Curriculum Development of Master's Degree Program in Industrial Engineering for Thailand Sustainable Smart Industry -MSIE4.0

WP1 TASK1.3

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WP1

WP1 is aimed to provide comparative analysis of the actual situation concerning the MSc curricula in Industrial Engineering offered in Thai and EU partner countries universities, the identification of the gaps between the real needs of the industry, the student needs and the actual offered curricula. The recommendations for the new curriculum development, are the most important deliverable working elements for the first year of the project in WP1.

Throughout the entire first year the WP1 will

1) identify the strengths and weaknesses , the common points, the differences and the good practices concerning curricula, teaching methods and tools in Thai and EU universities
2) identify the gap between the needs of industry, for being ready for Thailand 4.0, especially in capacity building, and the competence of MSc graduates from current curricula offered by Thai and EU universities
3) Recommend the specifications and focus areas of the new proposed MSIE curriculum.

The WP1 will be led by CMU close collaboration with UMinho that will co-lead and be the WP1 coordinator for EU partners. All partners will also participate and be responsible for tasks related to their geographical regions.

This analysis working plan is now revised after the approval of PEC the project executive committee-PEC.

WP1-1.3: Assessing needs of industry and student

The comprehensive analysis of needs of industry and students (all partners will conduct a survey with companies assigned in their regions in the list and with the help of the Associated Partners. They will also conduct survey with prospective students in their regions. The outcome of this activity will be classified as following

- Task 1.3.1 Preparing a survey form for identifying the needs of industry for MSIE graduates to support their success in Thailand 4.0 and Industry 4.0
- Task 1.3.2 Preparing a survey form for the needs of prospective students for preparing them for Thailand 4.0 and Industry 4.0
- Task 1.3.3 Conducting survey for companies and organizations in the list
- Task 1.3.4 Conducting survey from students
- Task 1.3.5 Identifying the needs of industry and students

The finding of statistics shows that the total number of program being reviewed is 28. So the total estimation of student population is at least 375 for M.S. students from all 9 partners. Therefore to have minimal 10% error margin of error, the total sampling size to be 385. Then each partner should have at least 40 students for each partner.

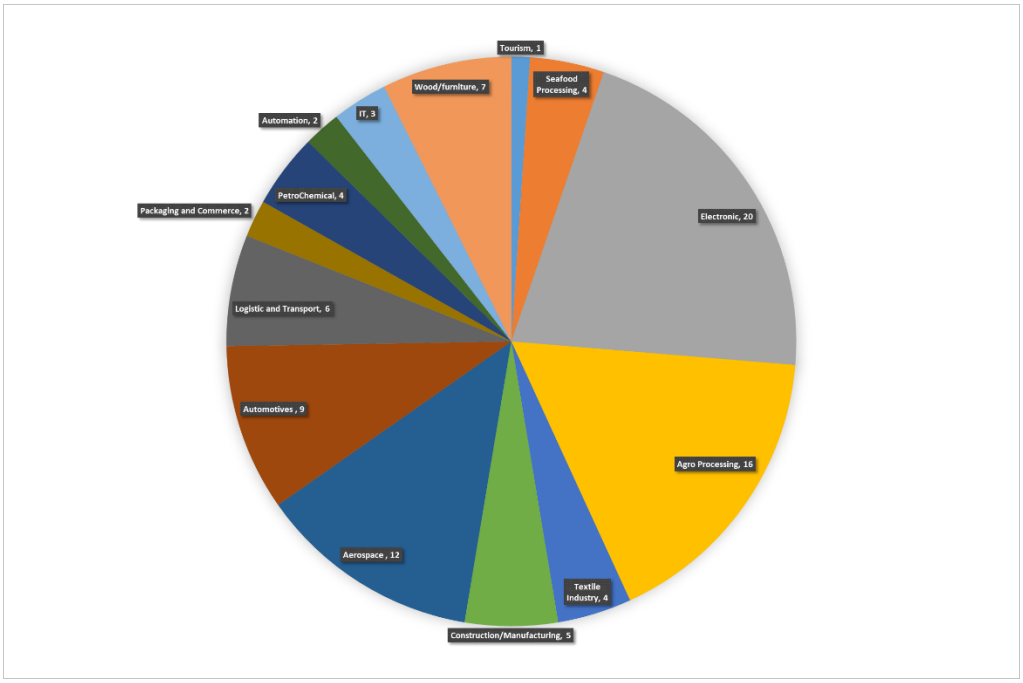
The finding of statistics for SME company in Thailand shows that there are more than 30,000 SME. By assuming that the high impact SME in Thailand is at least 1,000, the samplng table of YAMANE indicates that the minimum of 91 companies shall be listed based on the 10% error.

The The WP1 leader searches for the first and the new S-curves or new country competitive. The TL researcher decided to focus on only 4 groups of (First S-curve)

1) Next – Generation Automotive
2) Smart Electronics
3) Agriculture and Biotechnolgy
4) Food for the Future.

These classification the first S-curve in Thailand was consulted with CWPL and all partners. The specific names of the companies for all study group in Thailand were created and given to all partners for approval. The total of 95 companies are listed by the following clusters:

Tourism	Seafood Processing	Electronic
Agro Processing	Textile Industry	Construction/Manufacturing
Aerospace	Automotives	Logistic and Transport
Packaging and Commerce	PetroChemical	Automation
IT	Wood/furniture	



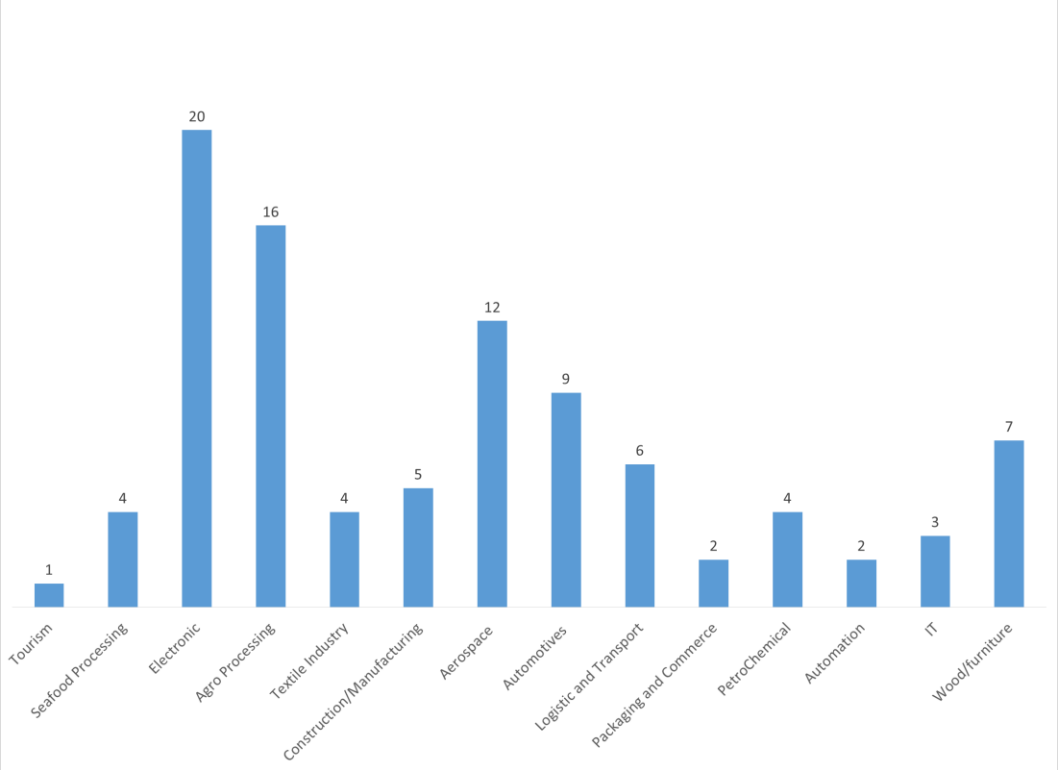


Figure 1 Classification of 95 companies by Sectors

The TL has adopted, modified the questionnaires from the "Industry 4.0 Readiness" study was commissioned by the IMPULS Foundation of the German Engineering Federation (VDMA) and conducted by IW Consult (a subsidiary of the Cologne Institute for Economic Research) and the Institute for Industrial Management (FIR) at RWTH Aachen University.

This questionnaires has 23 pages consists of 3 parts

1.Definitions of Industry 4.0, Industry 4.0 Adoption Scope and Readiness Scheme (p 1-4)

2. Business Background (p 5)

3. Part 1: Industry 4.0 Adoption Scope (page 6-11)

- 1. Business strategy, Business Models, Product & Service Portfolio
- 2. Transversal & Domain related Competences:Employee

4. Part 2 : Industry 4.0 Readiness Scheme (page 12-23)

1.Smart products & Co-created Design:

-To what extent can your products be controlled with IT, making it possible for them to communicate and interact with higher-level systems along the value chain?

2. Smart factory (Intelligence Manufacturing System):

-To what extent does your company have digitally integrated and automated production based on cyber-physical systems?

3. Smart operations (Controlling, Adjusting & Monitoring Process Real Time):

-To what extent are the processes and products in your company digitally modeled and capable of being controlled through ICT systems and algorithms in a virtual world?

4. Data driven services (Integrated Business&Operational Data Management):

-To what extent do you offer data-driven services that are possible only through the integration of products, production, and customers?

register completed in the system
registered but not completed
not register in the system
Canceled
Non-identifiable

University	Cluster	Company
Chiang Mai University (CMU)	Aerospace	Zodiac AirCatering Equipment (Thailand) Ltd.
Chiang Mai University (CMU)	Agro Processing	Betagro Agro Industry Co.,Ltd
Chiang Mai University (CMU)	Agro Processing	Four T Co., Ltd.
Chiang Mai University (CMU)	Agro Processing	Northern Food Company Limited
Chiang Mai University (CMU)	Agro Processing	Pepsi-Cola Thai Trading Co.,Ltd.
Chiang Mai University (CMU)	Automotives	TSM
Chiang Mai University (CMU)	Automotives	Keihin (Thailand) Co., Ltd.
Chiang Mai University (CMU)	Automotives	Toyota Thailand
Chiang Mai University (CMU)	Automotives	Keihin (Thailand) Co., Ltd.

Chiang Mai University (CMU)	Electronic	Fujikura Electronics(Ltd) Thailand
Chiang Mai University (CMU)	Electronic	Hoya optics
Chiang Mai University (CMU)	Electronic	Tokyo Coil Engineer (Thailand) Co., Ltd.
Chiang Mai University (CMU)	Electronic	Hana Microelectronics Public Co., Ltd. (Lamphun)
Chiang Mai University (CMU)	Electronic	Murata Electronics (Thailand) Ltd.
Chiang Mai University (CMU)	IT	Datamar
Chiang Mai University (CMU)	Logistic and Transport	Logistics of 7/11 Thailand
Chiang Mai University (CMU)	Manufacturing	Princess Foods Co.,Ltd.
Chiang Mai University (CMU)	Manufacturing	Siam Wire Netting
Chiang Mai University (CMU)	Manufacturing	Meshtec Internationnal
Chiang Mai University (CMU)	Seafood Processing	CP group
Chiang Mai University (CMU)	Textile Industry	Performance Manufacturing (Thailand) Ltd.
Chiang Mai University (CMU)	Textile Industry	Pattaya Lamphun Co., Ltd.

Chiang Mai University (CMU)	Textile Industry	Onsmooth Thai Co.,Ltd.
Chiang Mai University (CMU)	Wood/furniture	Suksawad
Khon Kaen University (KKU)	Agro Processing	Kalasin Mit Sugar Co.,Ltd
Khon Kaen University (KKU)	Agro Processing	CP RAM Company Limited
Khon Kaen University (KKU)	Agro Processing	Mondelez (Thailand) Co.,Ltd
Khon Kaen University (KKU)	Electronic	Panasonic Electric Works (Khon Kaen) Co.,LTD
Khon Kaen University (KKU)	Electronic	Seagate Technology (Thailand) Ltd.
Khon Kaen University (KKU)	Logistic and Transport	Thai Beverage Logistics Co., Ltd.
Khon Kaen University (KKU)	Logistic and Transport	Cho Thavee Public Co., Ltd.
Khon Kaen University (KKU)	Packaging and Commerce	Thai Containers Khonkaen Co., Ltd.
Khon Kaen University (KKU)	Packaging and Commerce	Siam Global House Plc. (Khon Kaen)
Khon Kaen University (KKU)	Textile Industry	NK Apparel Co., Ltd.
Prince of Songkla University (PSU)	Agro Processing	Stitrangglove

Prince of Songkla University (PSU)	Agro Processing	APK Furnishing Parawood
Prince of Songkla University (PSU)	Agro Processing	42 Natural rubber
Prince of Songkla University (PSU)	Agro Processing	Panel Plus
Prince of Songkla University (PSU)	Manufacturing	Juthamarth Marketing Co.,Ltd
Prince of Songkla University (PSU)	Manufacturing	rubbers innotech co.,ltd
Prince of Songkla University (PSU)	Manufacturing	Wonnatech
Prince of Songkla University (PSU)	Manufacturing	Honda Company
Prince of Songkla University (PSU)	Manufacturing	Southland Rubber Co.,Ltd
Prince of Songkla University (PSU)	Manufacturing	BK trading
Prince of Songkla University (PSU)	Rubber Processing	Sritrang Agro Industry
Prince of Songkla University (PSU)	Rubber Processing	Rubber Processing
Prince of Songkla University (PSU)	Rubber Processing	Michelin
Prince of Songkla University (PSU)	Rubber Processing	Siam Sempermed

Prince of Songkla University (PSU)	Seafood Processing	MANA
Prince of Songkla University (PSU)	Seafood Processing	KIANG HUAT SEA GULL TRADING FROZEN FOOD PUBLIC Co., Ltd.
Prince of Songkla University (PSU)	Seafood Processing	Chotiwat Manufacturing Co.,Ltd.
Prince of Songkla University (PSU)	Tourism	PKCD
Prince of Songkla University (PSU)	Wood Processing	SWP Parawood
Prince of Songkla University (PSU)	Wood/furniture	Xunthai Parawood
King Mongkut's University of Technology North	Automotives	DENSO(Thailand) Co.LTD.
King Mongkut's University of Technology North	Automotives	Thai Summit Harness Co,Ltd.
King Mongkut's University of Technology North	Automotives	Misuibishi Motor Thailand Co, Ltd.
King Mongkut's University of Technology North	Automotives	Komatsu Seiki (Thailand) Co., Ltd.
King Mongkut's University of Technology North	Automotives	Ford Thailand

King Mongkut's University of Technology North	Automotives	Nissan Motor (Thailand) Co., Ltd.
King Mongkut's University of Technology North	Electronic	Ronda Thailand
King Mongkut's University of Technology North	Electronic	WD / Western Digital (Thailand) Co,Ltd.
King Mongkut's University of Technology North	Electronic	Seagate Technology (Thailand) Ltd.
King Mongkut's University of Technology North	Electronic	TOSHIBA THAILAND (Thailand) LTD.
King Mongkut's University of Technology North	Electronic	Daikin Industries (Thailand) LTD.
King Mongkut's University of Technology North	Electronic	Samsung Thailand (Thailand) LTD.
King Mongkut's University of Technology North	Logistic and Transport	Grand Home Mart.Co., Ltd.
King Mongkut's University of Technology North	Logistic and Transport	DKSH (Thailand) Co., Ltd.
King Mongkut's University of Technology North	Logistic and Transport	Yusen Logistics (Thailand) Co. Ltd.

King Mongkut's University of Technology North	Logistic and Transport	DHL(Thailand) Co., Ltd.
King Mongkut's University of Technology North	Manufacturing	President Bakery Co, Ltd.
King Mongkut's University of Technology North	Manufacturing	Triple A Mechanies Co,Ltd.
AIT	Electronic	SVI
AIT	Electronic	WD
AIT	Packaging	Bangkok Glass Public Company Limited
Thammasat University (TU)	Manufacturing	M&R LABORATORY CO., LTD.
Thammasat University (TU)	Agro Processing	Cargill Thailand
Thammasat University (TU)	Automotives	Schavakon Co.,Ltd
Thammasat University (TU)	Automotives	Michelin
Thammasat University (TU)	Construction/Manufacturing	SCG
Thammasat University (TU)	Construction/Manufacturing	CHAVAKON CO., LTD.
Thammasat University (TU)	Construction/Manufacturing	Kohler (Thailand) Public Co., Ltd.
Thammasat University (TU)	Construction/Manufacturing	PAPER GREEN CO.,LTD.
Thammasat University (TU)	Construction/Manufacturing	The CPAC Roof Tile CO.,Ltd
Thammasat University (TU)	Electronic	Mitsubishi Electric Asia (Thailand) Co.,Ltd.
	Electronics	jyelectric

Thammasat University (TU)	Electronics	GE-General Electric
Thammasat University (TU)	IT	Symphony Communications
Thammasat University (TU)	Manufacturing	JCY HDD TECHNOLOGY COMPANY LIMITED
Thammasat University (TU)	Manufacturing	TGI
Thammasat University (TU)	PetroChemical	PTT
Thammasat University (TU)	Wood/furniture	WOODTECT
Thammasat University (TU)	Wood/furniture	S.B. Furniture Industry Co.,Ltd
Thammasat University (TU)	Wood/furniture	Modernform
UPB	Aerospace	TurboMecanica Bucharest
UPB	Aerospace	Unison Engine Components Bucharest – General Electric Aviation
UPB	Aerospace	Avioane Craiova
UPB	Automotives	Group Renault Romania
UPB	Automotives	Ford - Craiova Engine Plant
UPB	Automotives	Pirelli Romania
UPB	Electronic	MicroElectronica Voluntari
UPB	Electronic	Felix Electronic Services Bucharest
UPB	Electronic	Benchmark Romania
UPB	PetroChemical	Cameron Romania
UPB	PetroChemical	UPetrom 1 Mai Ploiesti
UPB	PetroChemical	UPet Targoviste
Uminho	Aerospace	Bosch Car-Multimedia systems
Uminho	Aerospace	Continental ITA
Uminho	Aerospace	Leoni
Uminho	Aerospace	Continental Mabor

Uminho	Aerospace	PREH
Uminho	Automation	Critical
Uminho	Automation	ITEC
Uminho	IT	Primavera
CUT	Aerospace	Wielton
CUT	Aerospace	ZF/TRW
CUT	Aerospace	Linex
CUT	Automotives	Nexteer
CUT	Electronic	Whirlpool
CUT	Electronic	Electrolux (Sosnowiec)
CUT	Electronic	Bosch und Siemens (BSH)
CUT	Wood/furniture	Waldii
CUT	Wood/furniture	MIRJAN
CUT	Wood/furniture	KLER
CUT	Wood/furniture	Opakowania Eksportowe
CUT	Wood/furniture	RC DESIGN S. z o.o.
	Automotives	ZF - PDPQ IT
	Electronic	Electrolux Poland Sp. z o.o.
	Automotives	Mitsubishi Corp LT
	Automotives	Toyota Daihatau Engineering and Manufacturing

Industry Type

☐ Electronic ☐ Agro Processing ☐ Textile Industry

☐ Manufacturing ☐ Aerospace ☐ Automotives

☐ Automation ☐ IT ☐ PetroChemical

☐ Seafood Processing ☐ Wood/furniture ☐ Construction

☐ Logistic and Transport ☐ Commerce&Tourism ☐ Packaging

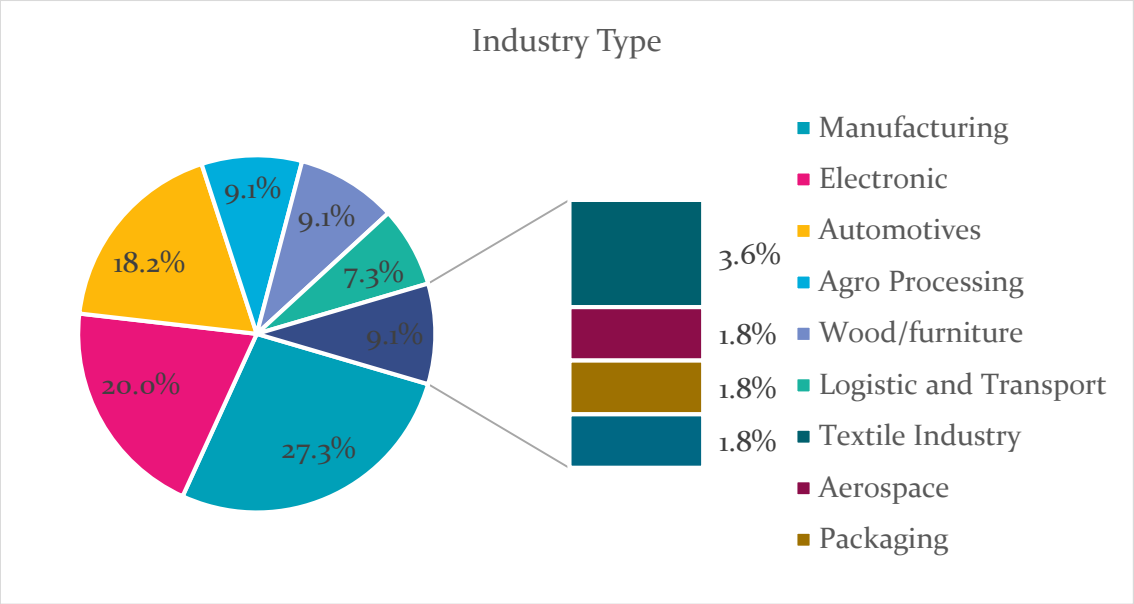


Figure 2 Industry Type

Please estimate the size of your company's domestic workforce.

☐ Up to 19 employees ☐ 20 to 99 employees ☐ 100 to 249 employees

☐ 250 to 499 employees ☐ 500 or more employees

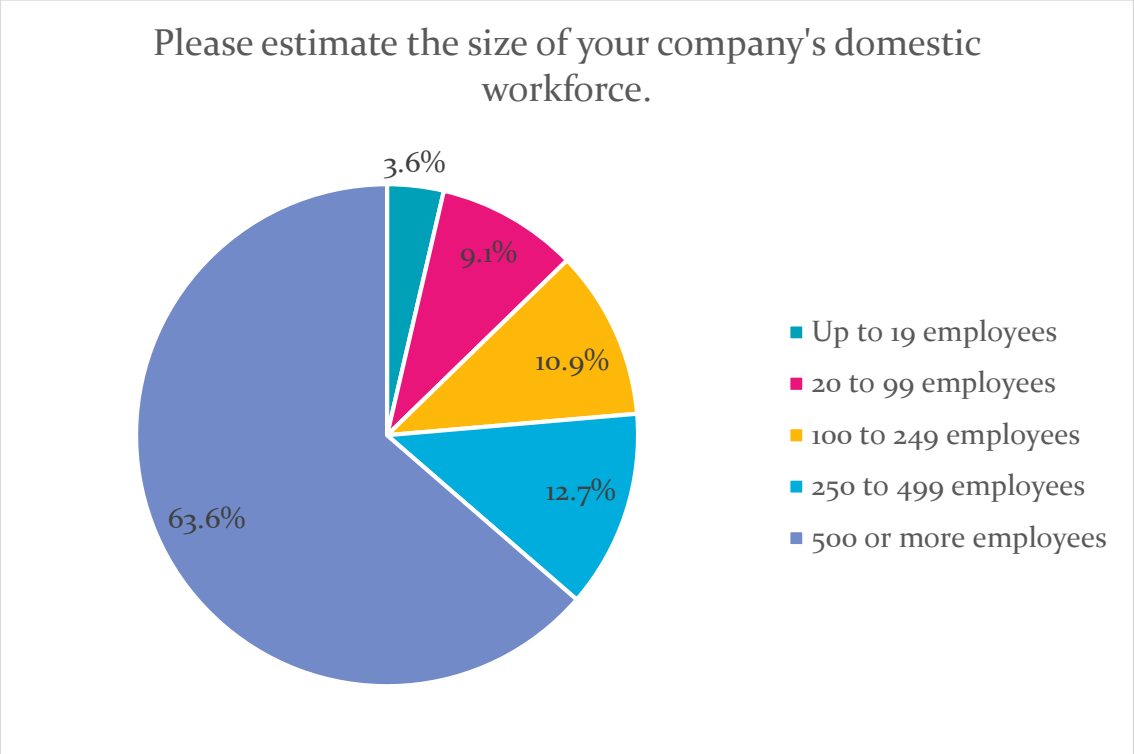


Figure 3 Please estimate the size of your company's domestic workforce.

