670)	0.0190 (0.0404)	0.0216 (0.0138)
2	-0.0454* (0.0242)	0.0254 (0.0380)	-0.0014 (0.0017)	0.0012 (0.0187)	-0.0165 (0.0350)	0.0440 (0.0280)
3	-0.0045* (0.0025)	0.0017 (0.0025)	0.0117 (0.0143)	0.0019 (0.0287)	-0.0026 (0.0054)	-0.0531 (0.0338)
4	-0.0069* (0.0038)	0.0002 (0.0003)	0.0116 (0.0141)	0.0008 (0.0129)		-0.0089 (0.0057)
5	-0.0006 (0.0004)	0.0002 (0.0002)	0.0022 (0.0027)	0.0003 (0.0047)		-0.0022 (0.0015)
6		0.0001 (0.0001)	0.0007 (0.0008)	0.0001 (0.0021)		-0.0015 (0.0010)
Central Highlands						
1	-0.1320*** (0.0494)	-0.1152 (0.0795)	0.0001 (0.0605)	-0.0143 (0.2193)	0.0075 (0.0836)	-0.0217 (0.0268)
2	0.1045*** (0.0392)	0.1065 (0.0735)	0.0000 (0.0033)	0.0041 (0.0611)	-0.0065 (0.0723)	-0.0441 (0.0545)
3	0.0103**	0.0070	-0.0000	0.0061	-0.0010	0.0532

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>		<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
4		(0.0042)	(0.0049)	(0.0285)	(0.0939)	(0.0112)	(0.0657)
		0.0159**	0.0009	-0.0000	0.0027		0.0089
		(0.0062)	(0.0007)	(0.0281)	(0.0421)		(0.0110)
5		0.0014*	0.0006	-0.0000	0.0010		0.0022
		(0.0008)	(0.0005)	(0.0054)	(0.0154)		(0.0028)
6			0.0002	-0.0000	0.0004		0.0015
			(0.0002)	(0.0016)	(0.0068)		(0.0019)
Mekong River Delta							
1		-0.0226	-0.0976**	-0.0742**	-0.0185	-0.1455** *	-0.0299**
		(0.0321)	(0.0422)	(0.0302)	(0.2837)	(0.0409)	(0.0136)
2		0.0179	0.0902**	-0.0040**	0.0053	0.1259** *	-0.0607**
		(0.0254)	(0.0391)	(0.0018)	(0.0791)	(0.0355)	(0.0277)
3		0.0018	0.0059**	0.0350**	0.0079	0.0196** *	0.0732**
		(0.0025)	(0.0027)	(0.0146)	(0.1215)	(0.0058)	(0.0334)
4		0.0027	0.0007*	0.0345**	0.0035		0.0123**
		(0.0039)	(0.0004)	(0.0141)	(0.0545)		(0.0057)
5		0.0002	0.0005*	0.0067**	0.0013		0.0030**
		(0.0003)	(0.0003)	(0.0029)	(0.0199)		(0.0015)
6			0.0002	0.0020**	0.0006		0.0021**
			(0.0001)	(0.0010)	(0.0088)		(0.0010)
Central coastal areas							
1		-0.0746***	-0.0693*	-0.0232	-0.0088	-0.0907**	-0.0333** *
		(0.0289)	(0.0407)	(0.0282)	(0.1352)	(0.0400)	(0.0127)
2		0.0590**	0.0640*	-0.0013	0.0025	0.0785**	0.0678** *
		(0.0229)	(0.0376)	(0.0016)	(0.0377)	(0.0346)	(0.0257)