Please estimate your 2017 revenues.

☐ Under 1 million (THB/euros)
☐ 1 million to under 10 million (THB/euros)
☐ 10 million to under 50 million (THB/euros)
☐ 50 million to under 100 million (THB/euros)
☐ 100 million to under 250 million euros(THB/euros)
☐ 250 million to under 500 million (THB/euros)
☐ 500 million euros (THB/euros)

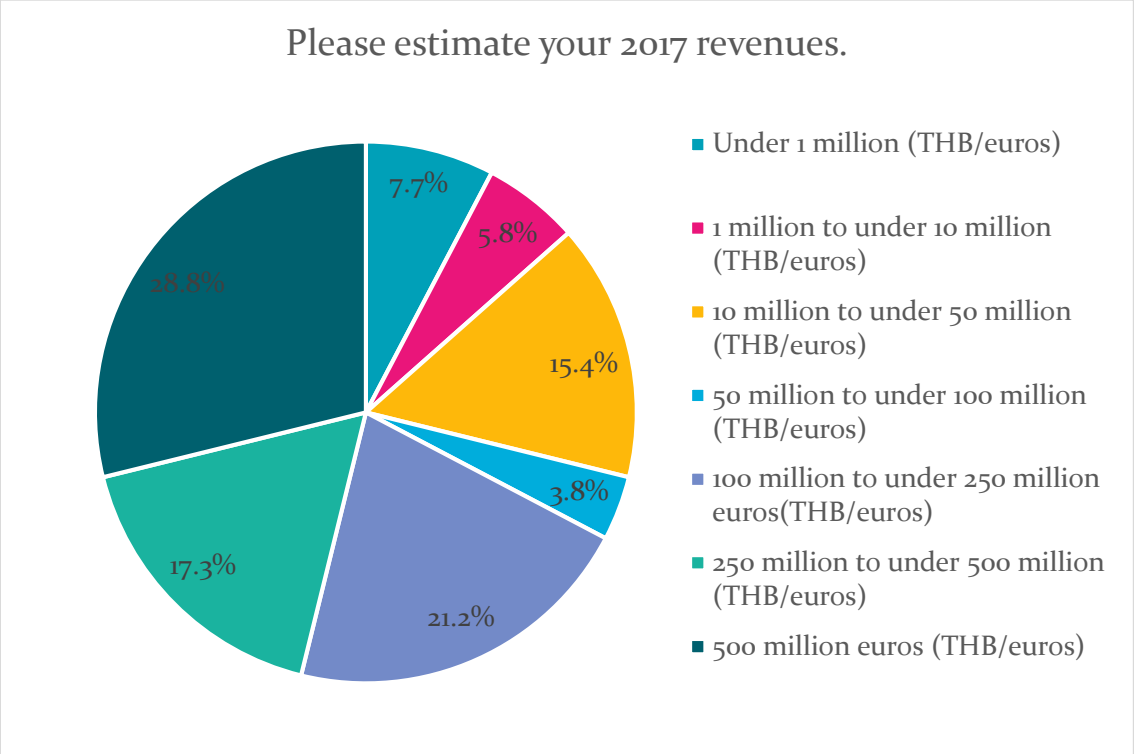


Figure 4 Please estimate your 2017 revenues.

Part1: Strategy Level

1. STRATEGY AND ORGANIZATION

Q1.1 Industry 4.0 is about more than just improving existing products or processes through the use of digital technologies – it actually offers the opportunity to develop entirely new business models. For this reason, its implementation is of great strategic importance.

- ☐ No strategy exists
- ☐ Pilot initiatives launched
- ☐ Strategy in development
- ☐ Strategy formulated
- ☐ Strategy in implementation
- ☐ Strategy implemented

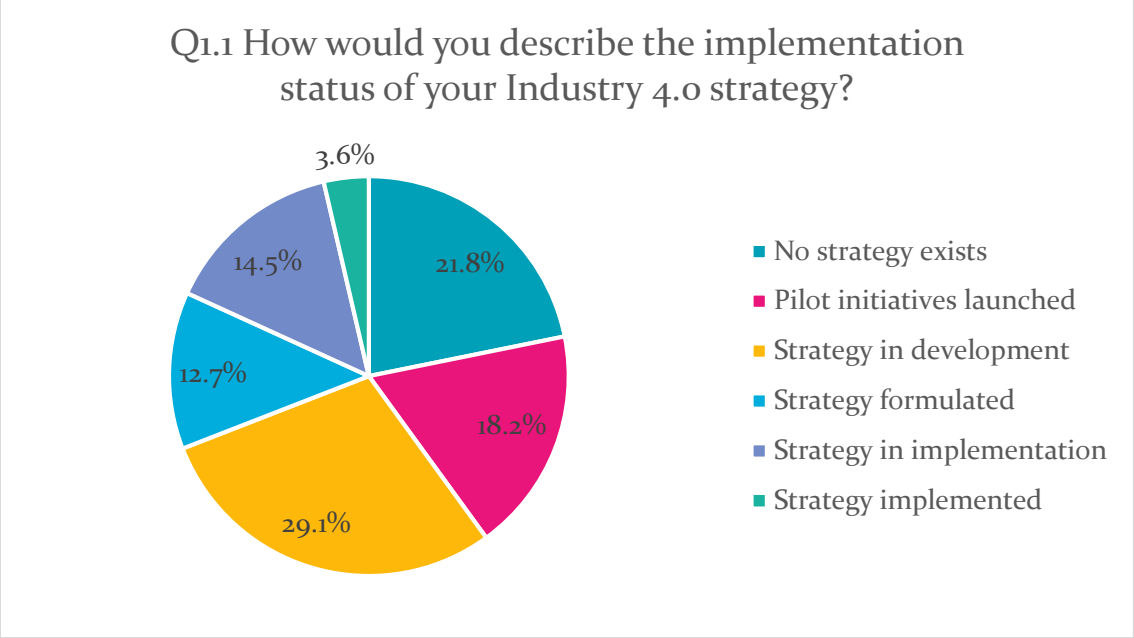


Figure 5 Q1.1 Industry 4.0 is about more than just improving existing products or processes through the use of digital technologies – it actually offers the opportunity to develop entirely new business models. For this reason, its implementation is of great strategic importance.

Q1.2 Do you use indicators to track the implementation status of your Industry 4.0 strategy?

- ☐ Yes, we have a system of indicators that we consider appropriate
- ☐ Yes, we have a system of indicators that gives us some orientation
- ☐ No, our approach is not yet that clearly defined

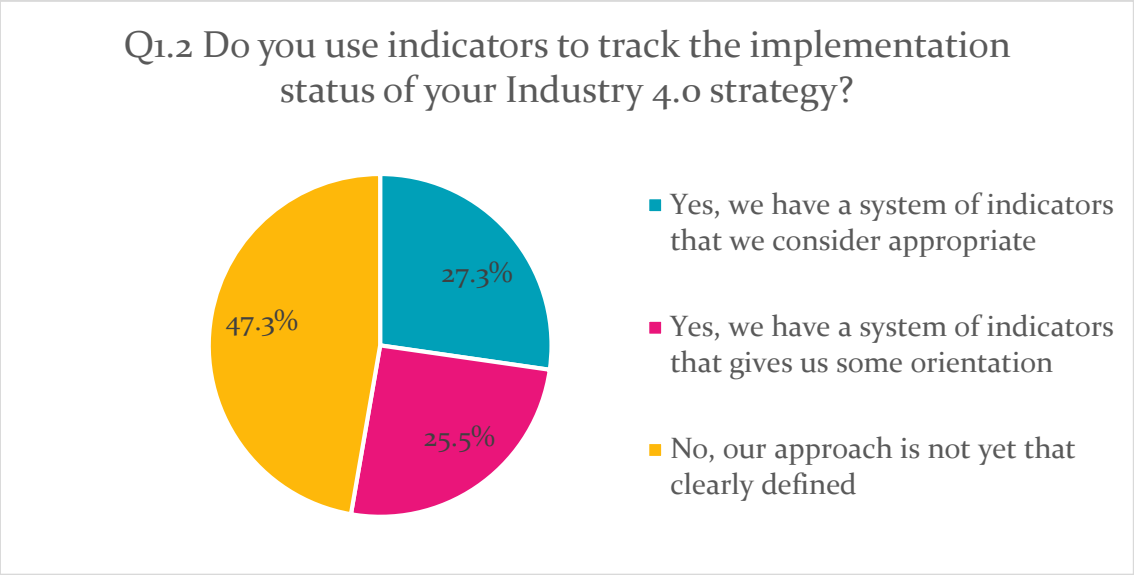


Figure 6 Q1.2 Do you use indicators to track the implementation status of your Industry 4.0 strategy?

Q1.3a Which technologies do you need in your company to enhance business competitiveness? (Can answer more than 1)

- ☐ Sensor technology
- ☐ Mobile end devices
- ☐ RFID
- ☐ Realtime location systems
- ☐ Big data to store and evaluate real-time data
- ☐ Cloud technologies as scalable IT infrastructure
- ☐ Embedded IT systems
- ☐ M2M communications

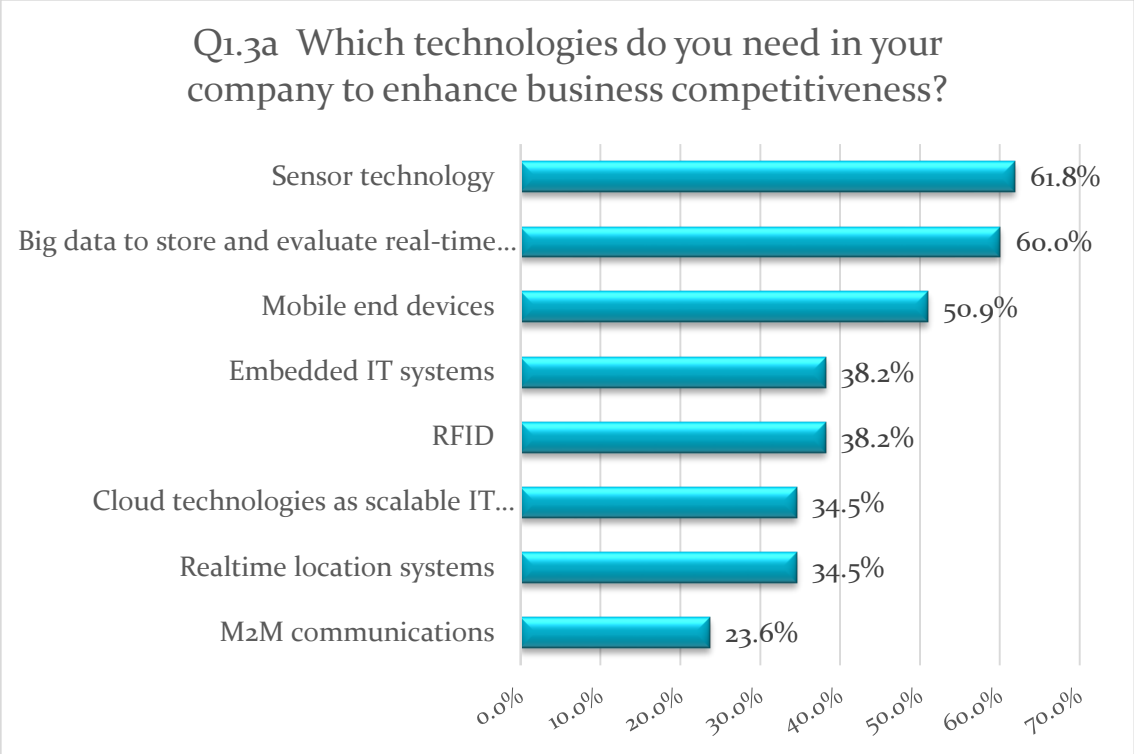


Figure 7 Q1.3a Which technologies do you need in your company to enhance business competitiveness?

Q1.3b Which technologies do you currently using in your company? (Can answer more than 1)

- ☐ Sensor technology
- ☐ Mobile end devices
- ☐ RFID
- ☐ Realtime location systems
- ☐ Big data to store and evaluate real-time data
- ☐ Cloud technologies as scalable IT infrastructure
- ☐ Embedded IT systems
- ☐ M2M communications

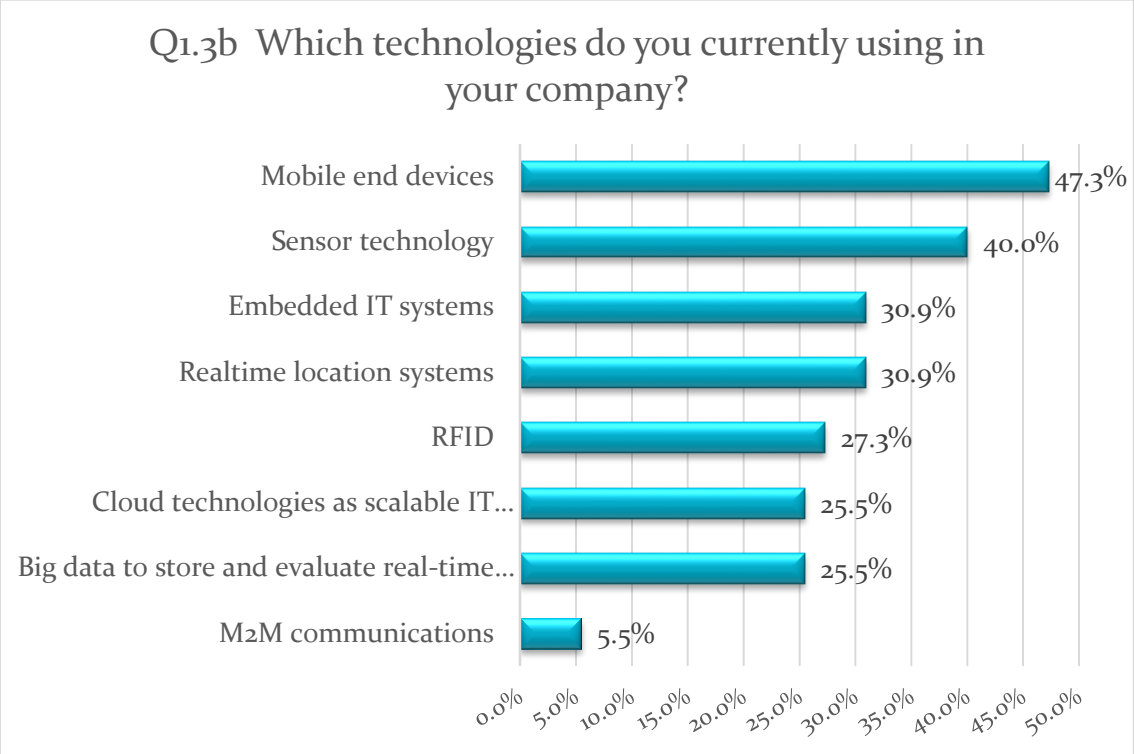


Figure 8 Q1.3b Which technologies do you currently using in your company?

Q1.4 In which parts of your company have you invested in the implementation of Industry 4.0 in the past two years, and what are your plans for the future?

Investments in the past 2 years

- Research and development

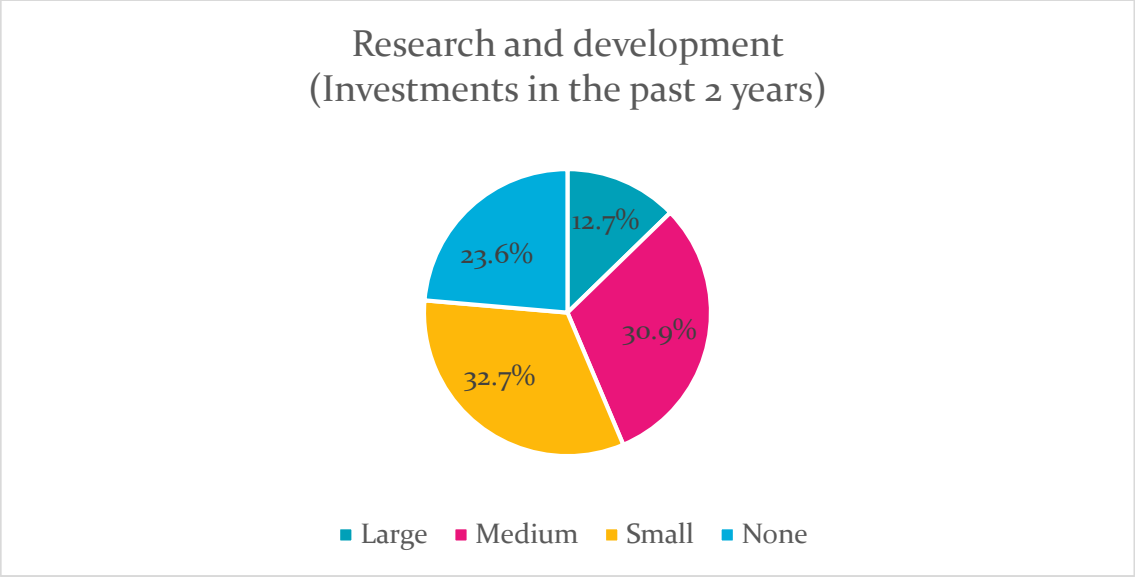


Figure 9 Research and development (Investments in the past 2 years)

- Production/Manufacturing

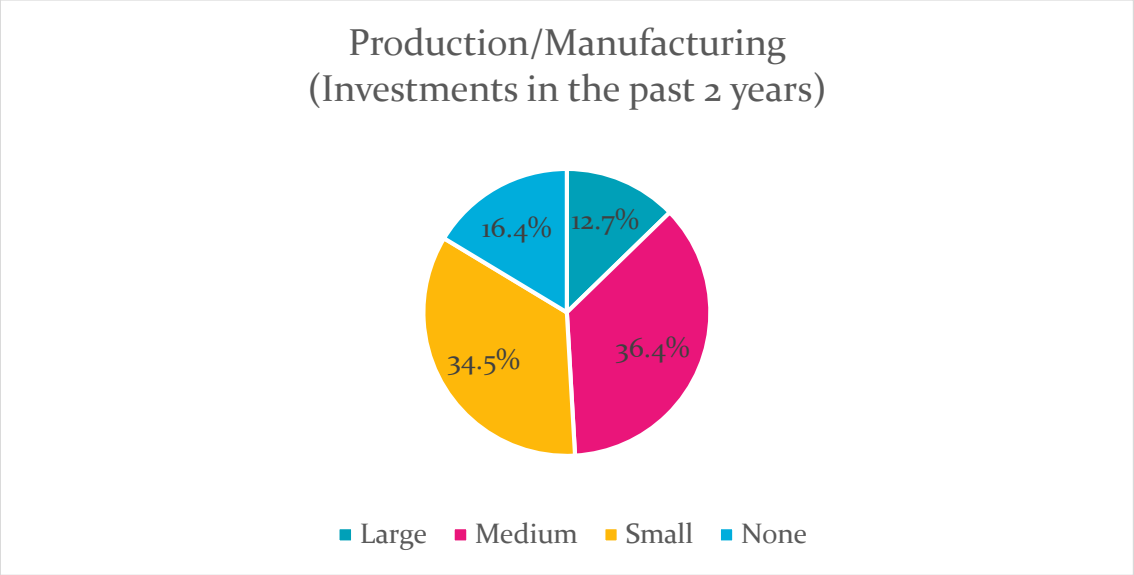


Figure 10 Production/Manufacturing (Investments in the past 2 years)

- Purchasing

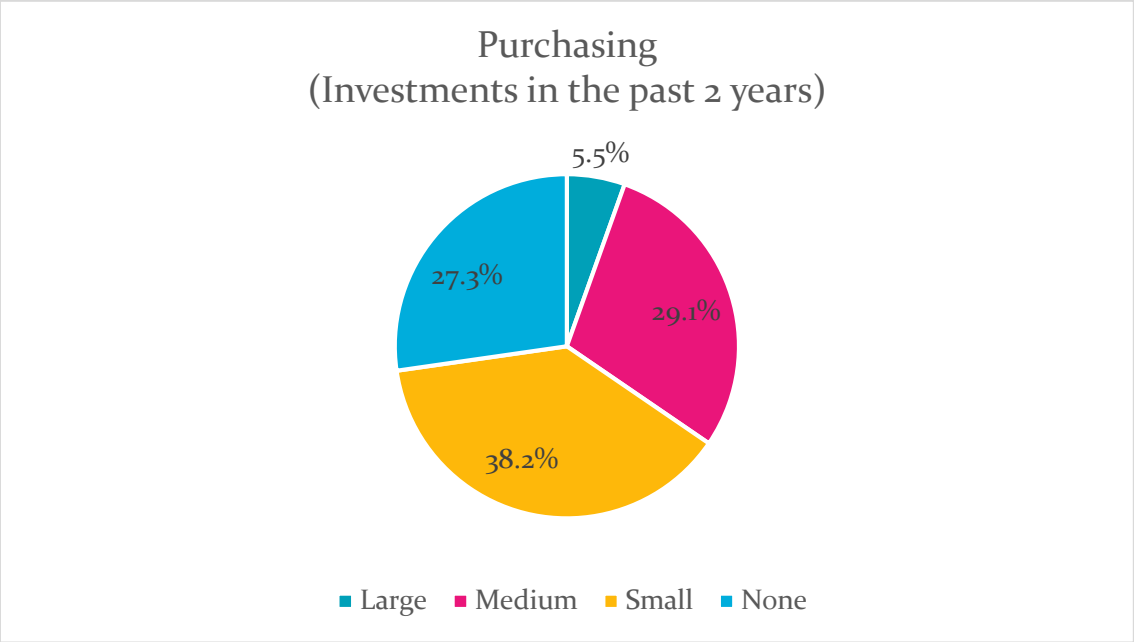


Figure 11 Purchasing (Investments in the past 2 years)

- Logistics

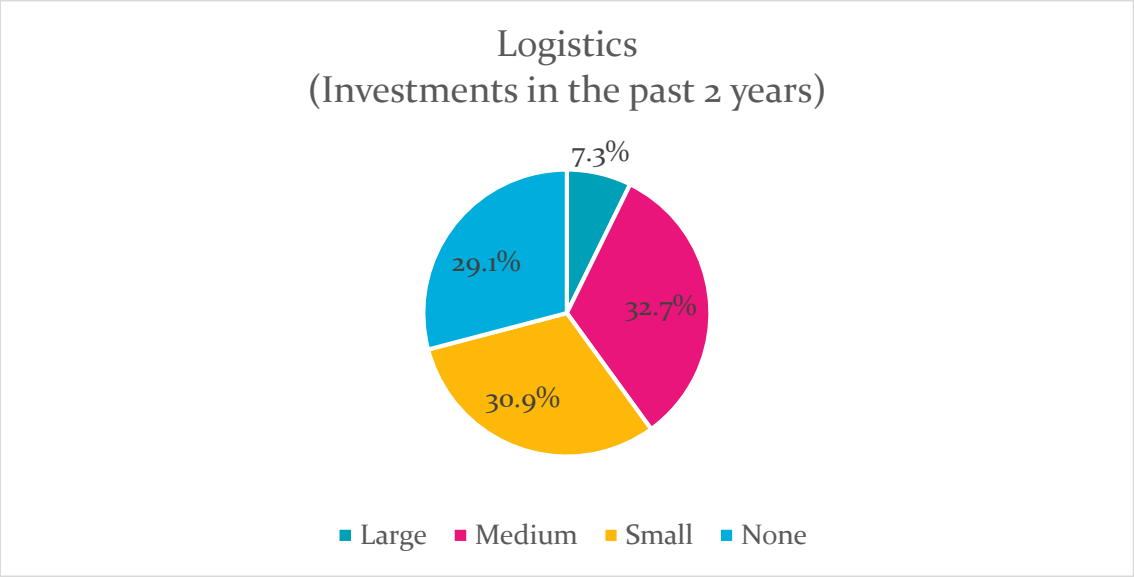


Figure 12 Logistics (Investments in the past 2 years)

- Sales

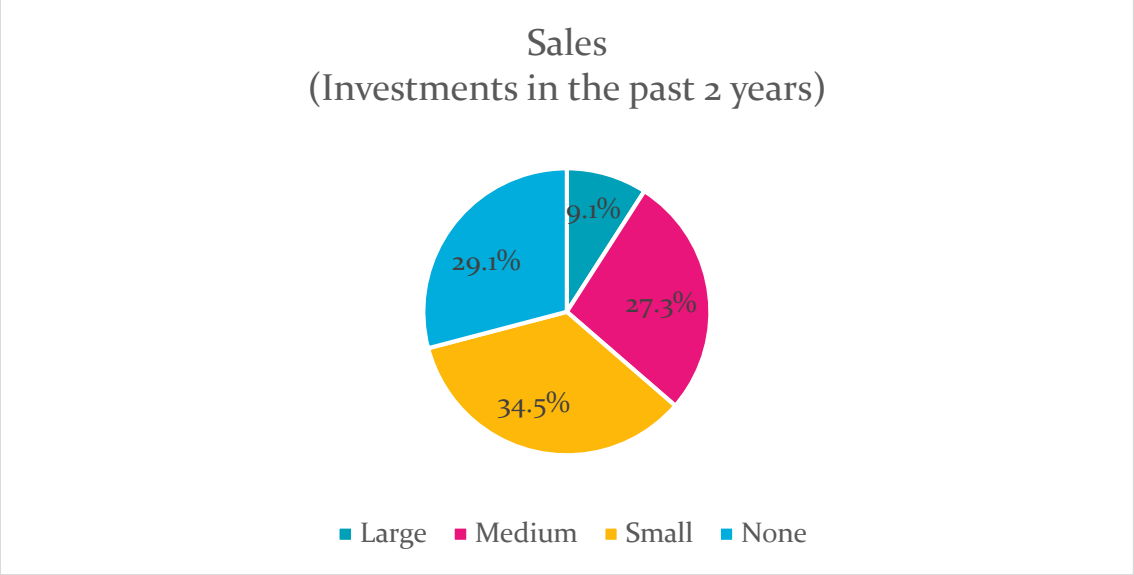


Figure 13 Sales (Investments in the past 2 years)

- Services

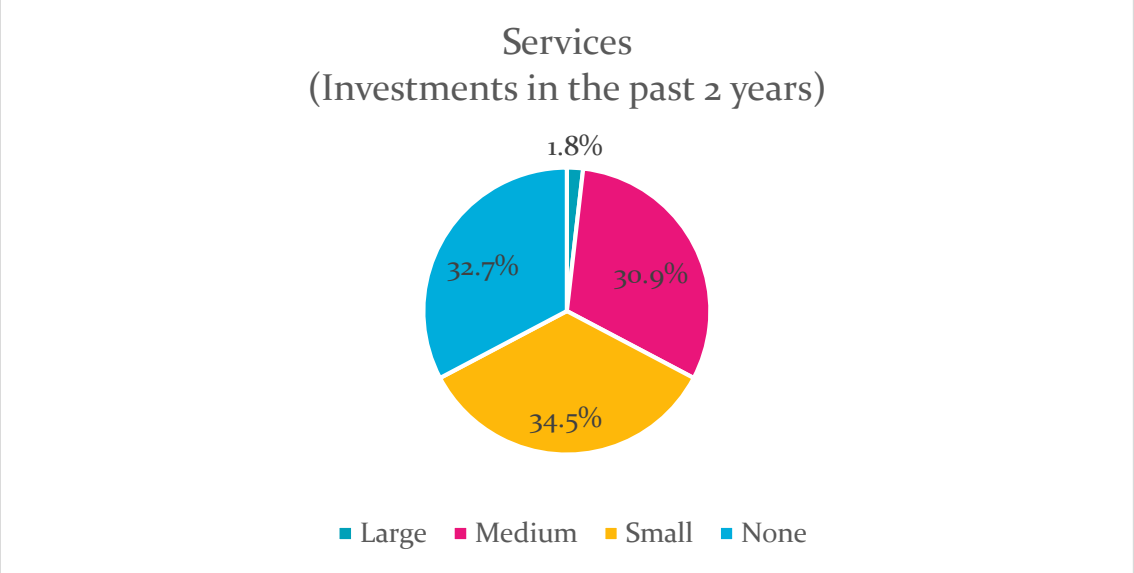


Figure 14 Service (Investments in the past 2 years)

- IT

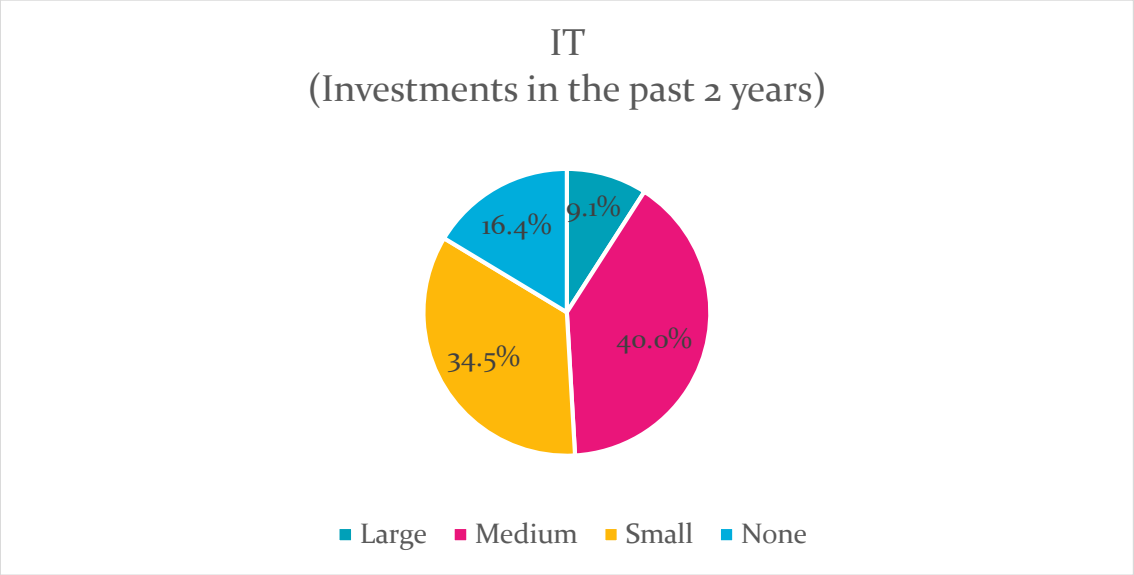


Figure 15 IT (Investments in the past 2 years)

Investments in the next 5 years

- Research and development

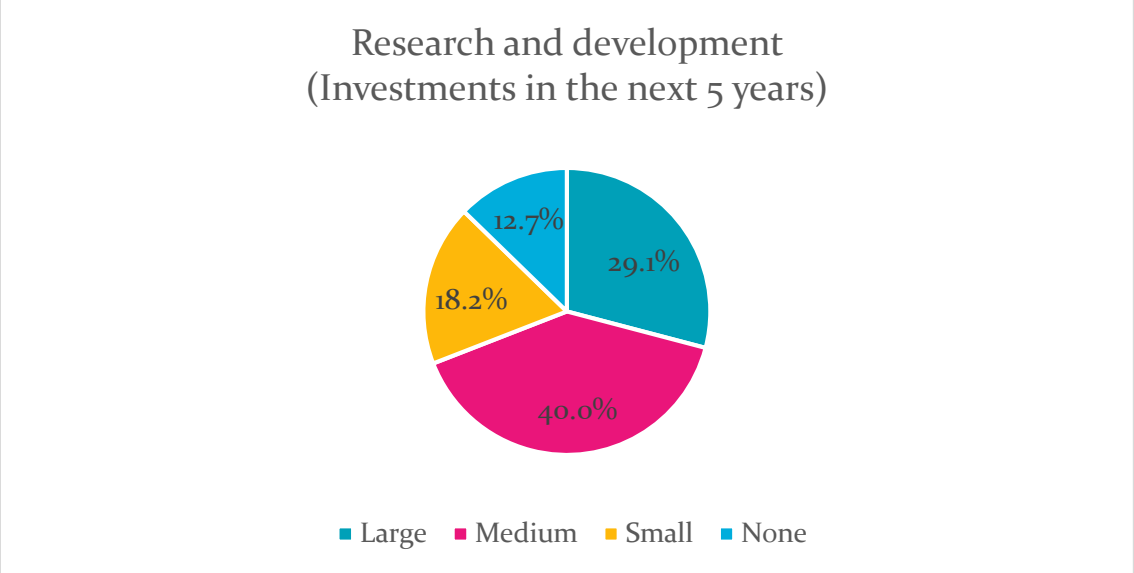


Figure 16 Research and development (Investments in the next 5 years)

- Production/Manufacturing

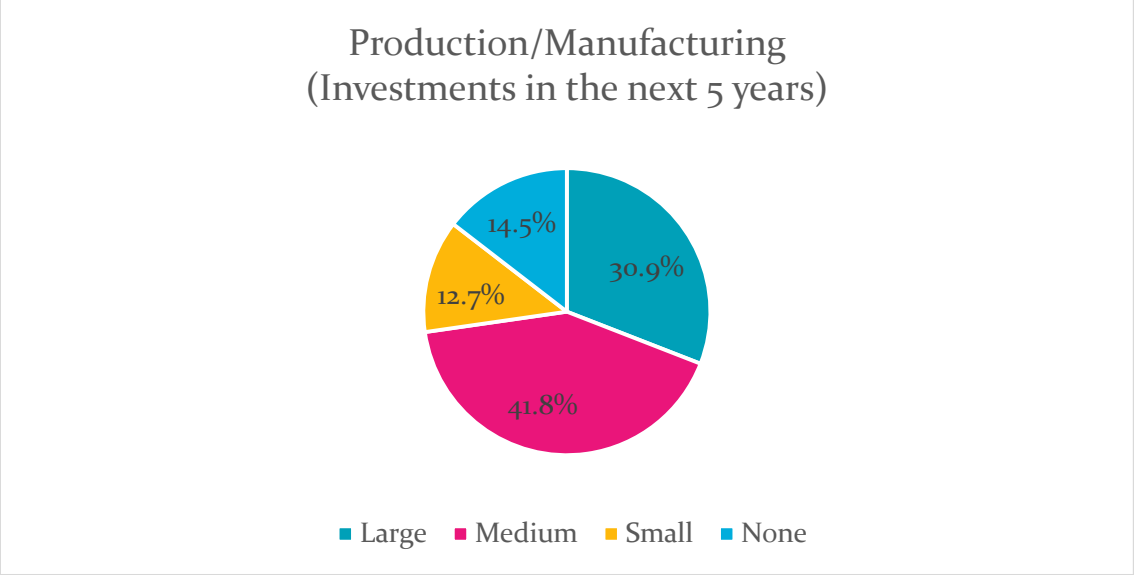


Figure 17 Production/Manufacturing (Investments in the next 5 years)

- Purchasing

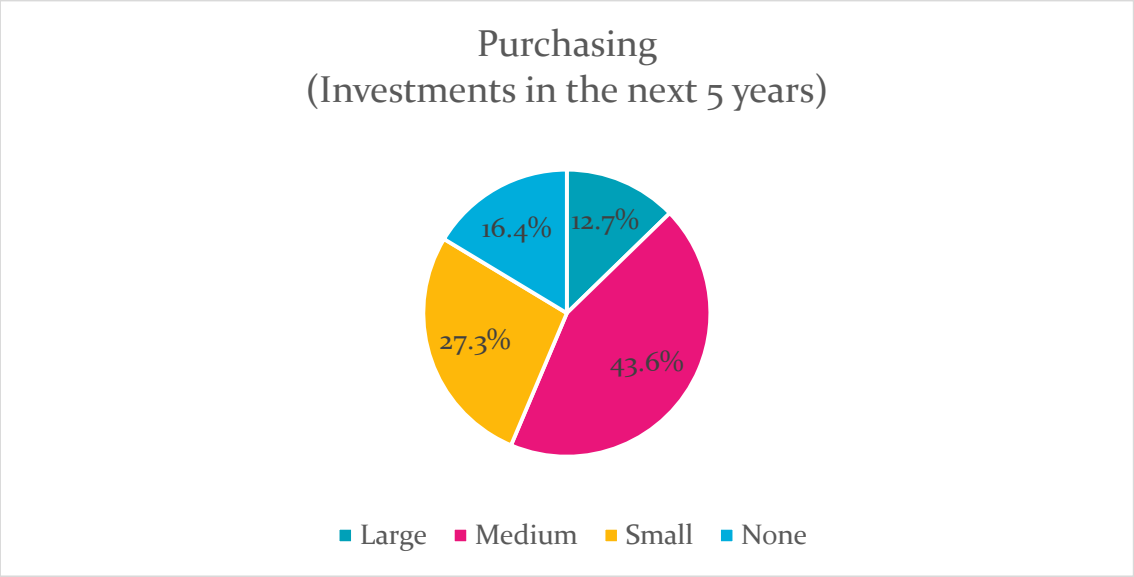


Figure 18 Purchasing (Investments in the next 5 years)

- Logistics

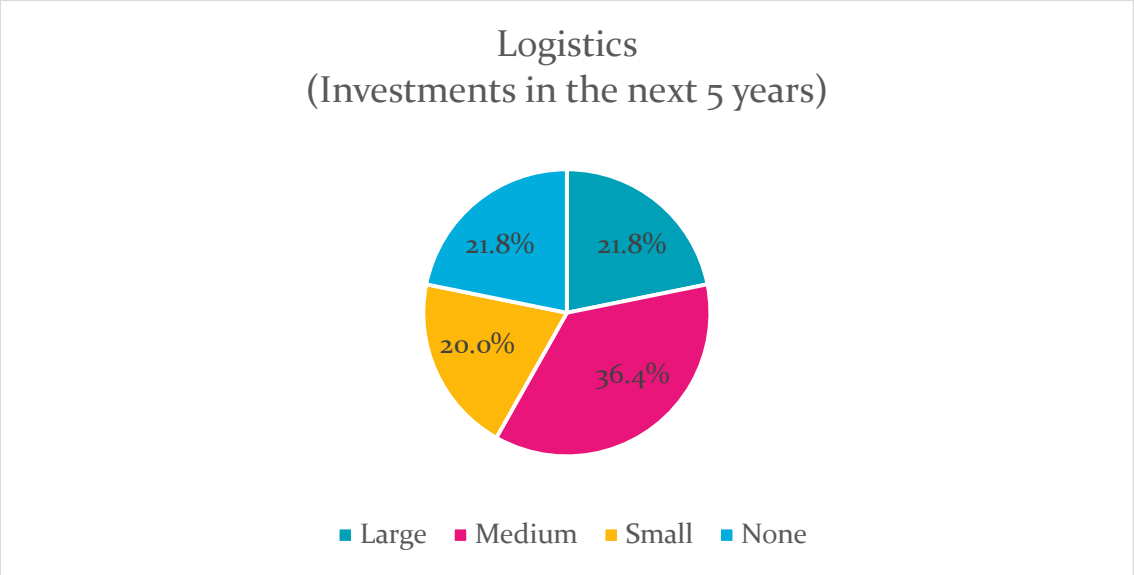


Figure 19 Logistics (Investments in the next 5 years)

- Sales

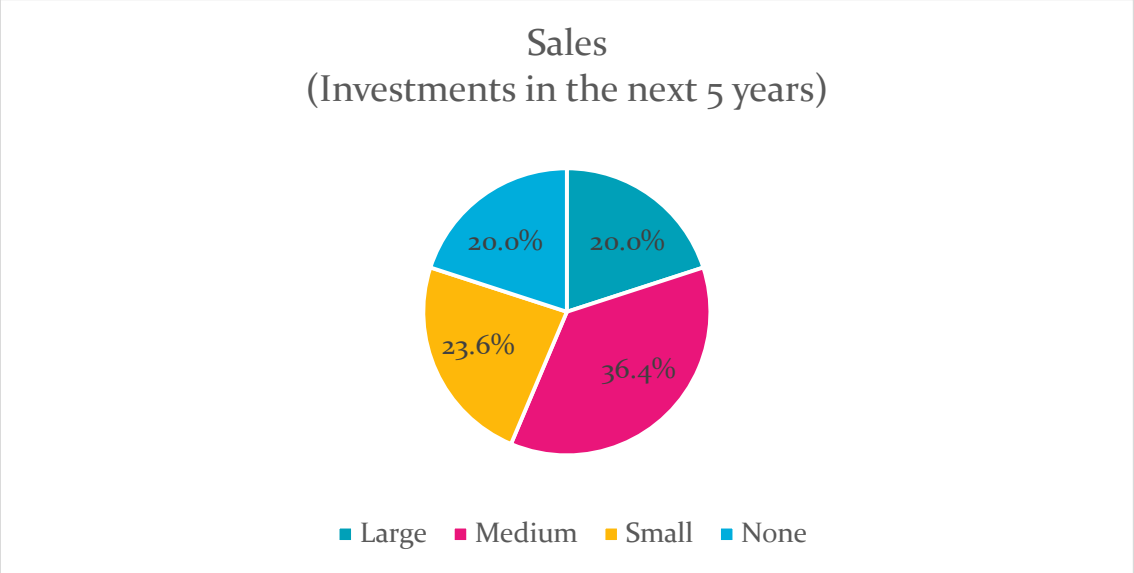


Figure 20 Sales (Investments in the next 5 years)

- Service

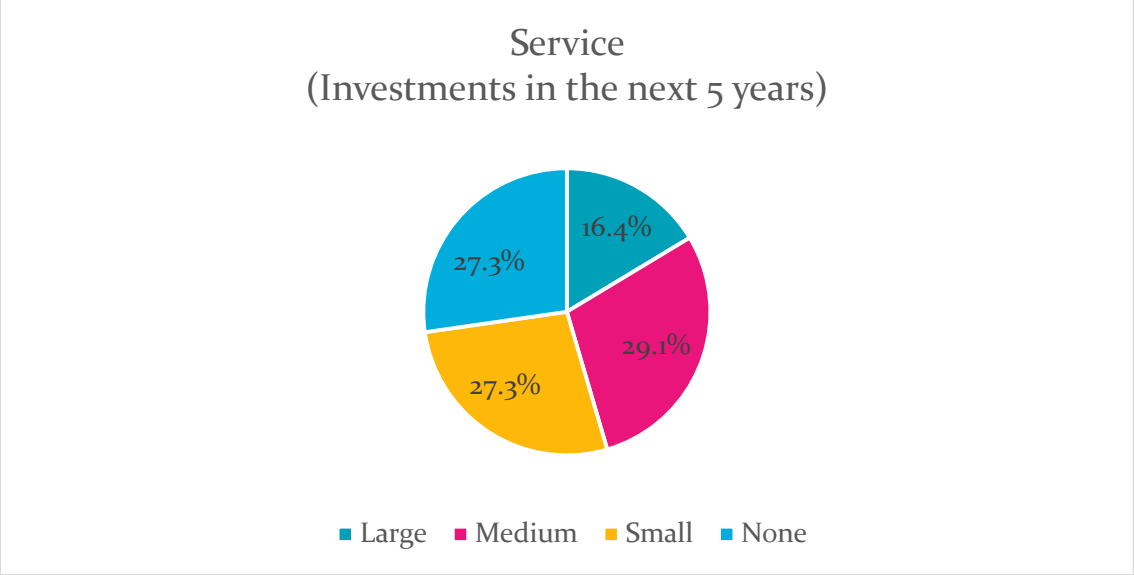


Figure 21 Service (Investments in the next 5 years)

- IT

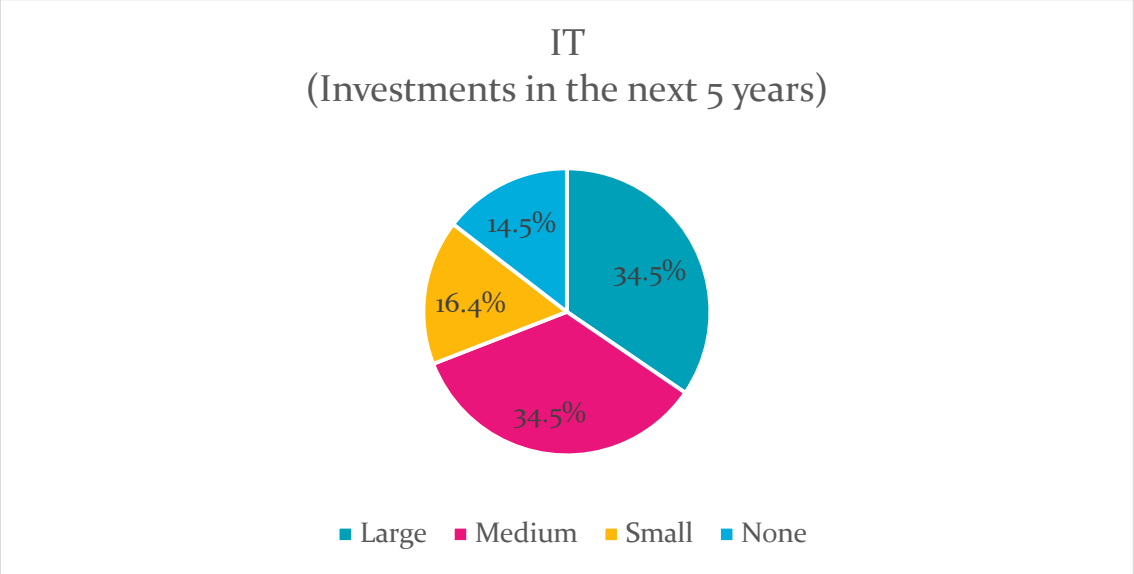


Figure 22 IT (Investments in the next 5 years)

Q1.5 In which areas does your company have systematic technology and innovation management? (Can answer more than 1)

- ☐ IT
- ☐ Production technology
- ☐ Product development
- ☐ Services
- ☐ Centralized, in integrative management
- ☐ Do not have

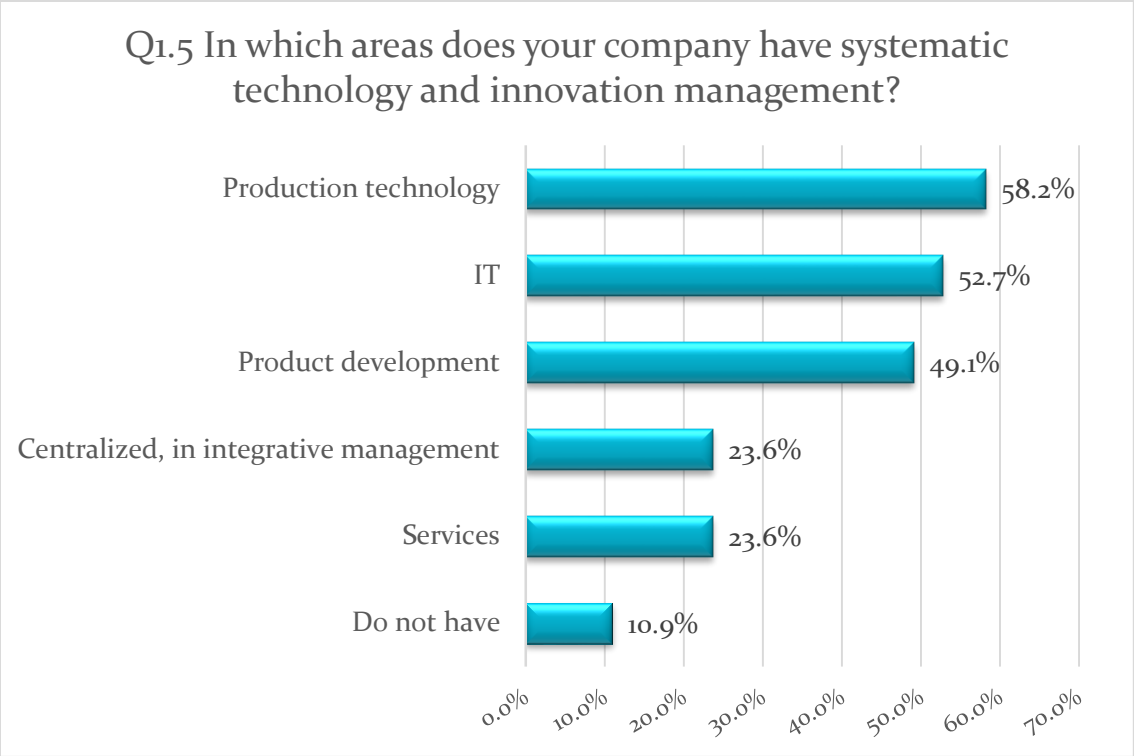


Figure 23 Q1.5 In which areas does your company have systematic technology and innovation management?