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
3	0.0058** (0.0024)	0.0042* (0.0025)	0.0110 (0.0134)	0.0038 (0.0579)	0.0122** (0.0055)	0.0817** * (0.0310)
4	0.0090** (0.0037)	0.0005 (0.0004)	0.0108 (0.0131)	0.0017 (0.0260)		0.0137** * (0.0053)
5	0.0008* (0.0005)	0.0004 (0.0003)	0.0021 (0.0026)	0.0006 (0.0095)		0.0034** (0.0014)
6		0.0001 (0.0001)	0.0006 (0.0008)	0.0003 (0.0042)		0.0023** (0.0010)
Northern mountain areas						
1	-0.0329 (0.0356)	-0.0621 (0.0485)	0.0241 (0.0363)	-0.0036 (0.0564)	-0.0518 (0.0497)	-0.0247 (0.0164)
2	0.0260 (0.0281)	0.0574 (0.0449)	0.0013 (0.0020)	0.0010 (0.0157)	0.0448 (0.0430)	-0.0502 (0.0334)
3	0.0026 (0.0028)	0.0038 (0.0030)	-0.0114 (0.0172)	0.0016 (0.0242)	0.0070 (0.0067)	0.0605 (0.0402)
4	0.0040 (0.0043)	0.0005 (0.0004)	-0.0112 (0.0169)	0.0007 (0.0108)		0.0101 (0.0068)
5	0.0003 (0.0004)	0.0003 (0.0003)	-0.0022 (0.0033)	0.0002 (0.0040)		0.0025 (0.0017)
6		0.0001 (0.0001)	-0.0007 (0.0010)	0.0001 (0.0017)		0.0017 (0.0012)
Ha Noi						
1	-0.0384 (0.0273)	-0.0571 (0.0368)	-0.0363 (0.0256)	-0.0095 (0.1453)	- 0.0945** *	-0.0112 (0.0115)
2	0.0304 (0.0217)	0.0527 (0.0341)	-0.0020 (0.0014)	0.0027 (0.0405)	0.0818** *	-0.0227 (0.0234)
3	0.0030	0.0035	0.0171	0.0041	0.0127** *	0.0274

Dependent variable: ranking scores from 1 - 5 for each field		Strategy and organization	Smart factory	Smart operations	Smart products	Data-driven services	Employees
4		(0.0022)	(0.0023)	(0.0122)	(0.0622)	(0.0049)	(0.0283)
		0.0046	0.0004	0.0169	0.0018		0.0046
		(0.0033)	(0.0003)	(0.0119)	(0.0279)		(0.0047)
5		0.0004	0.0003	0.0033	0.0006		0.0011
		(0.0003)	(0.0002)	(0.0024)	(0.0102)		(0.0012)
6			0.0001	0.0010	0.0003		0.0008
			(0.0001)	(0.0007)	(0.0045)		(0.0008)
Red River Delta, except Ha Noi							
1		-0.0619***	-0.0822**	-0.0147	-0.0111	-0.0531	-0.0210**
		(0.0238)	(0.0326)	(0.0231)	(0.1700)	(0.0324)	(0.0105)
2		0.0490***	0.0760**	-0.0008	0.0032	0.0459	-0.0426**
		(0.0189)	(0.0302)	(0.0013)	(0.0474)	(0.0281)	(0.0213)
3		0.0048**	0.0050**	0.0069	0.0048	0.0071	0.0514**
		(0.0020)	(0.0021)	(0.0109)	(0.0728)	(0.0044)	(0.0256)
4		0.0075**	0.0006*	0.0068	0.0021		0.0086**
		(0.0030)	(0.0003)	(0.0107)	(0.0326)		(0.0043)
5		0.0006*	0.0005*	0.0013	0.0008		0.0021*
		(0.0004)	(0.0003)	(0.0021)	(0.0119)		(0.0011)
6			0.0001	0.0004	0.0003		0.0014*
			(0.0001)	(0.0006)	(0.0053)		(0.0008)
South East, except Ho Chi Minh City							
1		-0.0122	-0.0256	-0.0131	-0.0029	-0.0976** *	0.0035
		(0.0283)	(0.0380)	(0.0266)	(0.0443)	(0.0365)	(0.0121)
2		0.0096	0.0237	-0.0007	0.0008	0.0845** *	0.0072
		(0.0224)	(0.0351)	(0.0015)	(0.0124)	(0.0316)	(0.0246)
3		0.0009	0.0016	0.0062	0.0012	0.0131** *	-0.0086

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
	(0.0022)	(0.0023)	(0.0126)	(0.0190)	(0.0051)	(0.0297)
4	0.0015	0.0002	0.0061	0.0005		-0.0014
	(0.0034)	(0.0003)	(0.0124)	(0.0085)		(0.0050)
5	0.0001	0.0001	0.0012	0.0002		-0.0004
	(0.0003)	(0.0002)	(0.0024)	(0.0031)		(0.0012)
6		0.0000	0.0004	0.0001		-0.0002
		(0.0001)	(0.0007)	(0.0014)		(0.0008)
Share of employees using computer						
1	0.0007	-0.0013*	-0.0008	0.0001	0.0017**	-0.0006**
	(0.0005)	(0.0008)	(0.0005)	(0.0020)	(0.0008)	(0.0003)
2	-0.0005	0.0012*	-0.0000	-0.0000	-0.0015**	-0.0013**
	(0.0004)	(0.0007)	(0.0000)	(0.0006)	(0.0007)	(0.0005)
3	-0.0001	0.0001*	0.0004	-0.0001	-0.0002**	0.0015**
	(0.0000)	(0.0000)	(0.0003)	(0.0008)	(0.0001)	(0.0006)
4	-0.0001	0.0000	0.0004	-0.0000		0.0003**
	(0.0001)	(0.0000)	(0.0003)	(0.0004)		(0.0001)
5	-0.0000	0.0000	0.0001	-0.0000		0.0001**
	(0.0000)	(0.0000)	(0.0000)	(0.0001)		(0.0000)
6		0.0000	0.0000	-0.0000		0.0000**
		(0.0000)	(0.0000)	(0.0001)		(0.0000)
Share of employees using internet						
1	-0.0011**	0.0003	0.0010**	-0.0002	-0.0011	0.0002
	(0.0005)	(0.0007)	(0.0005)	(0.0024)	(0.0007)	(0.0002)
2	0.0009**	-0.0003	0.0001*	0.0000	0.0009	0.0005
	(0.0004)	(0.0007)	(0.0000)	(0.0007)	(0.0006)	(0.0005)
3	0.0001**	-0.0000	-0.0005**	0.0001	0.0001	-0.0006
	(0.0000)	(0.0000)	(0.0002)	(0.0010)	(0.0001)	(0.0006)
4	0.0001**	-0.0000	-0.0005**	0.0000		-0.0001
	(0.0001)	(0.0000)	(0.0002)	(0.0005)		(0.0001)
5	0.0000	-0.0000	-0.0001*	0.0000		-0.0000

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
	(0.0000)	(0.0000)	(0.0000)	(0.0002)		(0.0000)
6		-0.0000	-0.0000*	0.0000		-0.0000
		(0.0000)	(0.0000)	(0.0001)		(0.0000)
Enterprise possessing computer						
1	0.0163	0.0555	-0.0288	-0.2166	-0.0077	-0.0136
	(0.0830)	(0.1071)	(0.0637)	(10.4716)	(0.1035)	(0.0297)
2	-0.0129	-0.0513	-0.0016	0.0620	0.0067	-0.0276
	(0.0657)	(0.0990)	(0.0035)	(3.0044)	(0.0895)	(0.0605)
3	-0.0013	-0.0034	0.0136	0.0927	0.0010	0.0333
	(0.0065)	(0.0065)	(0.0301)	(4.4818)	(0.0139)	(0.0729)
4	-0.0020	-0.0004	0.0134	0.0407		0.0056
	(0.0100)	(0.0008)	(0.0296)	(1.9635)		(0.0122)
5	-0.0002	-0.0003	0.0026	0.0147		0.0014
	(0.0009)	(0.0006)	(0.0058)	(0.7105)		(0.0030)
6		-0.0001	0.0008	0.0065		0.0009
		(0.0002)	(0.0017)	(0.3118)		(0.0021)
Enterprise possessing own website						
1	-0.0116	0.0322	-0.0410**	-0.0032	-0.0305	-0.0077
	(0.0169)	(0.0230)	(0.0168)	(0.0485)	(0.0226)	(0.0076)
2	0.0092	-0.0298	-0.0022**	0.0009	0.0264	-0.0156
	(0.0133)	(0.0213)	(0.0010)	(0.0135)	(0.0195)	(0.0154)
3	0.0009	-0.0020	0.0194**	0.0014	0.0041	0.0188
	(0.0013)	(0.0014)	(0.0081)	(0.0208)	(0.0031)	(0.0185)
4	0.0014	-0.0002	0.0191**	0.0006		0.0031
	(0.0020)	(0.0002)	(0.0079)	(0.0093)		(0.0031)
5	0.0001	-0.0002	0.0037**	0.0002		0.0008
	(0.0002)	(0.0001)	(0.0016)	(0.0034)		(0.0008)
6		-0.0001	0.0011**	0.0001		0.0005
		(0.0001)	(0.0006)	(0.0015)		(0.0005)