TO ENHANCE BUSINESS MODELS, PRODUCT & SERVICE

Q1.6a What is the level of contribution of Industry4.0 that your organization need in order to increase the competitiveness, overall value creation of your products & service?

☐ 1 (Industry4.0 is **not** relevance to business and we are not need to adopt it in next 5 years)
☐ 2 (Industry4.0 is **somewhat** relevance to business and we will need to adopt it in next 3 years)
☐ 3 (Industry4.0 is relevance to business and we are will need to adopt it in next 3 years)
☐ 4 (Industry4.0 is **very** relevance to business and we will need to adopt since past 3 years)
☐ 5 (Industry4.0 is **strongly** relevance to business and we are need to adopt it since past 5 years)

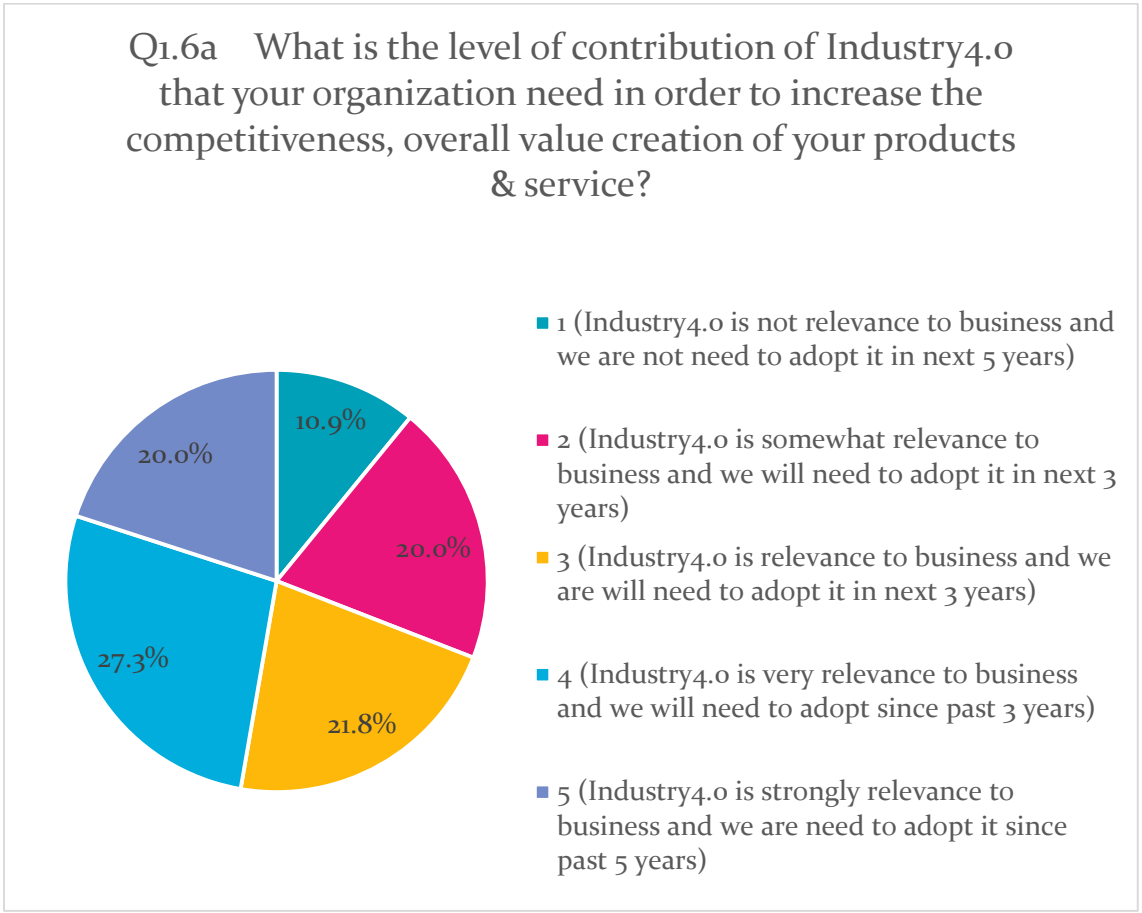


Figure 24 Q1.6a What is the level of contribution of Industry4.0 that your organization <u>need</u> in order to increase the competitiveness, overall value creation of your products & service?

Q1.6b What is the actual level of Industry4.0 that your organization is currently employing?

☐ 1 (We are not currently employing any of Industry4.0 because it is **not** relevance to business)

☐ 2 (We have adopted part of Industry4.0 because it is **somewhat** relevance to business)

☐ 3 (We have adopted part of Industry4.0 in the past 2 years because it is relevance to business)

☐ 4 (We have using Industry4.0 in the past 3 years because it is **very** relevance to business)

☐ 5 (We have fully employing Industry4.0 in the past 5 years because it is **strongly** relevance to business)

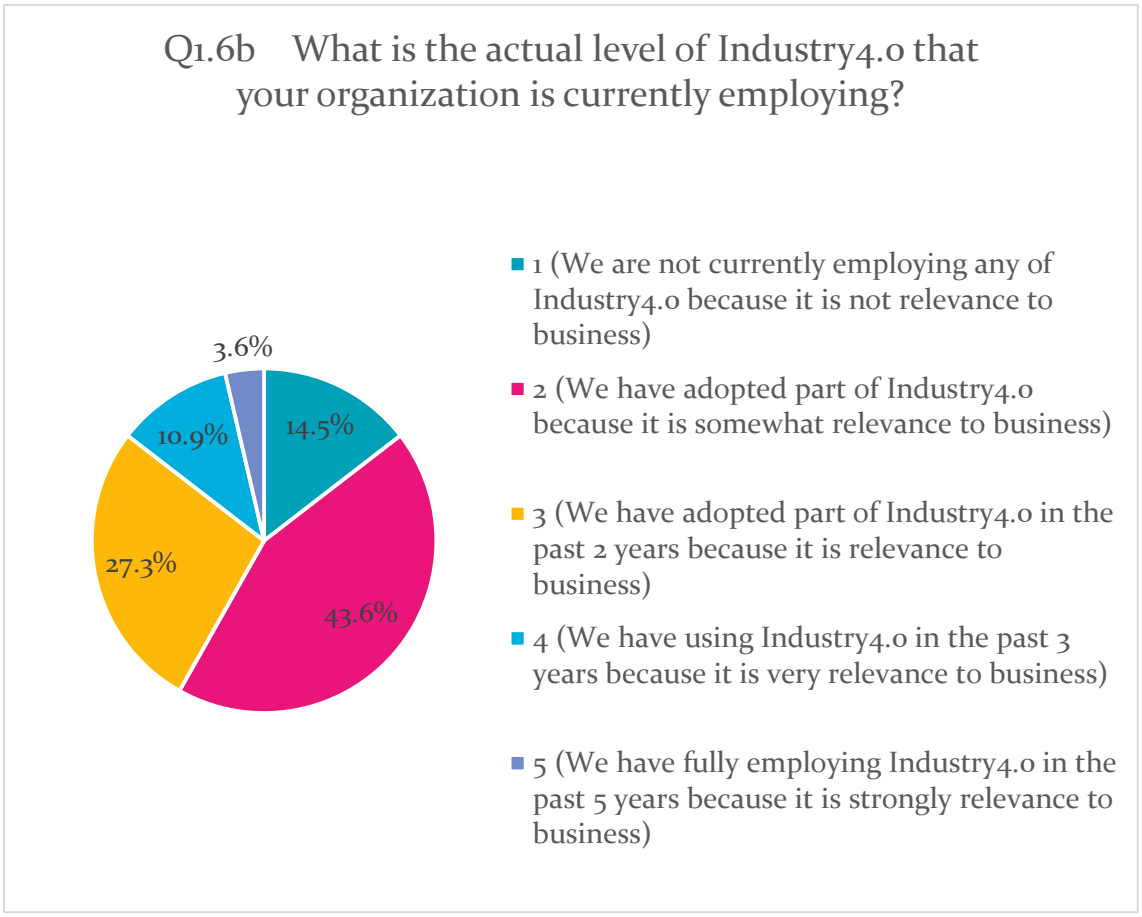


Figure 25 Q1.6b What is the actual level of Industry4.0 that your organization is currently employing?

Q1.7 To which degree is the average product in your portfolio digitized (e.g. RFID for identification, sensors, IoT connection, smart products etc.)?

☐ 1 (All our product and services are completely digitized and our portfolio is **never** based solely on digitized serviced/product)

☐ 2 (at least 25% of our product and services are digitized and our portfolio is **somewhat** based on digitized serviced/product)

☐ 3 (at least 50% of our product and services are digitized and our portfolio is based on digitized serviced/product)

☐ 4 (at least 75% of our product and services are digitized and our portfolio is **strongly** based on digitized serviced/product)

☐ 5 (All our product and services are **completely** digitized and our portfolio is **completely** based on digitized serviced/product)

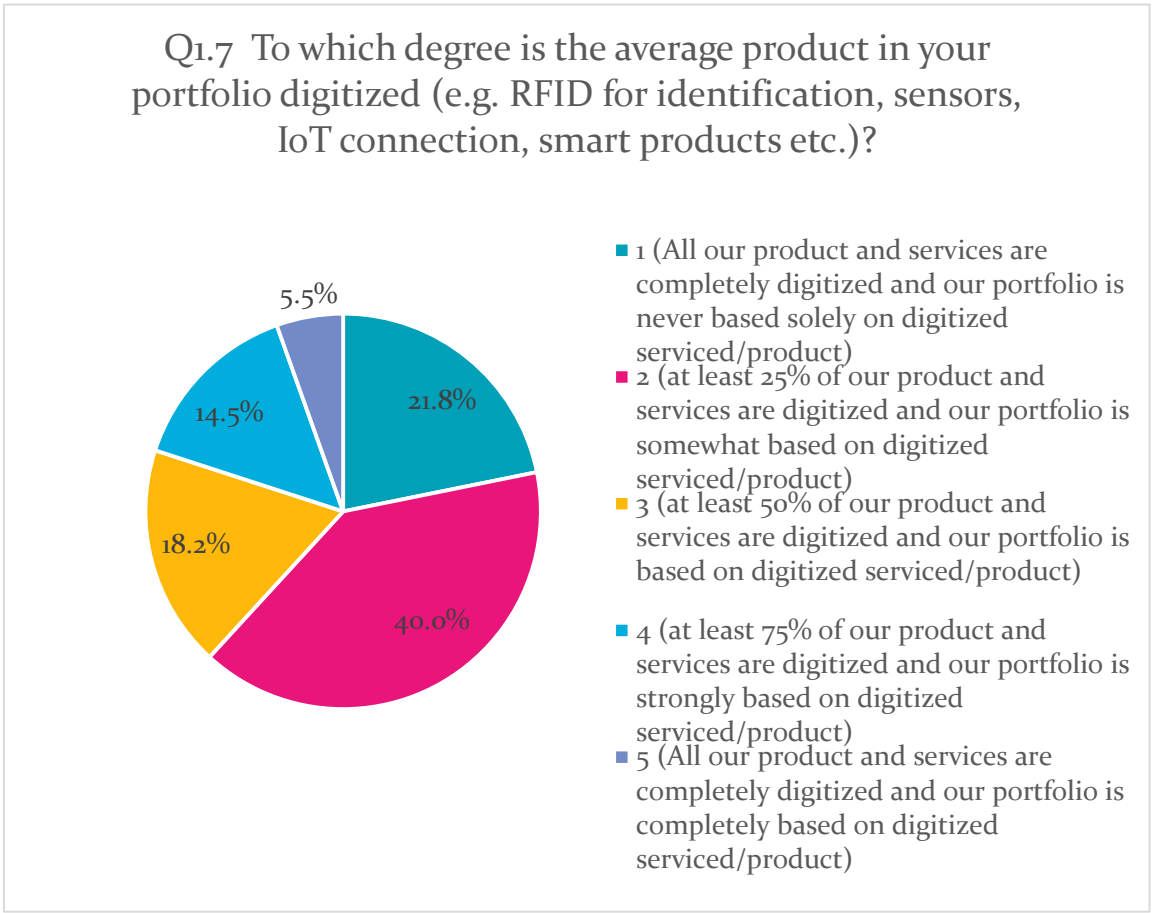


Figure 26 Q1.7 To which degree is the average product in your portfolio digitized (e.g. RFID for identification, sensors, IoT connection, smart products etc.)?

Q1.8 To which degree can your customers individualize the products they order?

☐ 1 (All our product and services are standardized mass production, cannot be defined by customer via configuration tools)

☐ 2 (at least 25% of our product and services can be defined by customer via configuration tools depending on lot size)

☐ 3 (at least 50% of our product and services can be defined by customer via configuration tools but cannot have lot size of 1)

☐ 4 (at least 75% of our product and services are defined by customer via configuration tools for customers, can have lot size of 1)

☐ 5 (All our product and services are **completely** defined customer by via configuration tools for customers, can have lot size of 1)

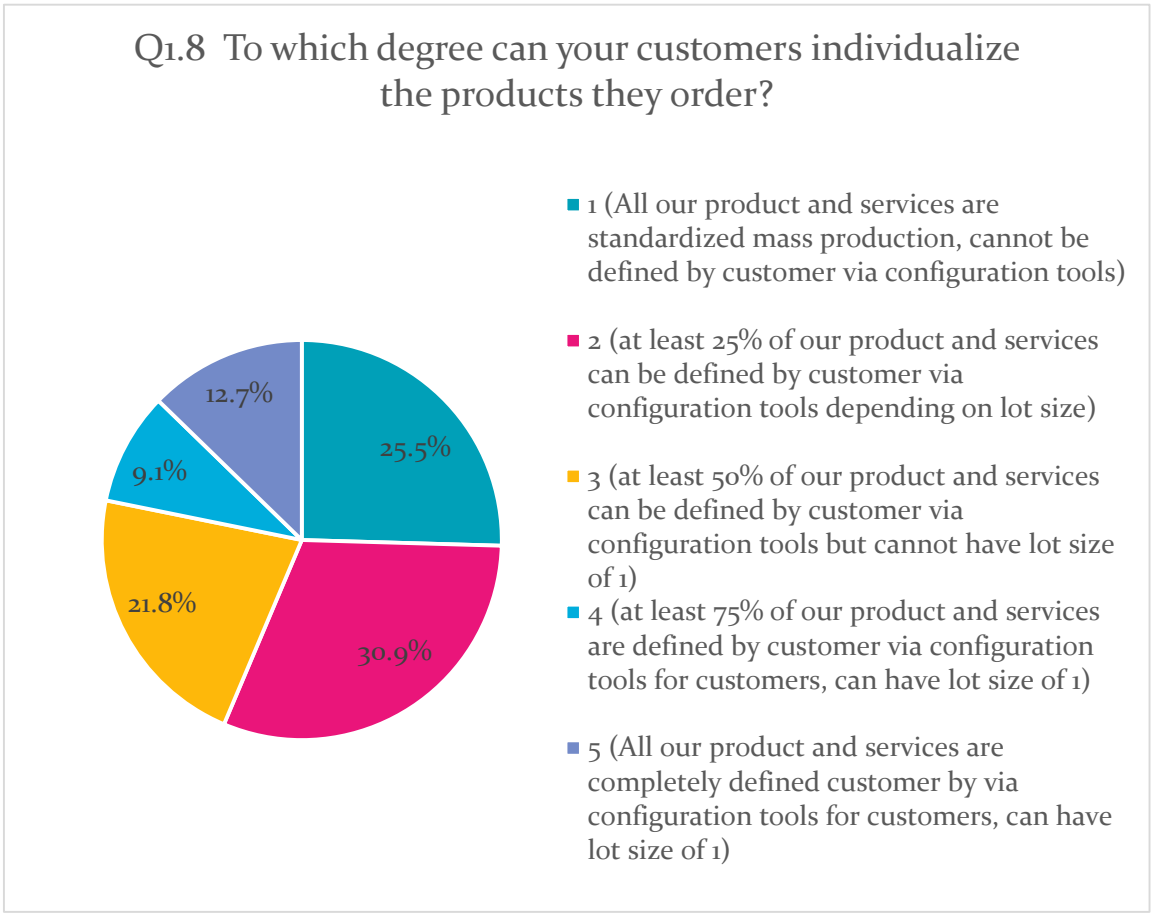


Figure 27 Q1.8 To which degree can your customers individualize the products they order?

Q1.9 To which degree are the life cycle phases of your products digitized (digitization and integration of design, planning, engineering, production, services & recycling)?

☐ 1 (No digitization & integration – None of any phases are digitized or using any IoT/IT as our basis operation

☐ 2 (Low digitization & integration – Only some phases such as design, planning, engineering are partly digitized for basis operation (e.g., using IT and software designed specifically for company operation)

☐ 3 (Medium digitization & integration – Only design, planning, engineering phases are digitized (e.g., producibility can directly be evaluated via virtual prototyping, virtual design)

☐ 4 (High digitization & integration – All phases in the product life cycle are **mostly** digitized from design, planning, engineering, production, services & recycling (e.g., producibility can directly be tested during product development via virtual prototyping)

☐ 5 (Complete digitization & integration - All phases in the product life cycle are **completely** digitized from design, planning, engineering, production, services & recycling (e.g., Quality, Producibility, Productivity can directly be tested during product development via virtual prototyping, virtual process)

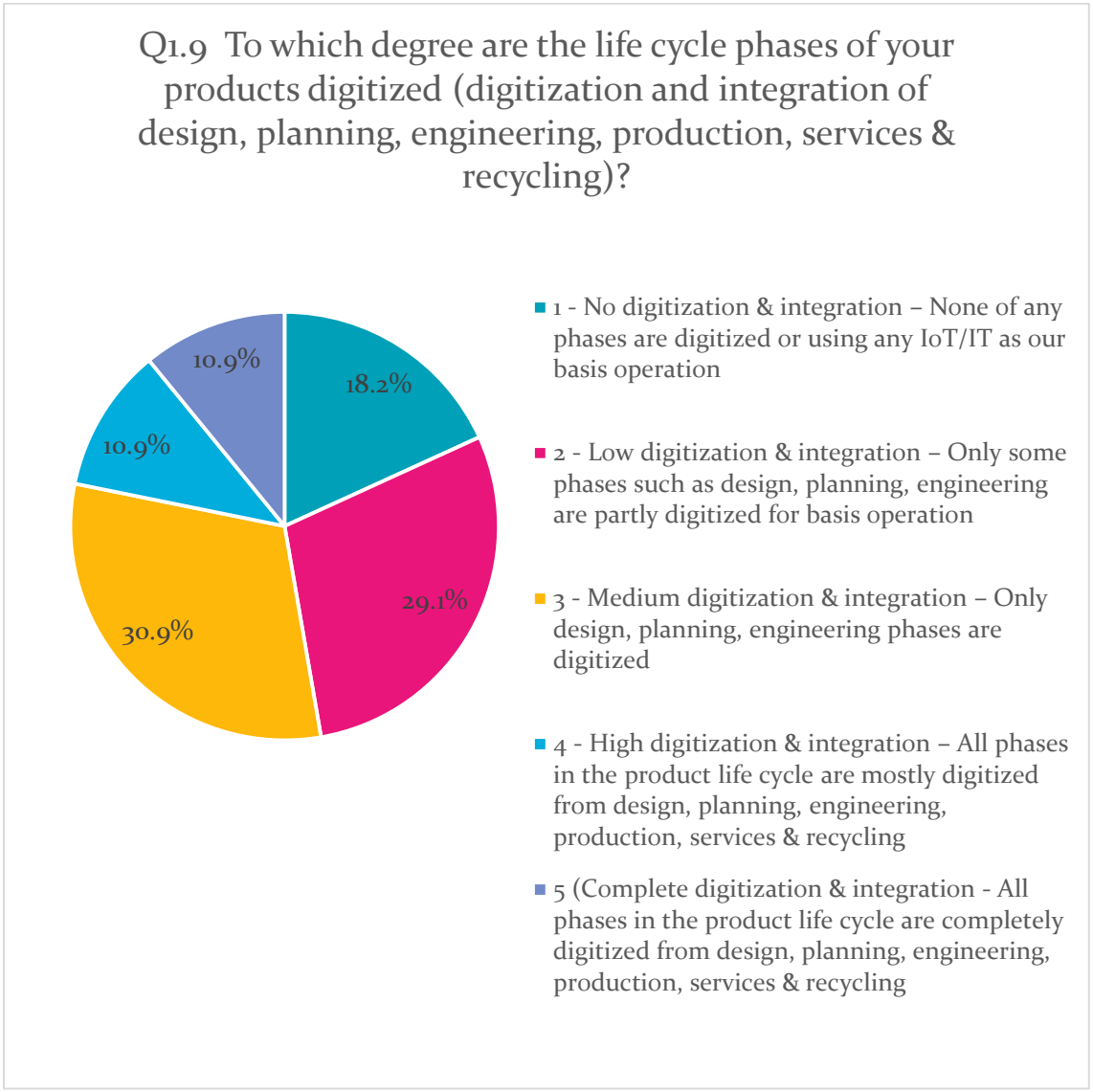


Figure 28 Q1.9 To which degree are the life cycle phases of your products digitized (digitization and integration of design, planning, engineering, production, services & recycling)?