<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
Enterprise using internet for operations management						
1	-0.0194 (0.0171)	-0.0395* (0.0235)	-0.0281 (0.0180)	-0.0004 (0.0072)	0.0063 (0.0236)	-0.0078 (0.0080)
2	0.0154 (0.0136)	0.0365* (0.0217)	-0.0015 (0.0010)	0.0001 (0.0020)	-0.0055 (0.0204)	-0.0159 (0.0163)
3	0.0015 (0.0014)	0.0024* (0.0015)	0.0133 (0.0086)	0.0002 (0.0031)	-0.0008 (0.0032)	0.0192 (0.0197)
4	0.0023 (0.0021)	0.0003 (0.0002)	0.0131 (0.0084)	0.0001 (0.0014)		0.0032 (0.0033)
5	0.0002 (0.0002)	0.0002 (0.0002)	0.0025 (0.0017)	0.0000 (0.0005)		0.0008 (0.0008)
6		0.0001 (0.0001)	0.0008 (0.0005)	0.0000 (0.0002)		0.0005 (0.0006)
Enterprise using internet for transactions						
1	0.0269 (0.0195)	0.0310 (0.0264)	0.0011 (0.0180)	0.0034 (0.0520)	0.0036 (0.0257)	0.0147* (0.0082)
2	-0.0213 (0.0154)	-0.0287 (0.0245)	0.0001 (0.0010)	-0.0010 (0.0145)	-0.0031 (0.0223)	0.0298* (0.0167)
3	-0.0021 (0.0015)	-0.0019 (0.0016)	-0.0005 (0.0085)	-0.0014 (0.0223)	-0.0005 (0.0035)	-0.0360* (0.0201)
4	-0.0032 (0.0024)	-0.0002 (0.0002)	-0.0005 (0.0084)	-0.0006 (0.0100)		-0.0060* (0.0034)
5	-0.0003 (0.0002)	-0.0002 (0.0002)	-0.0001 (0.0016)	-0.0002 (0.0037)		-0.0015* (0.0009)
6		-0.0001 (0.0001)	-0.0000 (0.0005)	-0.0001 (0.0016)		-0.0010* (0.0006)
Enterprise using internet						

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
for financial transactions						
1	-0.0052 (0.0171)	-0.0334 (0.0235)	0.0146 (0.0176)	-0.0020 (0.0303)	-0.0182 (0.0234)	-0.0153* (0.0079)
2	0.0041 (0.0135)	0.0309 (0.0217)	0.0008 (0.0010)	0.0006 (0.0084)	0.0158 (0.0202)	-0.0311* (0.0161)
3	0.0004 (0.0013)	0.0020 (0.0014)	-0.0069 (0.0084)	0.0008 (0.0130)	0.0025 (0.0031)	0.0374* (0.0194)
4	0.0006 (0.0021)	0.0003 (0.0002)	-0.0068 (0.0082)	0.0004 (0.0058)		0.0063* (0.0033)
5	0.0001 (0.0002)	0.0002 (0.0001)	-0.0013 (0.0016)	0.0001 (0.0021)		0.0016* (0.0009)
6		0.0001 (0.0001)	-0.0004 (0.0005)	0.0001 (0.0009)		0.0010* (0.0006)
Share of employees trained for less than 3 months						
1	0.0598* (0.0317)	0.0291 (0.0413)	0.0124 (0.0294)	0.0084 (0.1284)	0.1246** * (0.0407)	0.0268** (0.0134)
2	-0.0474* (0.0251)	-0.0269 (0.0382)	0.0007 (0.0016)	-0.0024 (0.0358)	- 0.1078** * (0.0353)	0.0545** (0.0272)
3	-0.0047* (0.0026)	-0.0018 (0.0025)	-0.0059 (0.0139)	-0.0036 (0.0550)	- 0.0168** * (0.0057)	-0.0657** (0.0328)
4	-0.0072* (0.0039)	-0.0002 (0.0003)	-0.0058 (0.0137)	-0.0016 (0.0247)		-0.0110** (0.0056)
5	-0.0006 (0.0004)	-0.0002 (0.0002)	-0.0011 (0.0027)	-0.0006 (0.0090)		-0.0027* (0.0014)
6		-0.0001 (0.0001)	-0.0003 (0.0008)	-0.0003 (0.0040)		-0.0018* (0.0010)