Q1.10 How important is the usage and analysis of data (customer data, product or machine generated data) for your business model?

☐ 1 (No data analytics are relevant or leveraged to our business model. Customer data, product or machine data are not relevance to our operation. We plan to analyze and monitor those data in the next 3-5 years)

☐ 2 (Customer data, product or machine generated data is **somewhat** relevance to business, can be value driver of the business model and we will analyzed and monitored these generated data in the next 1-3 years)

☐ 3 (Customer data, product or machine generated data is relevance to business, the value driver of the business model and we have analyzed and monitored these generated data in the past 1-3 years)

☐ 4 (All customer data, product or machine generated data is **very** relevance to business, the main value driver of the business model and we have analyzed and monitored these generated data in the past 2-3 years)

☐ 5 (Crucial - Data is the main value driver of the business model. All customer data, product or machine generated data is **strongly** relevance to business and we are continuously analyzing and monitoring these generated data in the past 3-5 years)

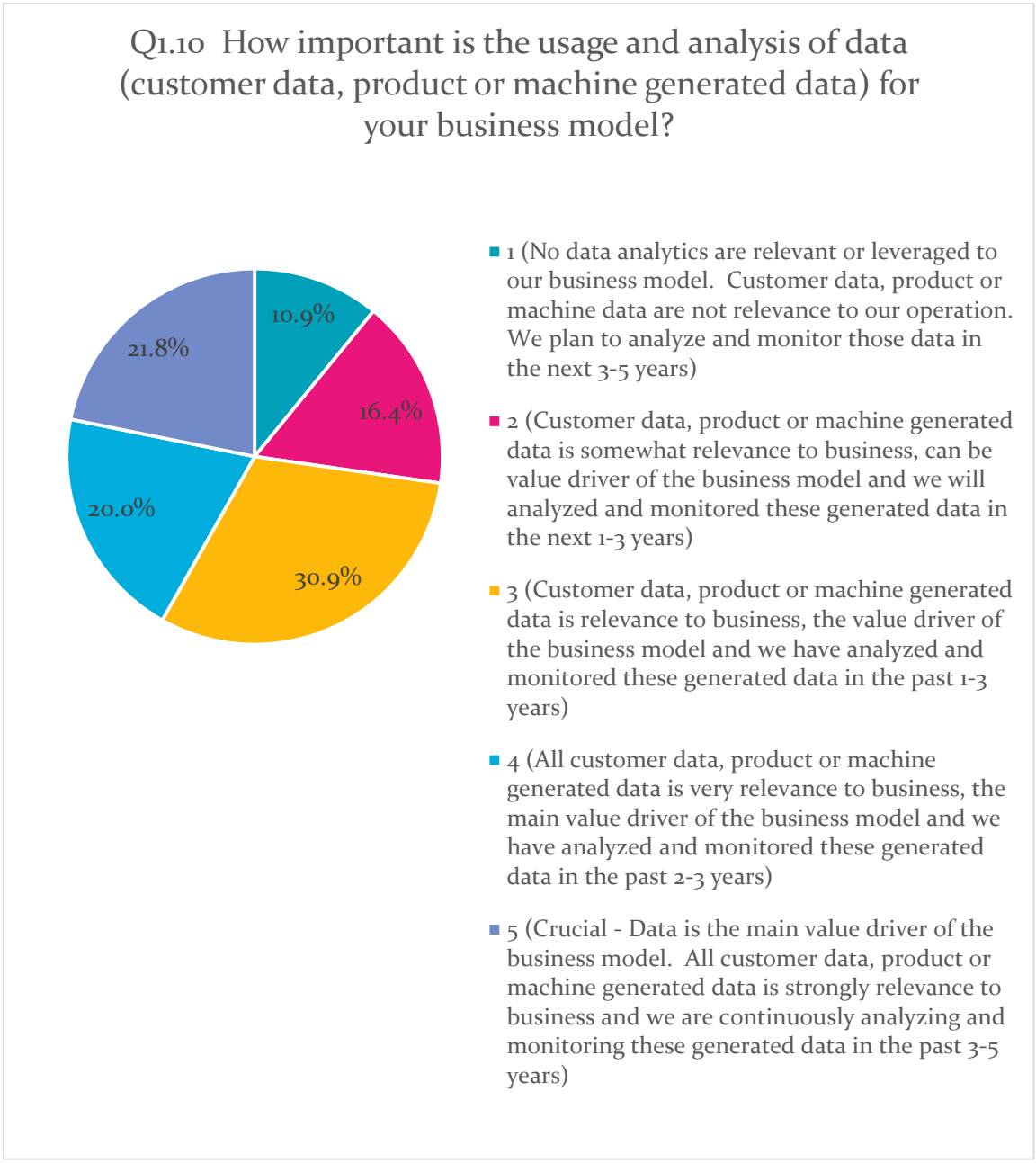


Figure 29 Q1.10 How important is the usage and analysis of data (customer data, product or machine generated data) for your business model?

Q1.11 How intense is your collaboration with partners, suppliers and clients for development of products and services?

☐ 1 (No Collaboration - Product development is done completely in-house without any exchange of information with partners, suppliers or customers)

☐ 2 (Low - collaboration - Collaborative development of products together with partners are low in our supply chain networks, can be communicated but cannot be integrated)

☐ 3 (Medium - collaboration - Collaborative development of products together with partners has been employed our supply chain networks, but are not integrated, transparent for the customers)

☐ 4 (High - collaboration - Collaborative development of products together with partners has been employed throughout our supply chain networks, and are transparent for the customers in the past 1-3 years)

☐ 5 (Crucial - collaboration - Collaborative development of products together with partners has been employed throughout our supply chain networks, and are transparent for the customers in the past 3-5 years)

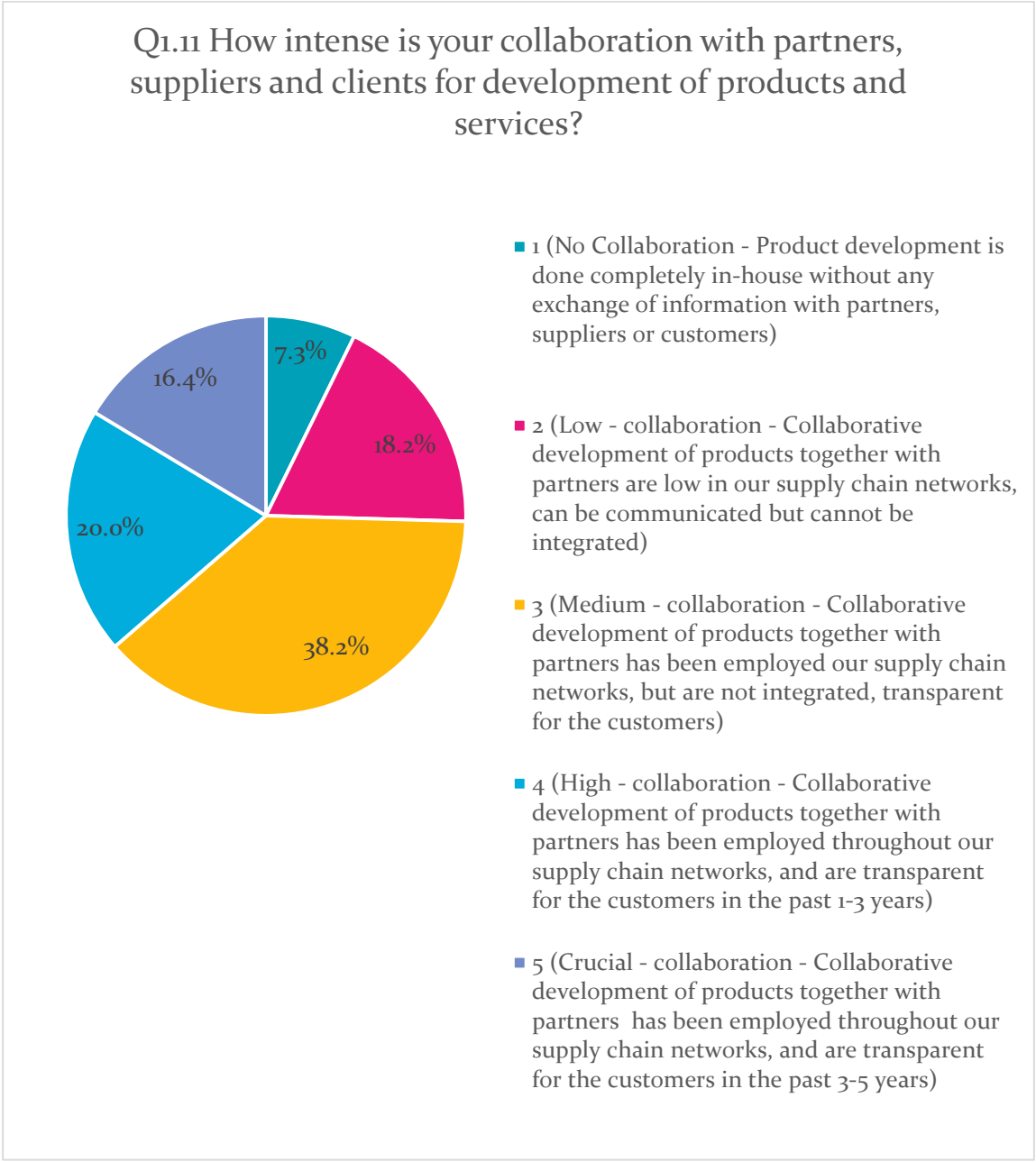


Figure 30 How intense is your collaboration with partners, suppliers and clients for development of products and services?

2. TRANSVERSAL&DOMAIN RELATED COMPETENCES: EMPLOYEES

Employees help companies realize their digital transformation and are the ones most affected by the changes of the digital workplace. Their direct working environment is altered, requiring them to acquire new skills and qualifications. This makes it more and more critical that companies prepare their employees for these changes through appropriate training and continuing education.

Q2.1 How do you assess the skills of your employees when it comes to the future requirements under Industry 4.0?

- IT infrastructure

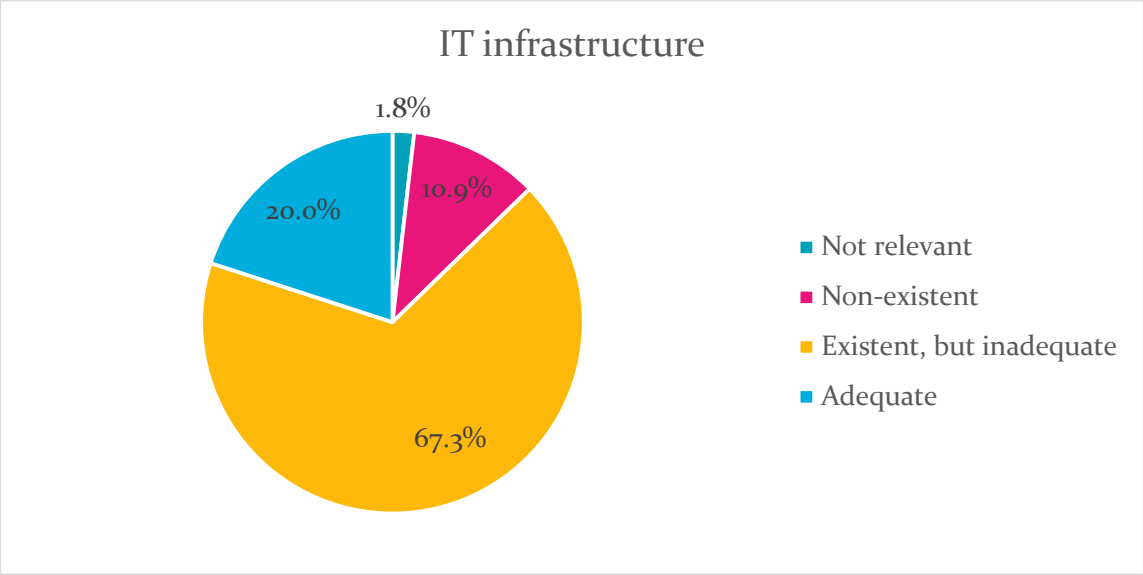


Figure 31 IT infrastructure

- Automation technology

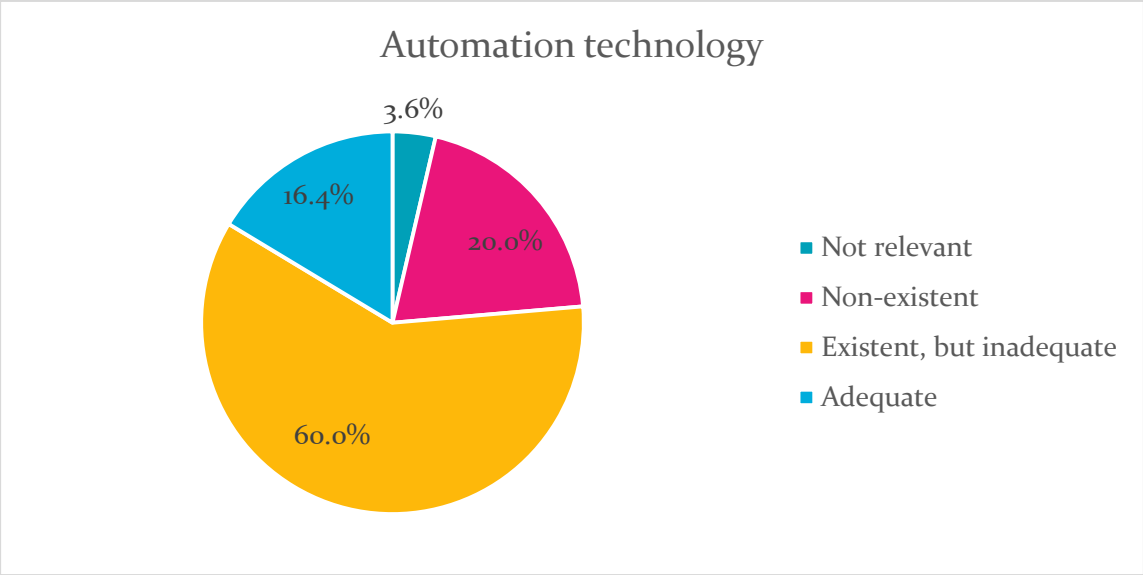


Figure 32 Automation technology

- Data analytics

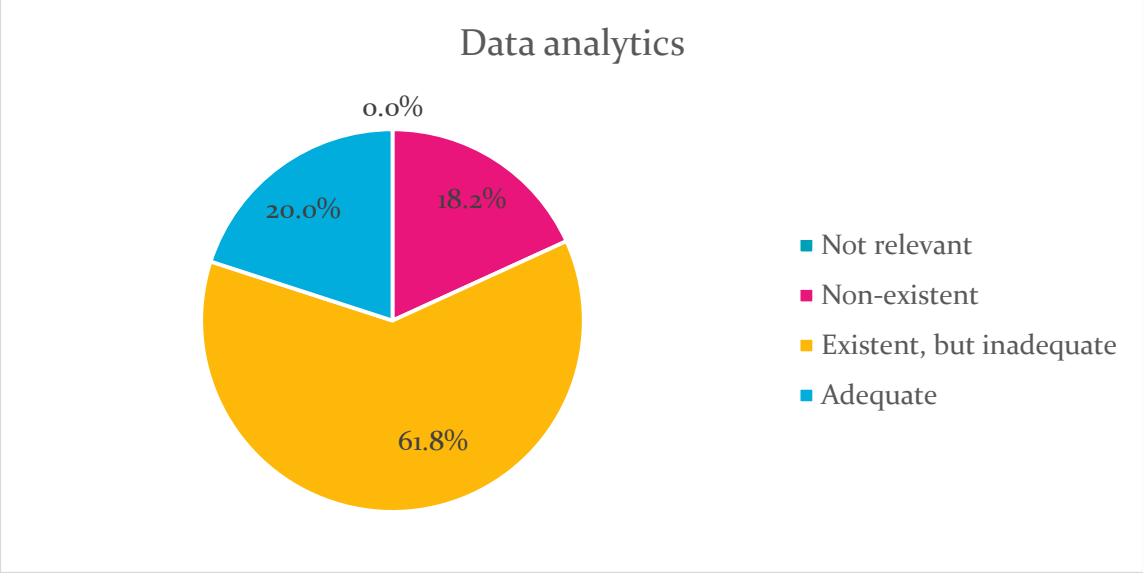


Figure 33 Data analytics

- Data security / communications security

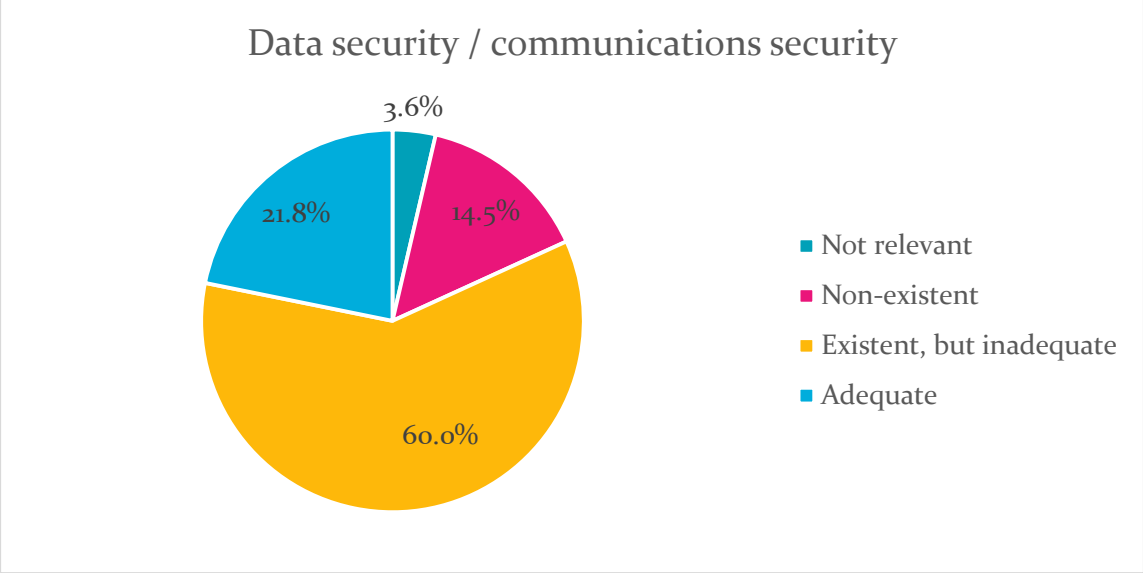


Figure 34 Data security / communications security

- Development or application of assistance systems

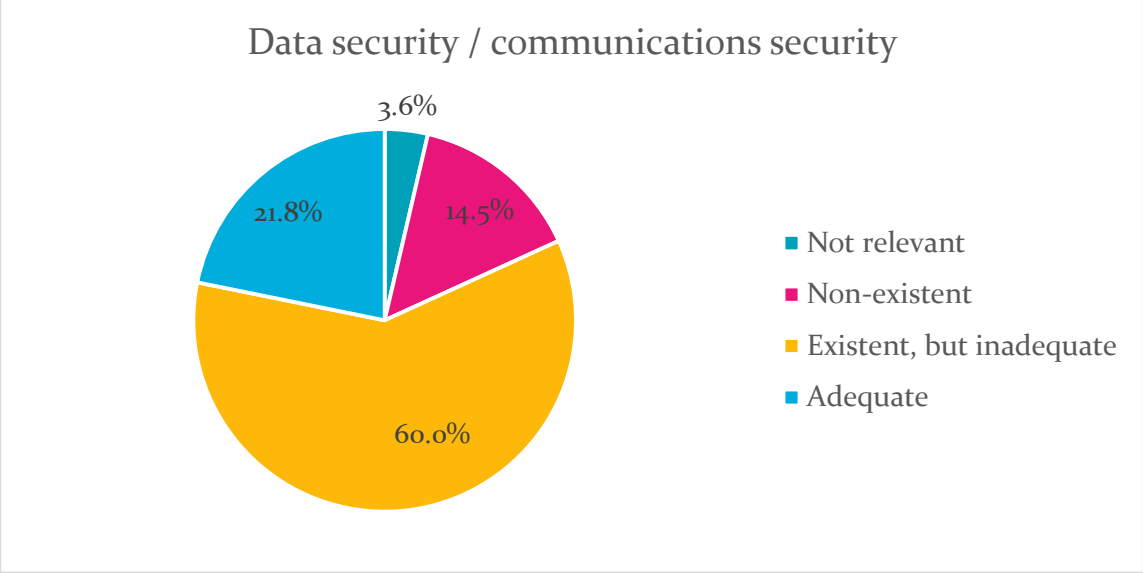


Figure 35 Development or application of assistance systems

- Collaboration software

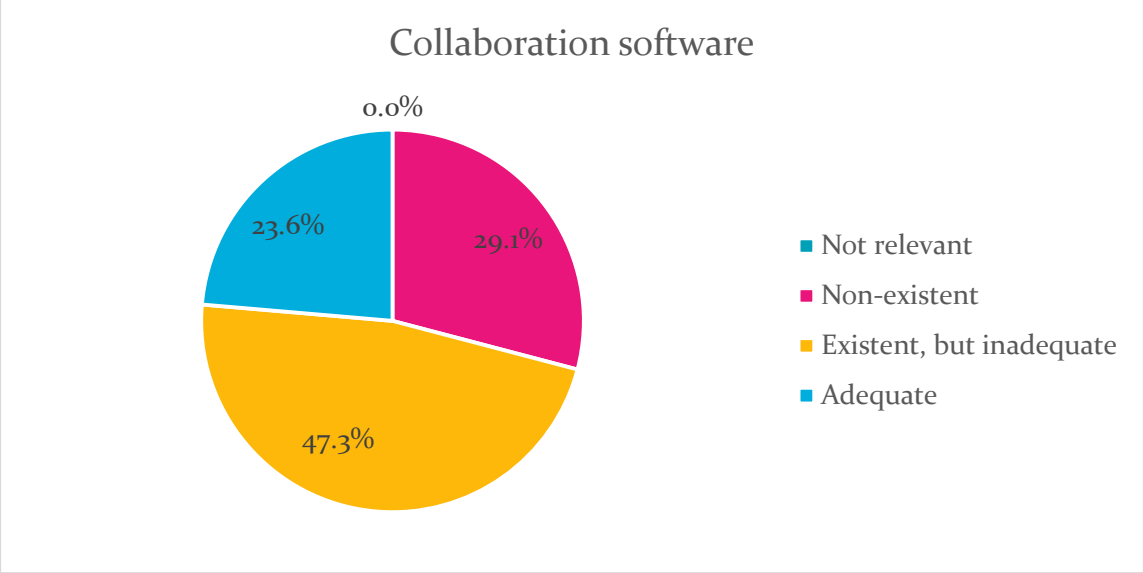


Figure 36 Collaboration software

- Non-technical skills such as systems thinking and process understanding

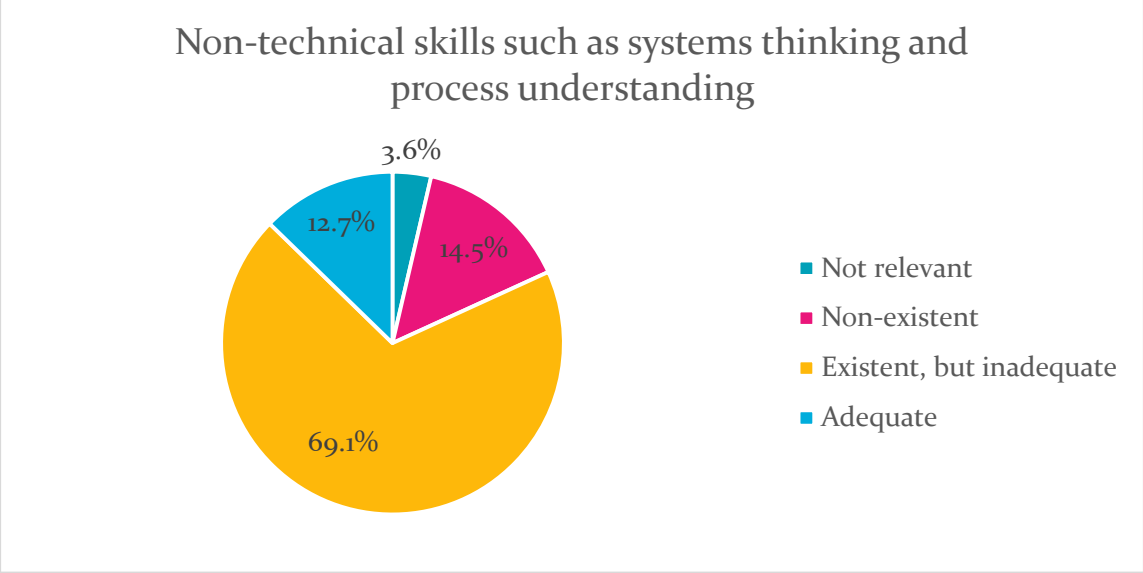


Figure 37 Non-technical skills such as systems thinking and process understanding

Q2.2 In which areas does your company need to have to attain Industry4.0?

(Can answer more than 1)

- ☐ IT
- ☐ Production technology
- ☐ Product development
- ☐ Services
- ☐ Centralized, in integrative management
- ☐ Do not have

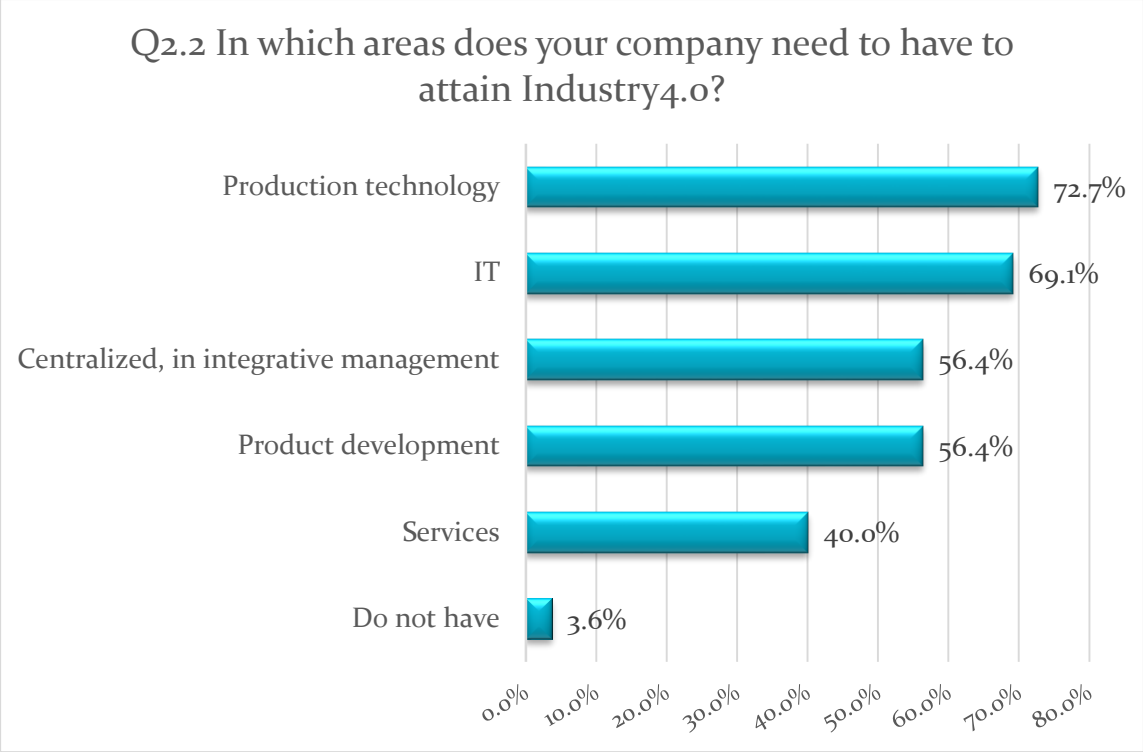


Figure 38 Q2.2 In which areas does your company need to have to attain Industry4.0?

Q2.3 What kind and level of competence that your company will need for new employees when it comes to the Industry 4.0?

- IT infrastructure

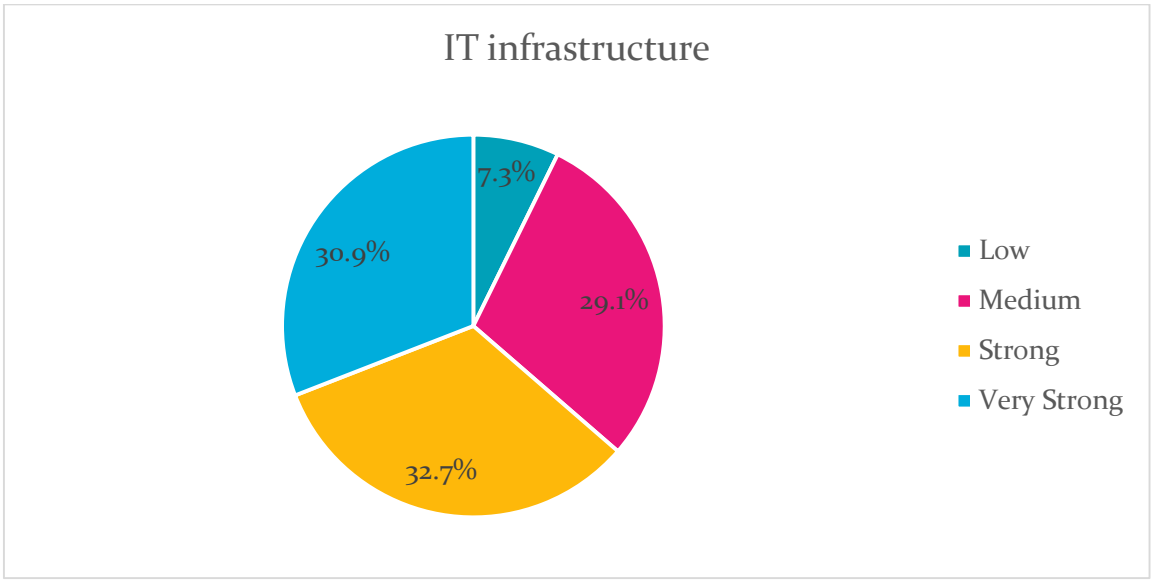


Figure 39 IT infrastructure

- Automation technology

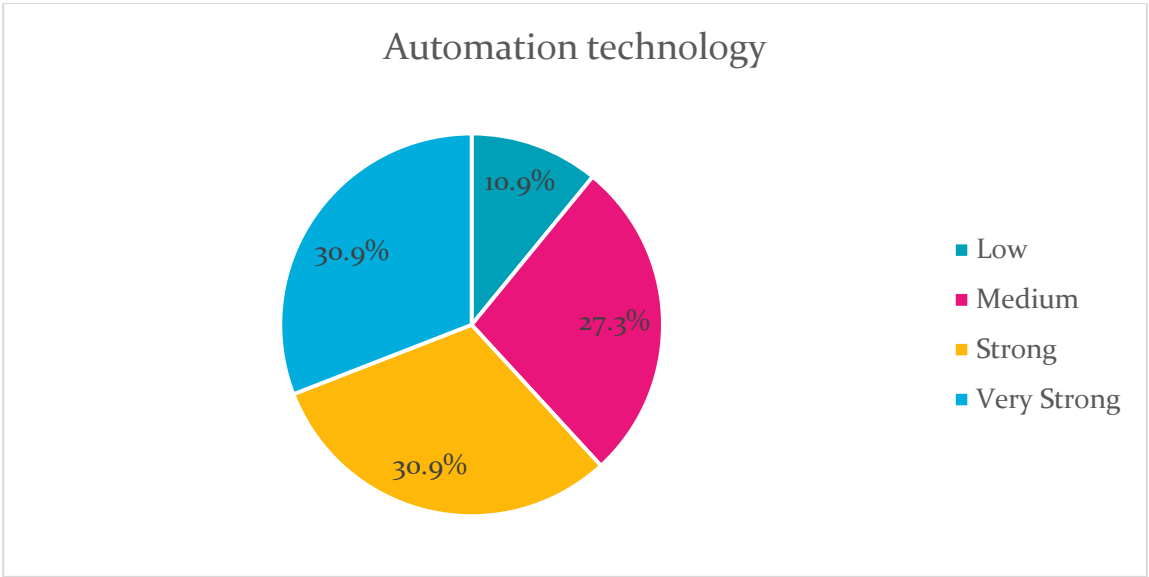


Figure 40 Automation technology

- Data analytics

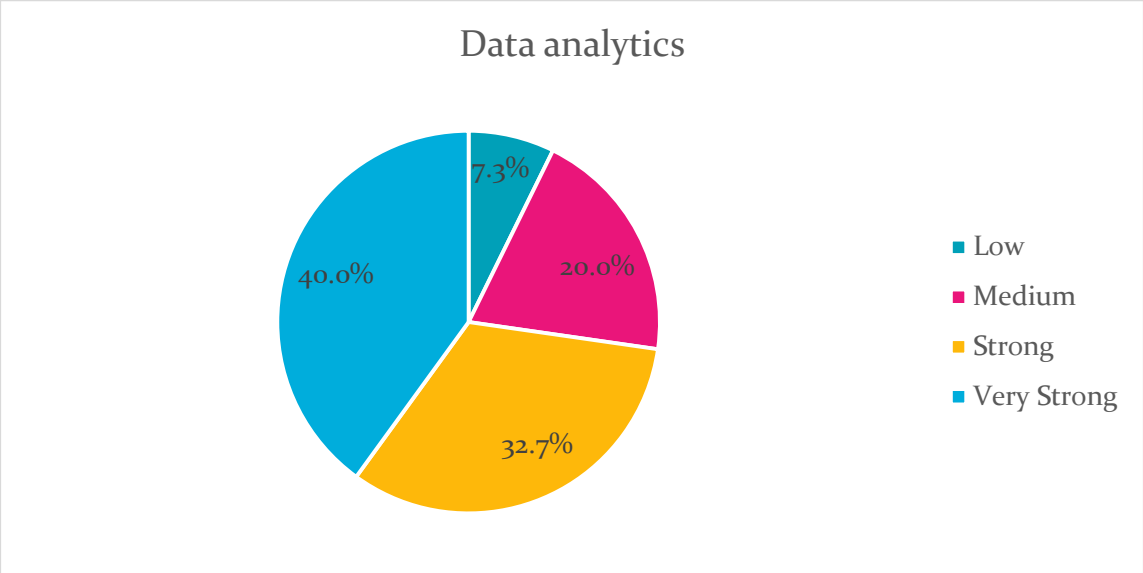


Figure 41 Data analytics

- Data security / communications security

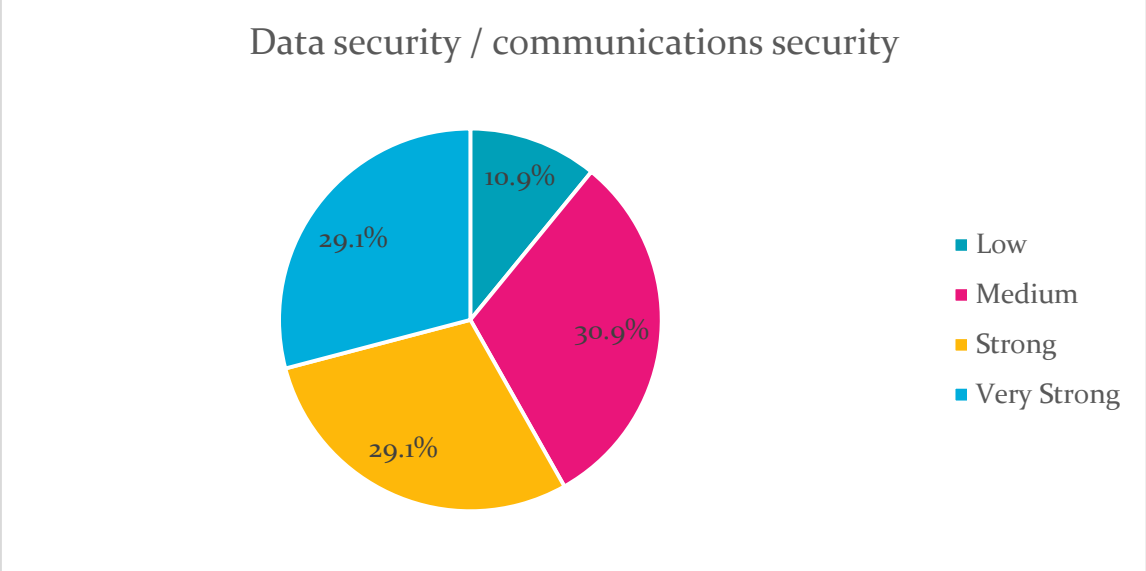


Figure 42 Data security / communications security

- Development or application of assistance systems

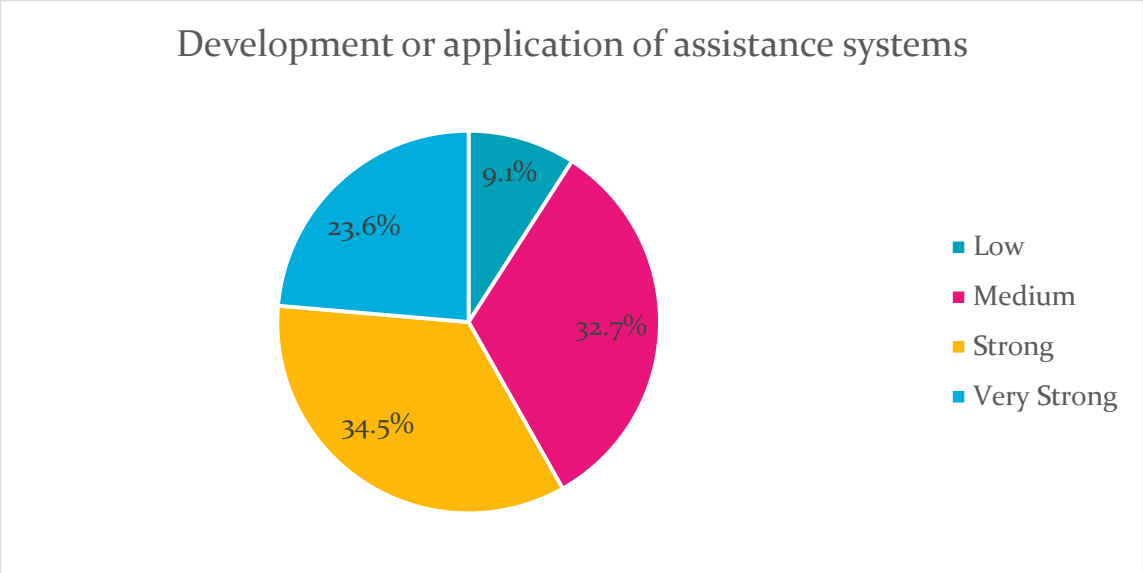


Figure 43 Development or application of assistance systems

- Collaboration software

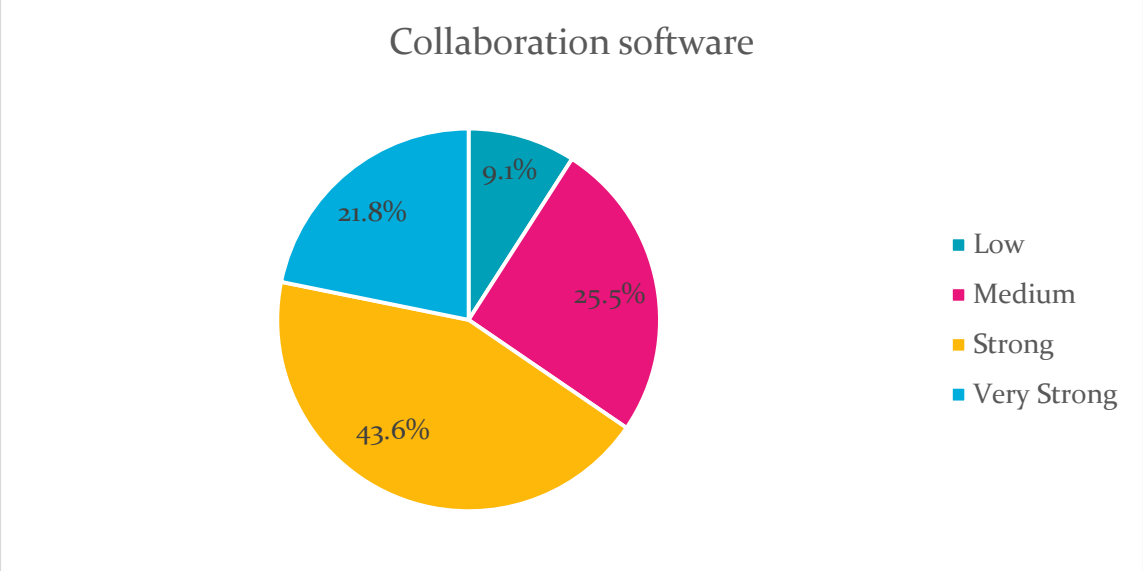


Figure 44 Collaboration software

- Non-technical skills such as systems thinking and process understanding

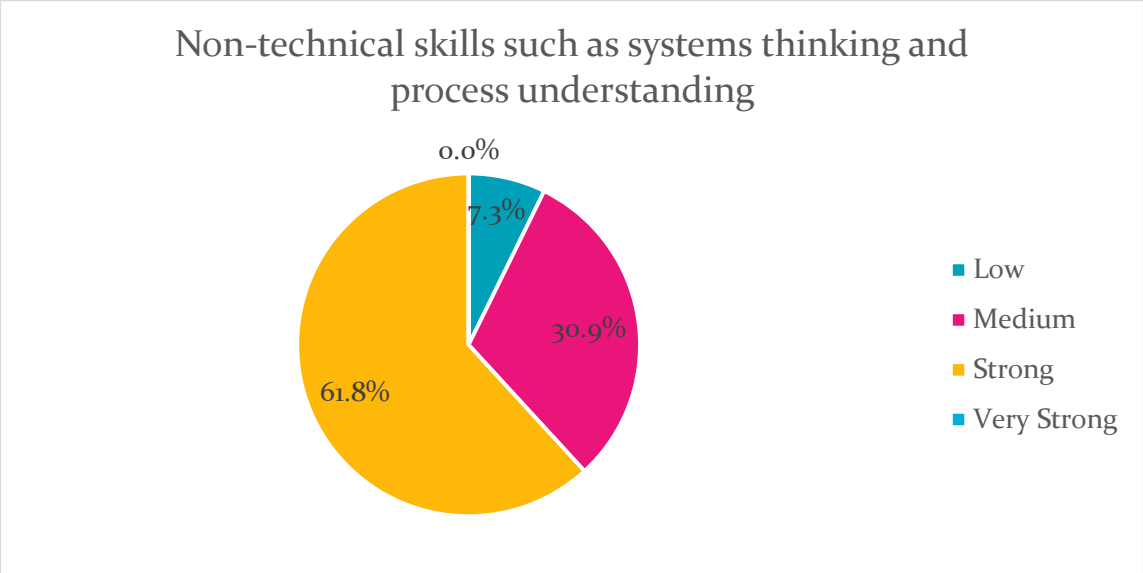


Figure 45 Non-technical skills such as systems thinking and process understanding

Q2.4 Are you making efforts to acquire the skills that are lacking? Through special training seminars, knowledge transfer systems, coaching, etc.

☐ Yes

☐ No

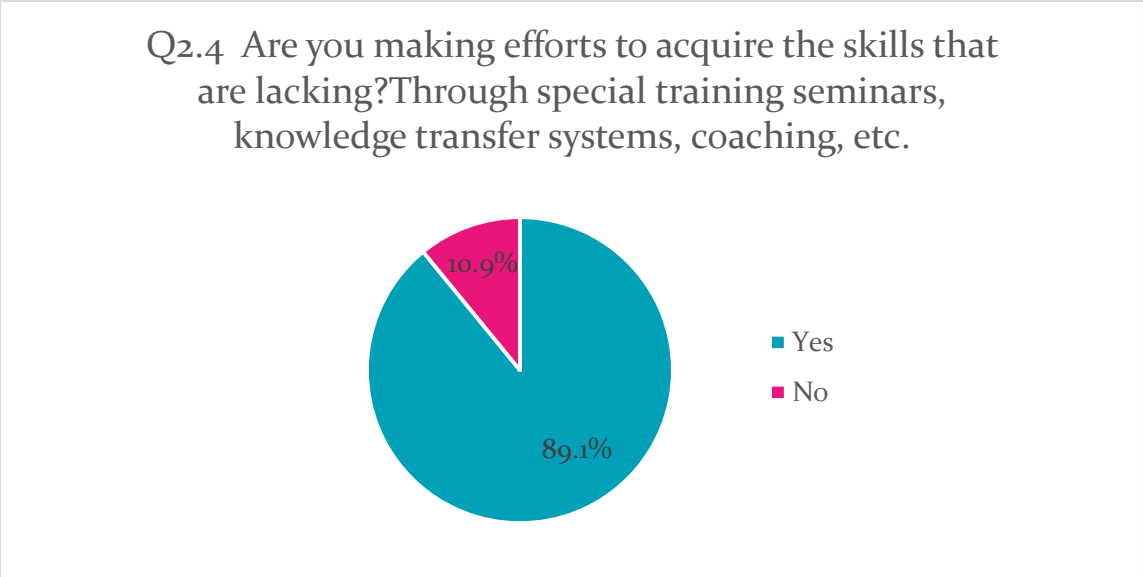


Figure 46 Q2.4 Are you making efforts to acquire the skills that are lacking? Through special training seminars, knowledge transfer systems, coaching, etc.