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>		<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
Share of employees holding primary vocational certificate							
1		0.0186	0.0226	0.0050	0.0031	0.0638	0.0004
		(0.0379)	(0.0511)	(0.0374)	(0.0484)	(0.0508)	(0.0169)
2		-0.0148	-0.0209	0.0003	-0.0009	-0.0552	0.0007
		(0.0300)	(0.0472)	(0.0020)	(0.0135)	(0.0440)	(0.0343)
3		-0.0014	-0.0014	-0.0023	-0.0013	-0.0086	-0.0009
		(0.0030)	(0.0031)	(0.0177)	(0.0207)	(0.0069)	(0.0414)
4		-0.0022	-0.0002	-0.0023	-0.0006		-0.0001
		(0.0046)	(0.0004)	(0.0174)	(0.0093)		(0.0069)
5		-0.0002	-0.0001	-0.0004	-0.0002		-0.0000
		(0.0004)	(0.0003)	(0.0034)	(0.0034)		(0.0017)
6			-0.0000	-0.0001	-0.0001		-0.0000
			(0.0001)	(0.0010)	(0.0015)		(0.0012)
Share of employees holding intermediate vocational certificate							
1		-0.0312	0.0173	-0.0087	-0.0164	0.0167	-0.0045
		(0.0375)	(0.0531)	(0.0359)	(0.2516)	(0.0514)	(0.0164)
2		0.0247	-0.0160	-0.0005	0.0047	-0.0145	-0.0091
		(0.0297)	(0.0491)	(0.0020)	(0.0701)	(0.0445)	(0.0333)
3		0.0024	-0.0010	0.0041	0.0070	-0.0023	0.0110
		(0.0029)	(0.0032)	(0.0170)	(0.1077)	(0.0069)	(0.0401)
4		0.0038	-0.0001	0.0040	0.0031		0.0018
		(0.0045)	(0.0004)	(0.0167)	(0.0483)		(0.0067)
5		0.0003	-0.0001	0.0008	0.0011		0.0005
		(0.0004)	(0.0003)	(0.0032)	(0.0177)		(0.0017)
6			-0.0000	0.0002	0.0005		0.0003
			(0.0001)	(0.0010)	(0.0078)		(0.0011)

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
Share of employees holding university degree and above						
1	-0.0169 (0.0509)	-0.0951 (0.0680)	-0.0723 (0.0468)	-0.0133 (0.2038)	-0.0802 (0.0681)	-0.0305 (0.0212)
2	0.0133 (0.0403)	0.0879 (0.0629)	-0.0039 (0.0026)	0.0038 (0.0568)	0.0694 (0.0589)	-0.0620 (0.0431)
3	0.0013 (0.0040)	0.0058 (0.0042)	0.0341 (0.0223)	0.0057 (0.0873)	0.0108 (0.0092)	0.0748 (0.0519)
4	0.0020 (0.0061)	0.0007 (0.0006)	0.0336 (0.0218)	0.0025 (0.0392)		0.0125 (0.0088)
5	0.0002 (0.0005)	0.0005 (0.0004)	0.0065 (0.0043)	0.0009 (0.0143)		0.0031 (0.0022)
6		0.0002 (0.0002)	0.0020 (0.0014)	0.0004 (0.0063)		0.0021 (0.0015)
Share of employees holding other certificates						
1	0.0102 (0.0352)	0.1534** *	0.0288 (0.0353)	0.0138 (0.2108)	0.0614 (0.0467)	0.0258 (0.0161)
2	-0.0080 (0.0279)	- 0.1418** *	0.0016 (0.0019)	-0.0039 (0.0588)	-0.0532 (0.0404)	0.0525 (0.0328)
3	-0.0008 (0.0027)	- 0.0093** *	-0.0136 (0.0167)	-0.0059 (0.0902)	-0.0083 (0.0063)	-0.0633 (0.0395)
4	-0.0012 (0.0042)	- 0.0012**	-0.0134 (0.0164)	-0.0026 (0.0405)		-0.0106 (0.0067)
5	-0.0001	-0.0008*	-0.0026	-0.0009		-0.0026