Q2.5 Which of the following technological competence do you need for employee to enhance business operation? (Can answer more than 1)

- ☐ Sensor technology
- ☐ Mobile end devices
- ☐ RFID
- ☐ Real¬time location systems
- ☐ Big data to store and evaluate real-time data
- ☐ Cloud technologies as scalable IT infrastructure
- ☐ Embedded IT systems
- ☐ M2M communications

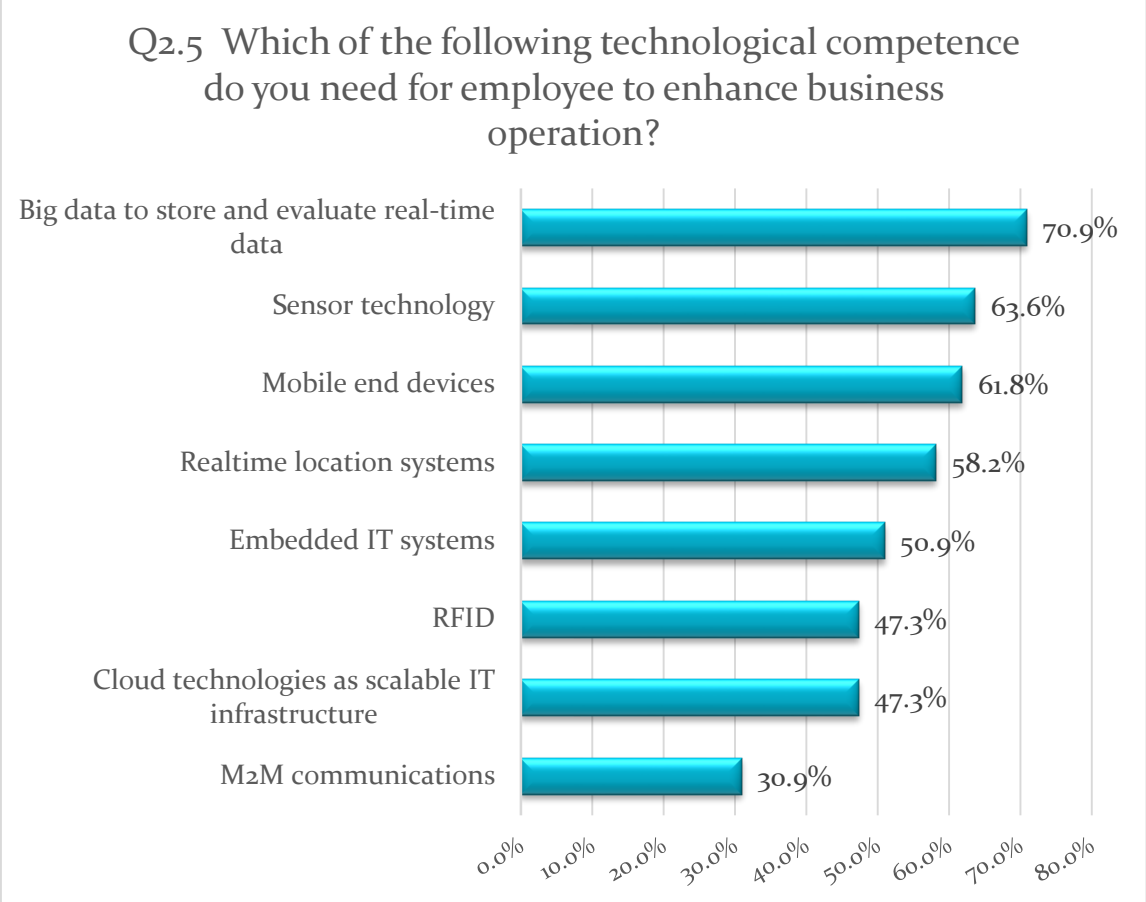


Figure 47 Q2.5 Which of the following technological competence do you need for employee to enhance business operation?

Part 2: Adoption Level

This is broken down into four dimensions of Industry 4.0, each containing questions on a different set of issues:

1. SMART PRODUCTS - CO-CREATED DESIGN CONCEPTS

The smart co-created design product are a vital value of the company and the customer by allowing the customer to co-construct the service experience to suit their context. This requires value-based collaboration between stakeholders and users, in contrast to standard market research. The Co-design is the process where stakeholders (business or customers) can involve and participate during the design development process to ensure the results meet their needs and are usable.

Smart Product where physical products are equipped with ICT components (sensors, RFID, communications interface, etc.) to collect data on their environment and their own status. Only when products gather data, know their way through production, and communicate with the higher-level systems can production processes be improved and guided autonomously and in real time. It also becomes possible to monitor and optimize the status of the individual products. This has potential applications beyond production alone. Using smart products during the usage phase makes new services possible in the first place – through communications between customers and manufacturers, for example.

Q1.1 Does your company allowing the customer to co design the product or service experience to suit their context?

- Product

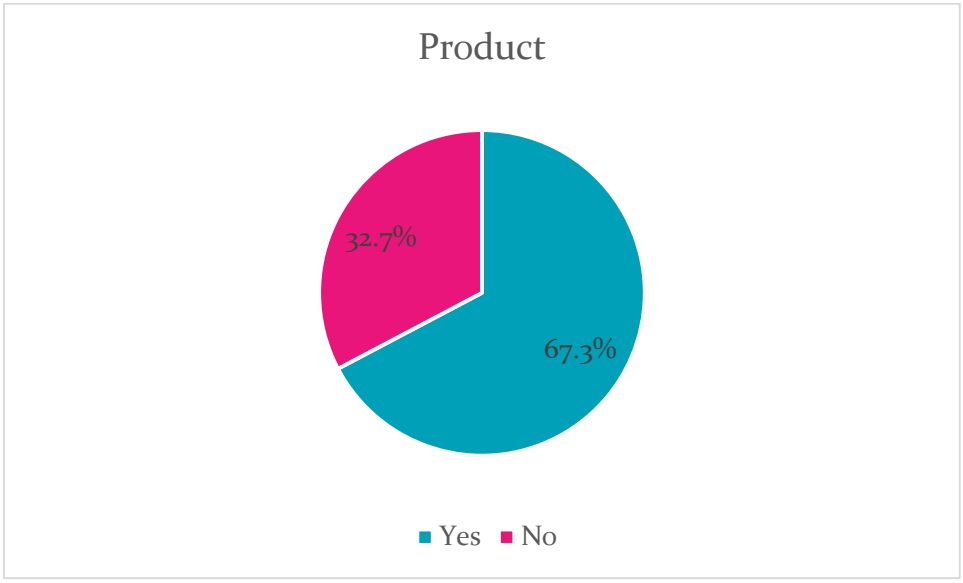


Figure 48 Product

- Product (IF Yes, please specify)

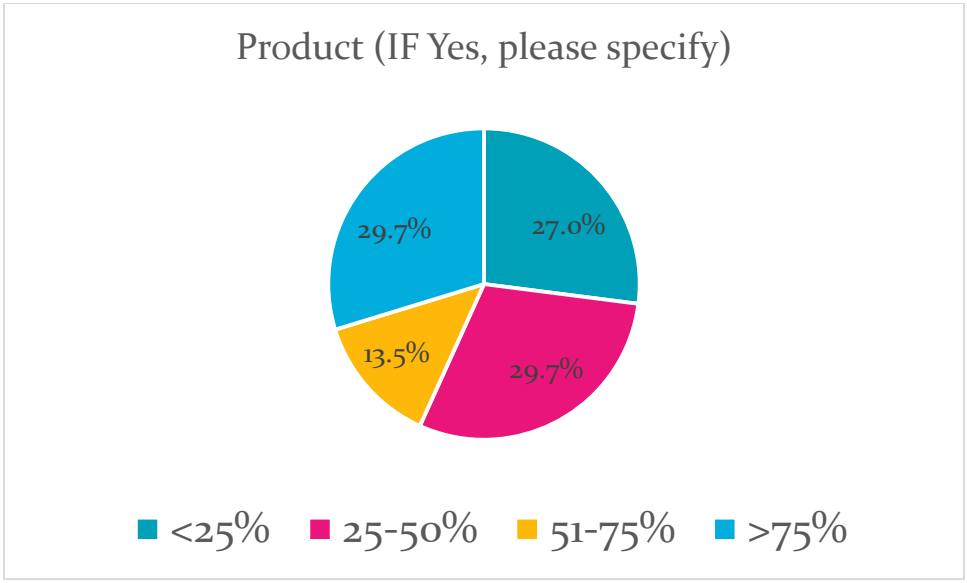


Figure 49 Product (IF Yes, please specify)

- Service

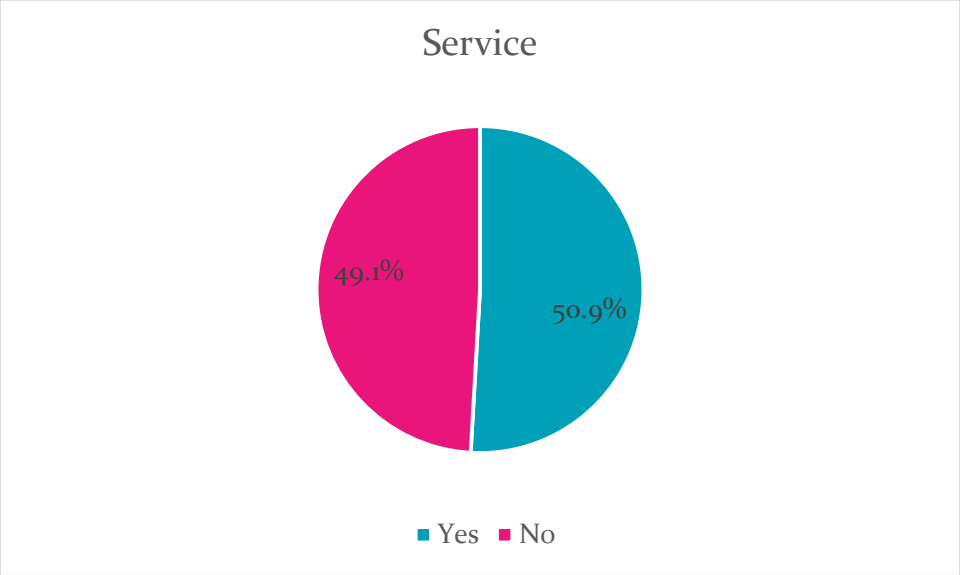


Figure 50Service

- Service (IF Yes, please specify)

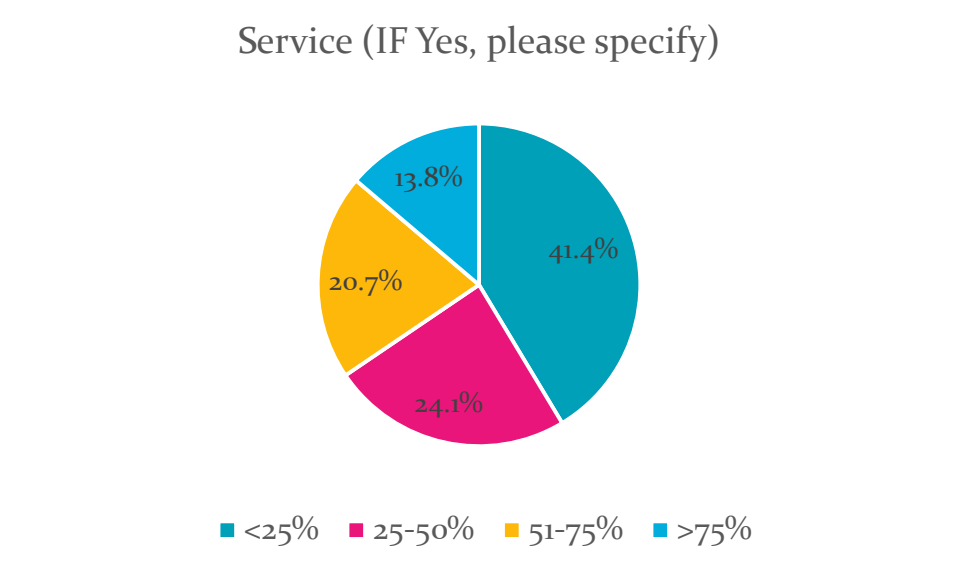


Figure 51 Service (IF Yes, please specify)

- Product/Service Integration

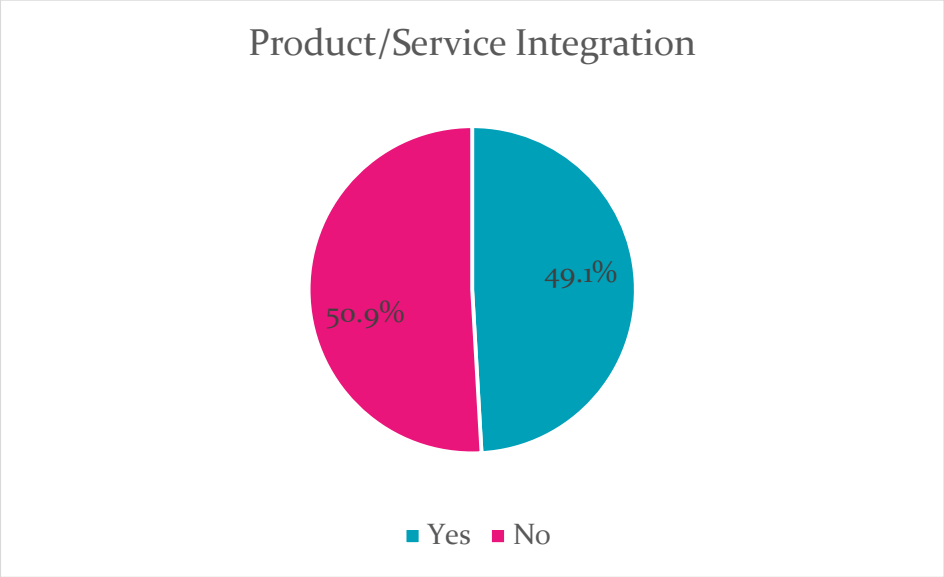


Figure 52 Product/Service Integration

- Product/Service Integration (IF Yes, please specify)

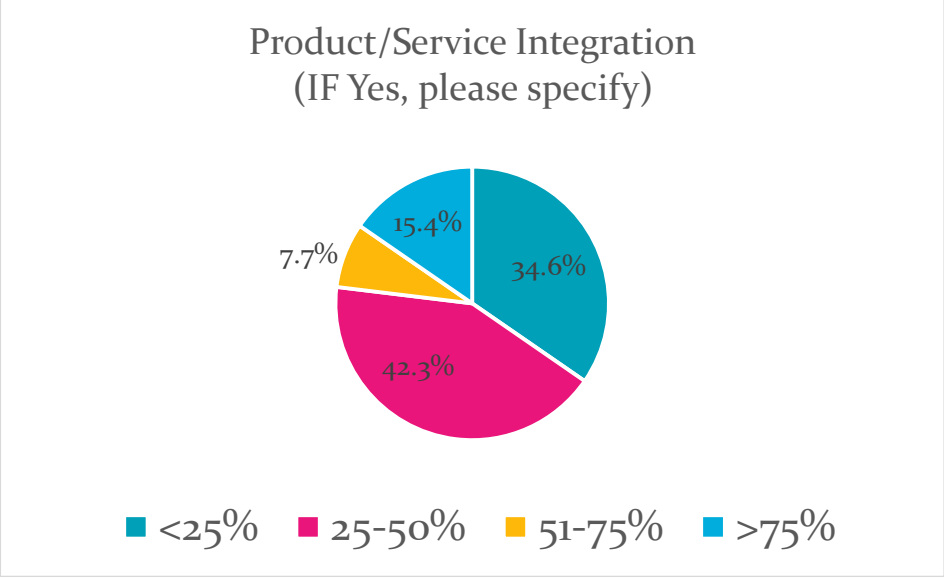


Figure 53 Product/Service Integration (IF Yes, please specify)

Q1.2 Does your company allowing the customer to co-construct the product or service experience to suit their context?

- Product

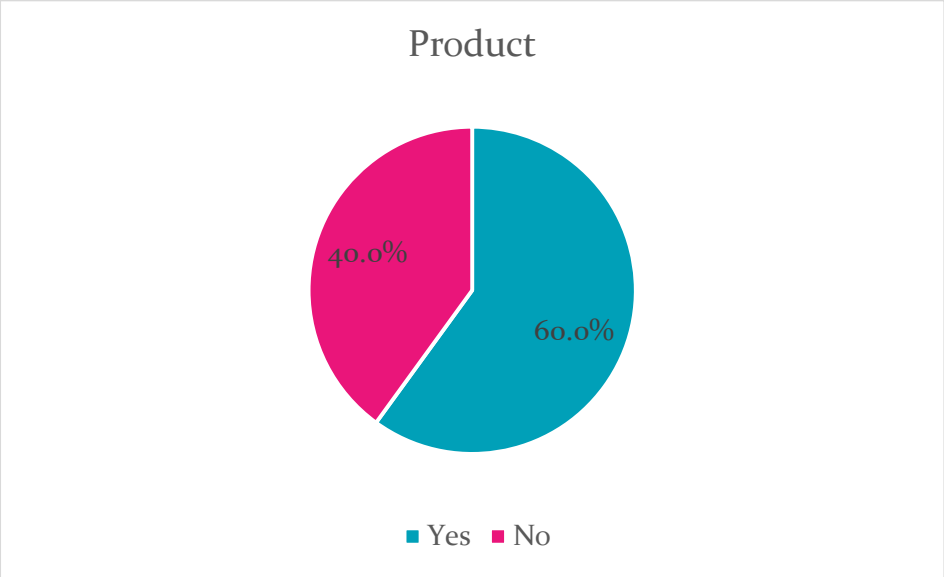


Figure 54 Product

- Product (IF Yes, please specify)

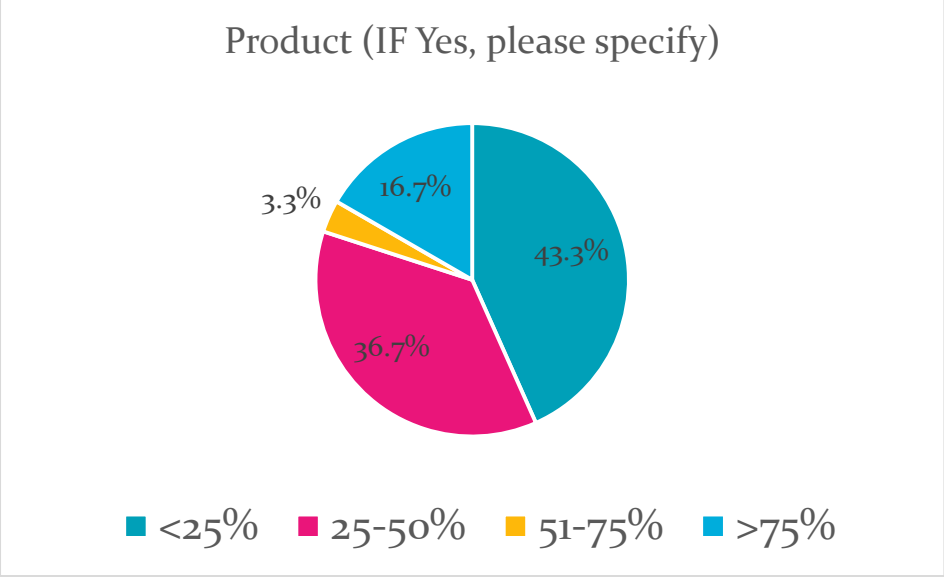


Figure 55 Product (IF Yes, please specify)

- Service

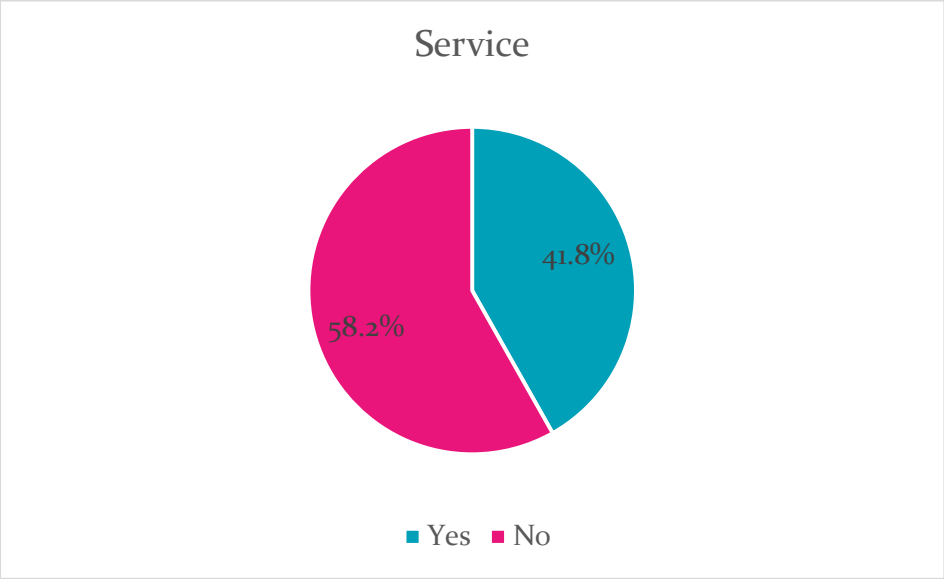


Figure 56 Service

- Service (IF Yes, please specify)

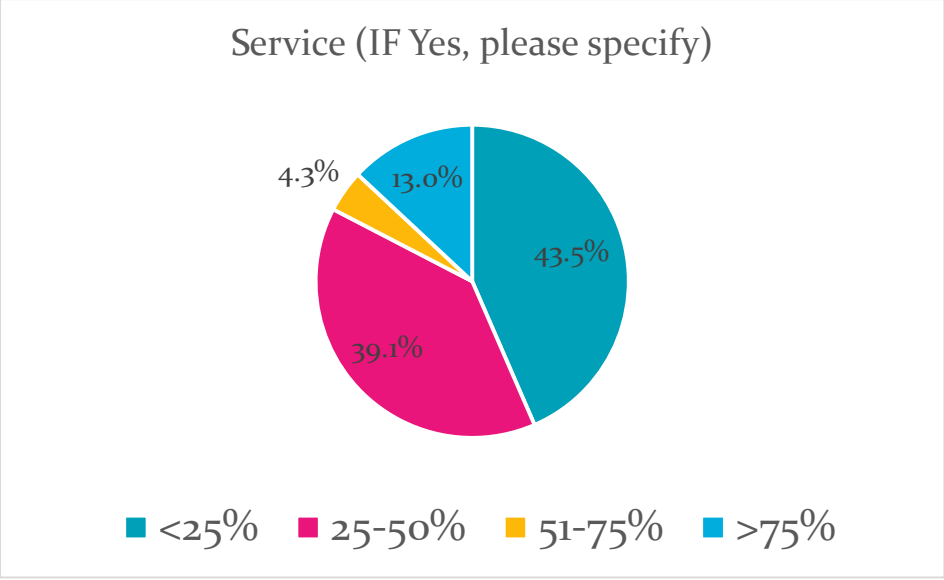


Figure 57 Service (IF Yes, please specify)

- Product/Service Integration

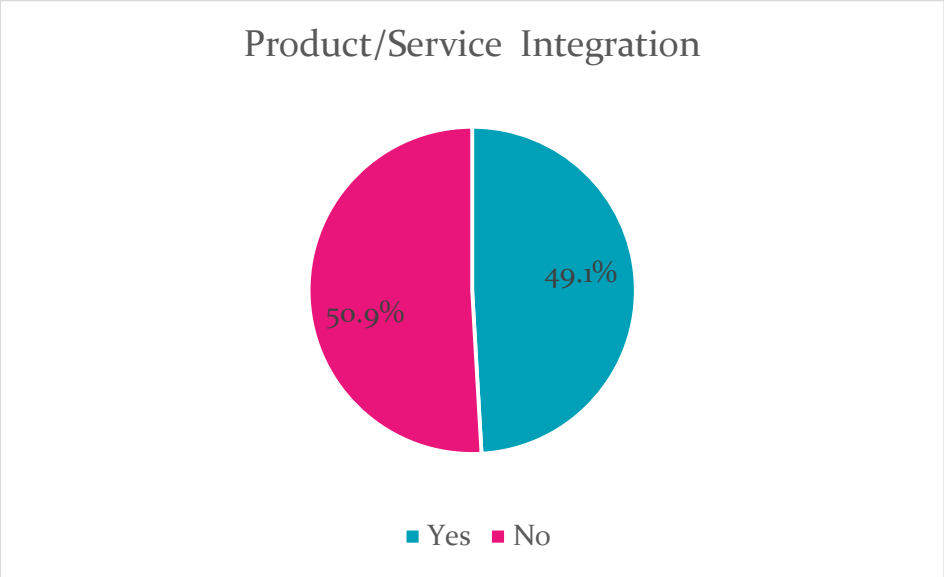


Figure 58 Product/Service Integration

- Product/Service Integration (IF Yes, please specify)

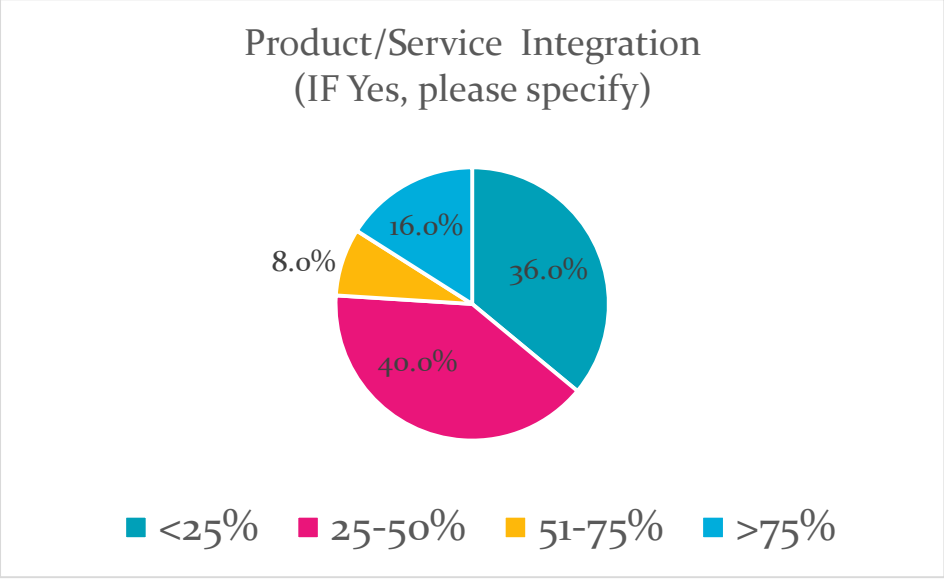


Figure 59 Product/Service Integration (IF Yes, please specify)

Q1.3 Does your company offer products equipped with the following add-on functionalities based on information and communications technology?