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
6	(0.0004)	(0.0004)	(0.0032)	(0.0148)		(0.0017)
		-0.0003	-0.0008	-0.0004		-0.0018
		(0.0002)	(0.0010)	(0.0065)		(0.0012)
Share of employees aged from 31 to 45 years old						
1	0.0703**	0.0199	0.0119	0.0032	0.0066	0.0154
	(0.0334)	(0.0447)	(0.0307)	(0.0498)	(0.0438)	(0.0140)
2	-0.0557**	-0.0184	0.0006	-0.0009	-0.0057	0.0313
	(0.0265)	(0.0413)	(0.0017)	(0.0139)	(0.0379)	(0.0285)
3	-0.0055**	-0.0012	-0.0056	-0.0014	-0.0009	-0.0377
	(0.0027)	(0.0027)	(0.0145)	(0.0213)	(0.0059)	(0.0344)
4	-0.0085**	-0.0001	-0.0055	-0.0006		-0.0063
	(0.0042)	(0.0003)	(0.0143)	(0.0096)		(0.0058)
5	-0.0007	-0.0001	-0.0011	-0.0002		-0.0016
	(0.0005)	(0.0003)	(0.0028)	(0.0035)		(0.0015)
6		-0.0000	-0.0003	-0.0001		-0.0011
		(0.0001)	(0.0008)	(0.0015)		(0.0010)
Share of employees aged from 46 to 55 years old						
1	0.1291*	0.0674	0.0268	0.0430	0.0208	0.0497**
	(0.0661)	(0.0855)	(0.0539)	(0.6586)	(0.0827)	(0.0247)
2	-0.1022*	-0.0623	0.0015	-0.0123	-0.0180	0.1011**
	(0.0524)	(0.0790)	(0.0029)	(0.1836)	(0.0715)	(0.0502)
3	-0.0100*	-0.0041	-0.0127	-0.0184	-0.0028	-0.1219**
	(0.0054)	(0.0052)	(0.0255)	(0.2819)	(0.0111)	(0.0604)
4	-0.0156*	-0.0005	-0.0125	-0.0081		-0.0204**
	(0.0082)	(0.0007)	(0.0251)	(0.1265)		(0.0103)
5	-0.0013	-0.0004	-0.0024	-0.0029		-0.0051*
	(0.0009)	(0.0005)	(0.0049)	(0.0462)		(0.0027)
6		-0.0001	-0.0007	-0.0013		-0.0034*
		(0.0002)	(0.0015)	(0.0204)		(0.0018)

<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organization</b>	<b>Smart factory</b>	<b>Smart operations</b>	<b>Smart products</b>	<b>Data-driven services</b>	<b>Employees</b>
Share of employees aged from 56 to 60 years old						
1	0.3090* (0.1699)	0.3536 (0.2223)	0.0361 (0.1096)	0.0672 (1.0297)	0.0296 (0.1852)	0.0368 (0.0494)
2	-0.2446* (0.1347)	-0.3269 (0.2056)	0.0020 (0.0060)	-0.0192 (0.2871)	-0.0256 (0.1602)	0.0749 (0.1005)
3	-0.0240* (0.0137)	-0.0215 (0.0138)	-0.0170 (0.0518)	-0.0287 (0.4408)	-0.0040 (0.0249)	-0.0903 (0.1211)
4	-0.0372* (0.0209)	-0.0027 (0.0019)	-0.0168 (0.0510)	-0.0126 (0.1978)		-0.0151 (0.0203)
5	-0.0032 (0.0022)	-0.0020 (0.0015)	-0.0032 (0.0099)	-0.0046 (0.0723)		-0.0038 (0.0051)
6		-0.0006 (0.0006)	-0.0010 (0.0030)	-0.0020 (0.0318)		-0.0025 (0.0034)
Share of employees aged from over 60 years old						
1	-0.2735 (0.1731)	-0.2162 (0.2753)	0.1618 (0.1769)	-0.0503 (0.7719)	-0.0203 (0.2868)	0.0684 (0.0852)
2	0.2164 (0.1372)	0.1998 (0.2545)	0.0088 (0.0098)	0.0144 (0.2152)	0.0176 (0.2482)	0.1391 (0.1732)
3	0.0213 (0.0139)	0.0131 (0.0168)	-0.0764 (0.0839)	0.0215 (0.3304)	0.0027 (0.0386)	-0.1678 (0.2088)
4	0.0330 (0.0212)	0.0016 (0.0022)	-0.0752 (0.0823)	0.0095 (0.1483)		-0.0281 (0.0351)
5	0.0028 (0.0022)	0.0012 (0.0016)	-0.0146 (0.0161)	0.0034 (0.0542)		-0.0070 (0.0088)
6		0.0004 (0.0006)	-0.0044 (0.0050)	0.0015 (0.0239)		-0.0047 (0.0059)
Number of observations	2,416	2,416	2,416	2,416	2,416	2,416

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

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<b>Dependent variable: ranking scores from 1 - 5 for each field</b>	<b>Strategy and organizati on</b>	<b>Smart factory</b>	<b>Smart operatio ns</b>	<b>Smart product s</b>	<b>Data- driven services</b>	<b>Employe es</b>
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*Source: Calculated from data of IR4.0 Readiness Survey data*

## APPENDIX 7: IN-DEPTH INTERVIEW "ON THE IMPACT OF THE 4TH INDUSTRIAL REVOLUTION AND RESPONSE STRATEGIES OF ENTERPRISES - ECONOMIC GROUPS"

### 1. THE SUBJECTS OF THE SURVEY

The surveyed enterprises were the ones that had completed the questionnaire of the enterprise survey on the impact and readiness level for the 4th Industrial Revolution conducted by the MOIT with 2,700 enterprises, and were ranked as enterprise with high readiness level.

### 2. THE PURPOSE OF THE SURVEY

The survey aimed to answer two questions:

- 1. What is the impact of the 4th Industrial Revolution on the enterprise?*
- 2. What is the response strategy of the enterprise in the coming time?*

### 3. THE SUBJECT MATTERS TO BE INTERVIEWED WHEN CONDUCTING SURVEY AT THE ENTERPRISES

Based on detailed information for each of the selected enterprises for in-depth interview (extracted from the data of the survey of 2,747 enterprises), the in-depth interviews will use specific questions for each enterprise depending on the type of technology and production organization method of IR4.0 that the enterprise applies. The following is a group of the oriented issues that will be addressed in the interviews.

Regarding the application of IR4.0 technology in the operation of an enterprise, which has been implemented (according to the data collected from the quantitative survey of the MOIT):

- Causes that made the enterprise to apply the IR4.0 technology
- Difficulties faced when applying them (both objective and subjective): from the enterprise as well as from the outside
- How did the enterprise overcome the difficulties?
- What changes did the enterprise make when applying the IR4.0 technology?
- What benefit(s) does the enterprise get from the application?
- When the enterprise applies IR4.0 technology, what the obstacles encountered are in terms of policies, infrastructure, access to technology, etc.

#### **The impact of applying IR4.0 technology to the enterprise**

Impacts are considered in the following aspects:



- Finance of the enterprise: costs, profits increase or decrease, rates of investment
- Technology: how it has changed
- Human resources: increased or decreased, what changes made in the structure of workforce
- Operating capacity: how has it been increased
- Management: How ways of managing operations have changed, and qualification requirements for managers
- Business: Whether the product range, customer network have expanded, and if yes, how was the expansion

### **Response strategy of the enterprise in the coming time**

- Is there a strategy for expanding the application of IR4.0 technology and specifically how to expand it?
- Obstacles the enterprise face when expanding the application of IR4.0 technology
- Obstacles to the government policy when enterprises expanding the application of IR4.0 technology
- Evaluate the expected impact of expanding the application of IR4.0 technology on the enterprise

## **4. THE CONDUCT OF THE INTERVIEW**

The subject matters mentioned above for the interview for an enterprise are general suggestion for all enterprises. Each enterprise has its own characteristics and therefore interviewers are required to find out and study them in depth during the conduct of the interview. Interview contents will be expanded and further developed following the answers of interviewees from the enterprise.

## **5. REPORT WRITING**

Upon the completion of the interview with the enterprise, besides the minutes and notes taken, the interviewers shall write a report for each of the surveyed enterprises according to the following forms:

How was the application of IR4.0 technology implemented, and how was the impact made on the enterprise (mainly the complementary information in addition to the database of the survey of 2,747 enterprises).

	<b>Applied / ready to apply which IR4.0 technology?</b>	<b>Obstacles faced during implementation</b>	<b>How obstacles've been overcome</b>	<b>Impact made on the enterprise</b>
1				
2				
3				

Response strategy of the enterprise in the coming time (mainly the complementary information in addition to the database of the survey of 2,747 enterprises)

	<b>Will apply which IR4.0 technology?</b>	<b>Possible obstacles during implementation</b>	<b>Measures overcome obstacles to the</b>	<b>Expected impact on the enterprise</b>
1				
2				
3				