- Product memory

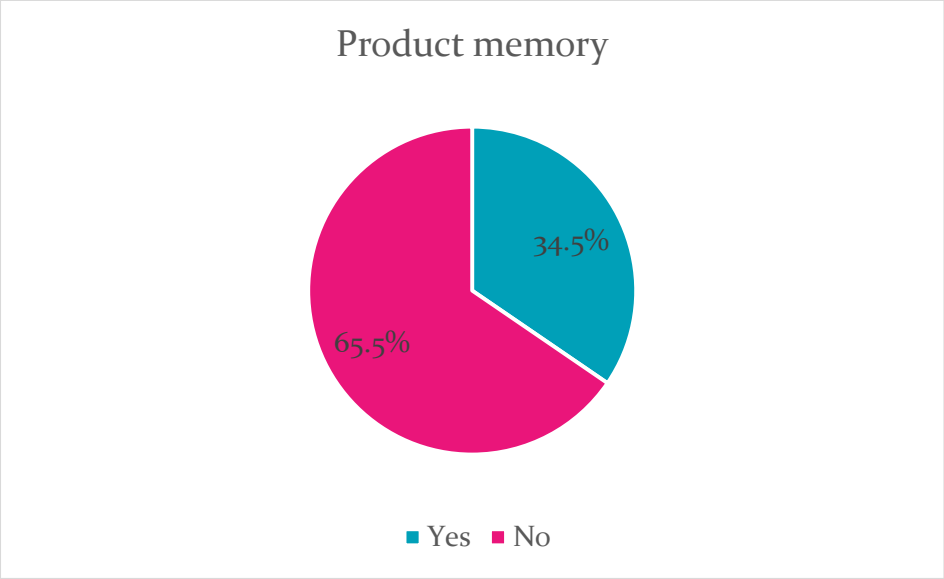


Figure 60 Product memory

- Product memory (IF Yes, please specify)

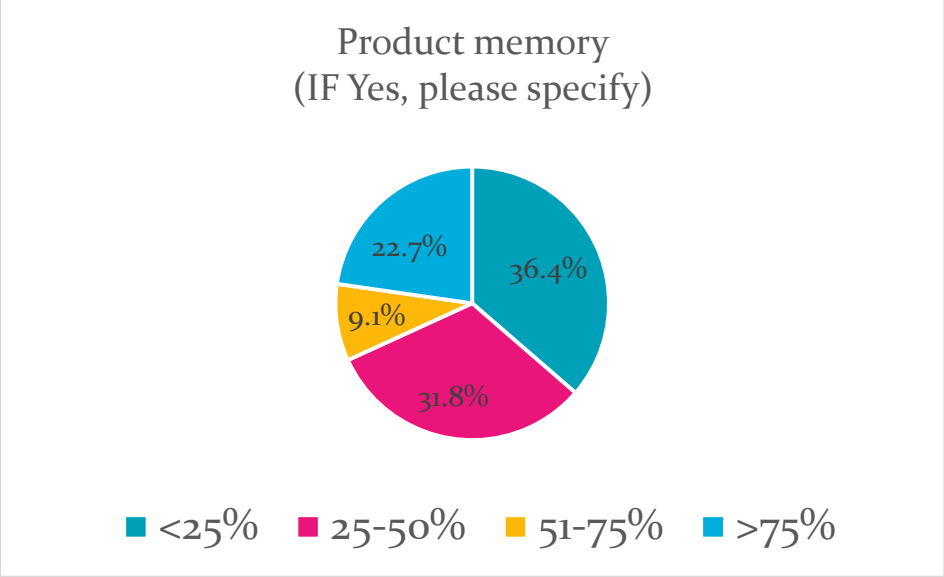


Figure 61 Product memory (IF Yes, please specify)

- Self-reporting

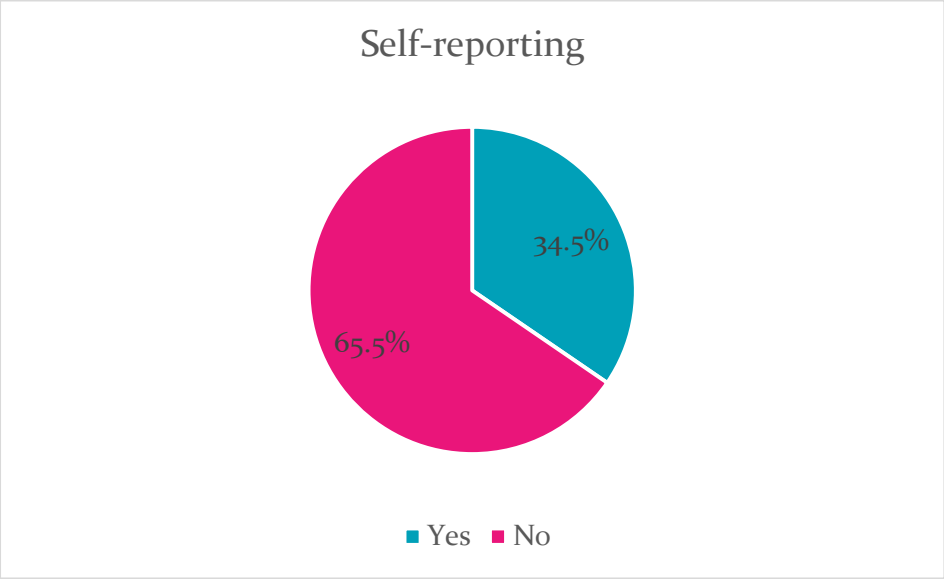


Figure 62 Self-reporting

- Self-reporting (IF Yes, please specify)

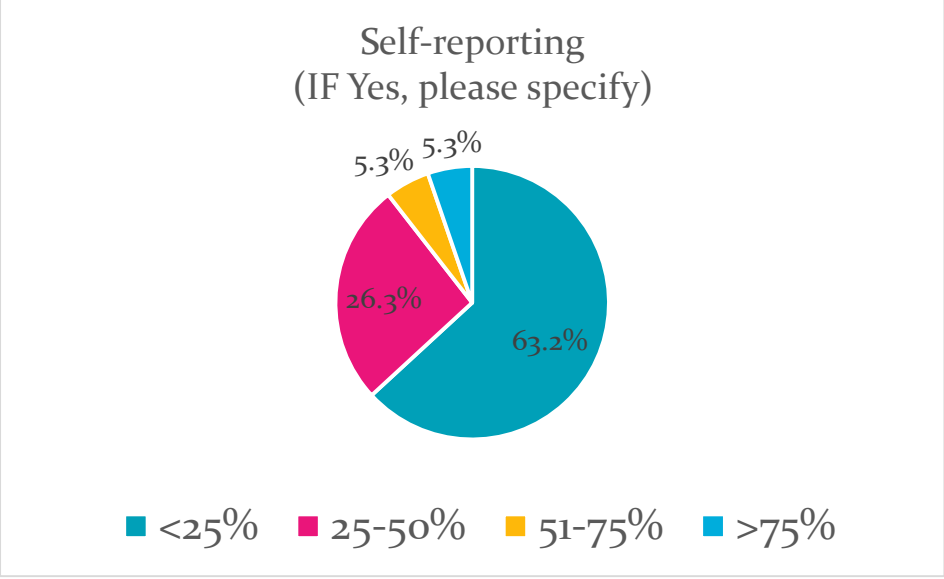


Figure 63 Self-reporting (IF Yes, please specify)

- Integration

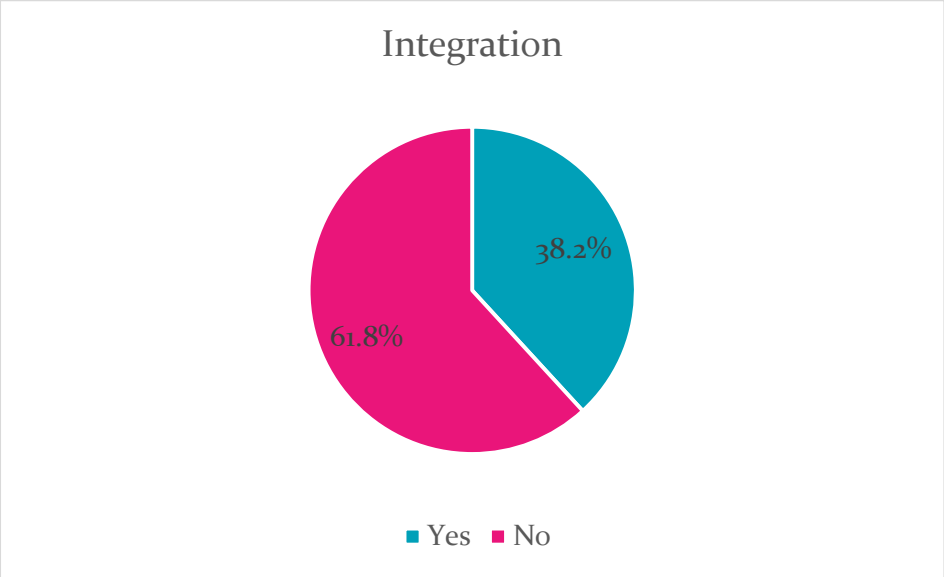


Figure 64 Integration

- Integration (IF Yes, please specify)

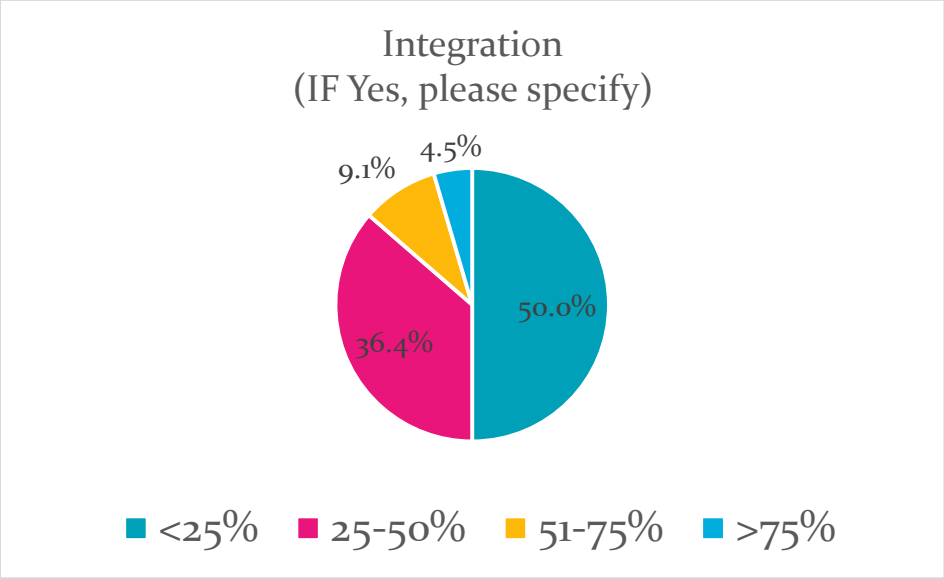


Figure 65 Integration (IF Yes, please specify)

- Localization

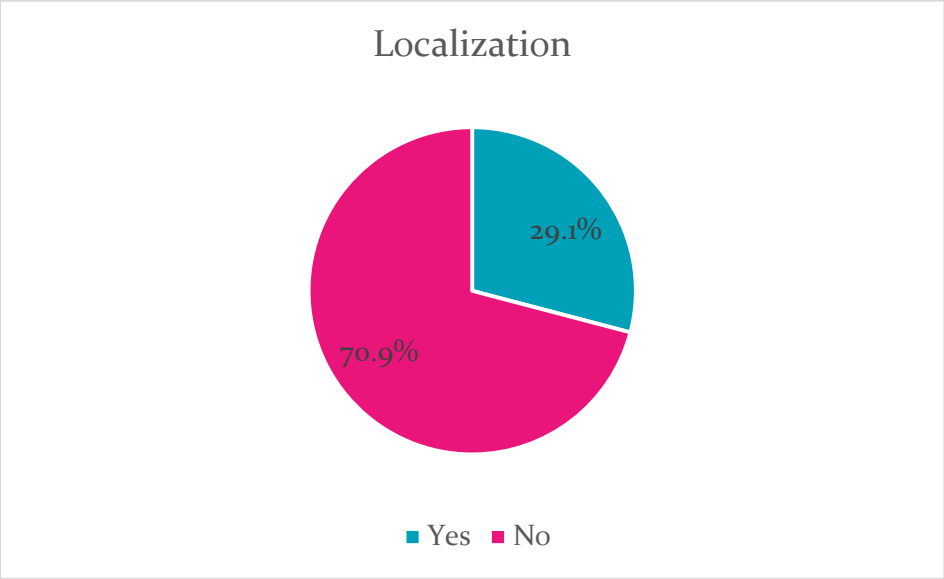


Figure 66 Localization

- Localization (IF Yes, please specify)

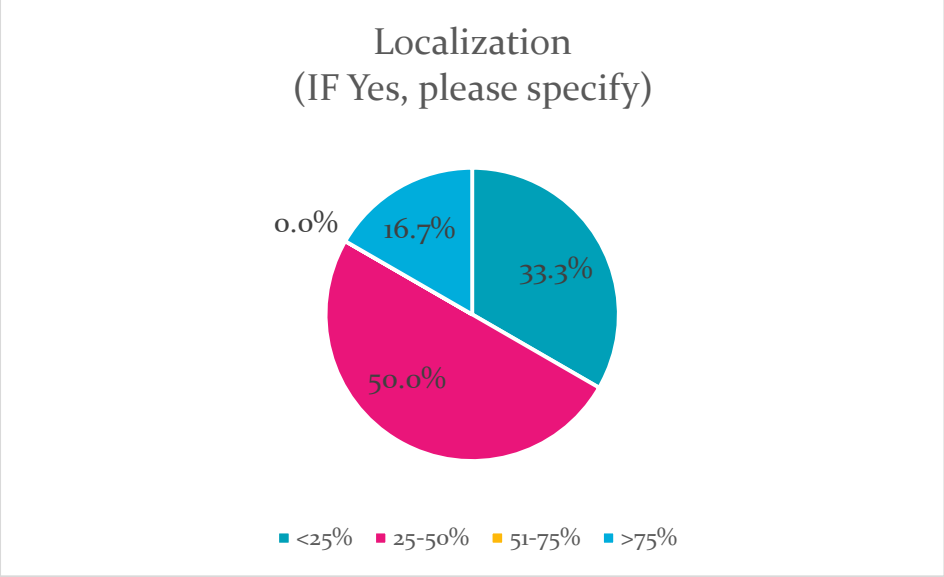


Figure 67 Localization (IF Yes, please specify)

- Assistance systems

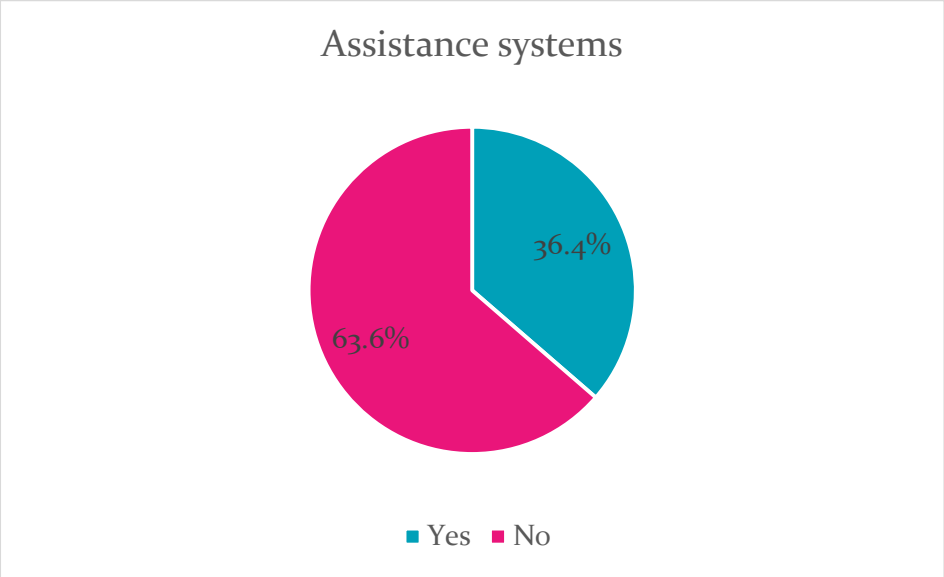


Figure 68 Assistance systems

- Assistance systems (IF Yes, please specify)

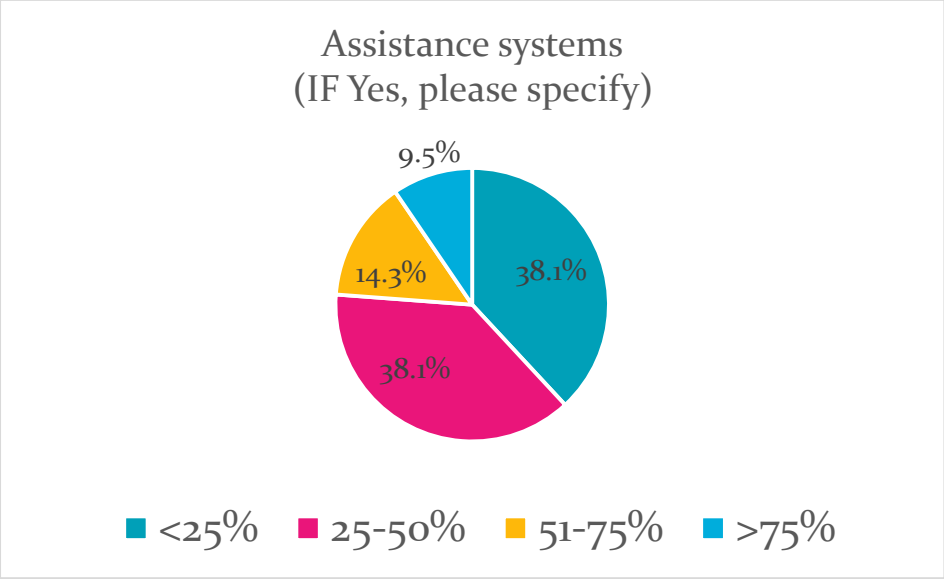


Figure 69 Assistance systems (IF Yes, please specify)

- Monitoring

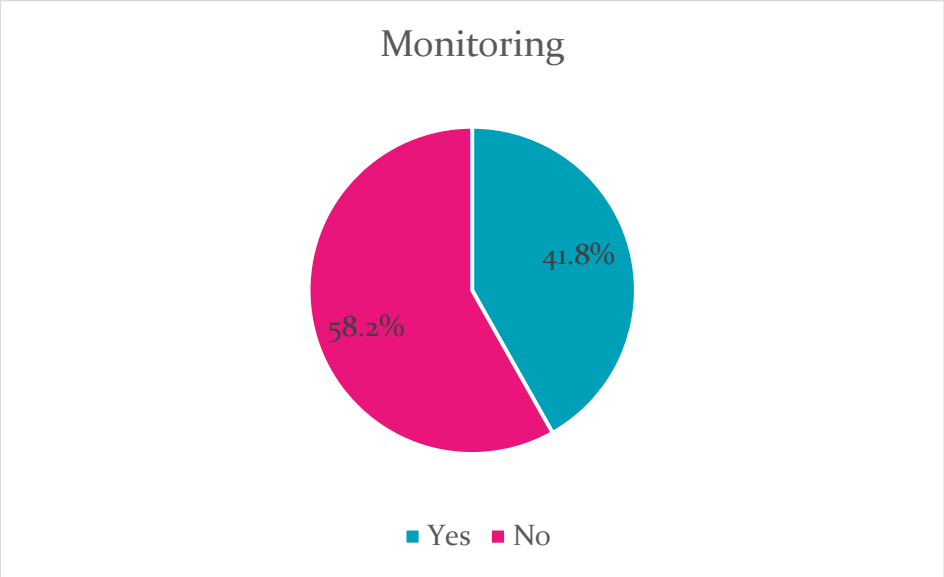


Figure 70 Monitoring

- Monitor (IF Yes, please specify)

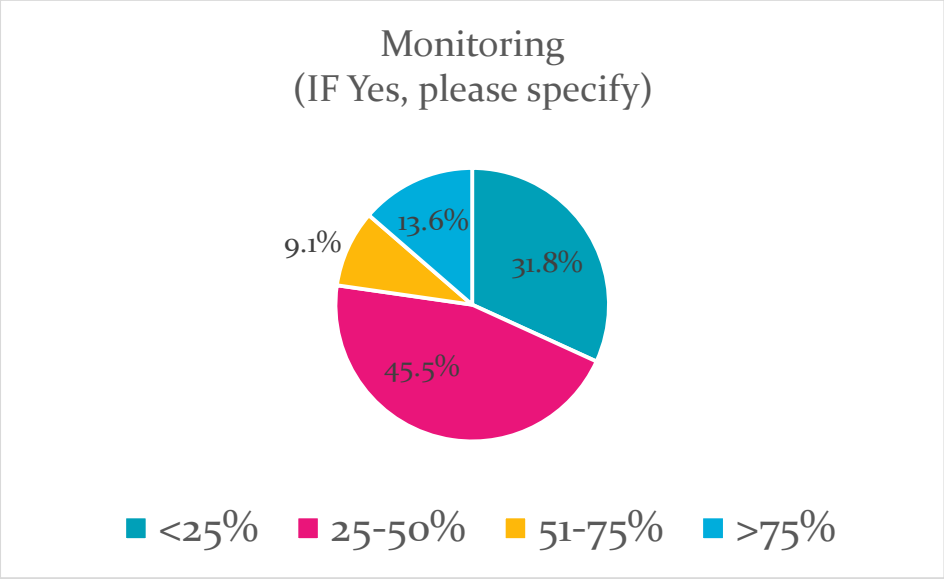


Figure 71 Monitoring (IF Yes, please specify)

- Object information

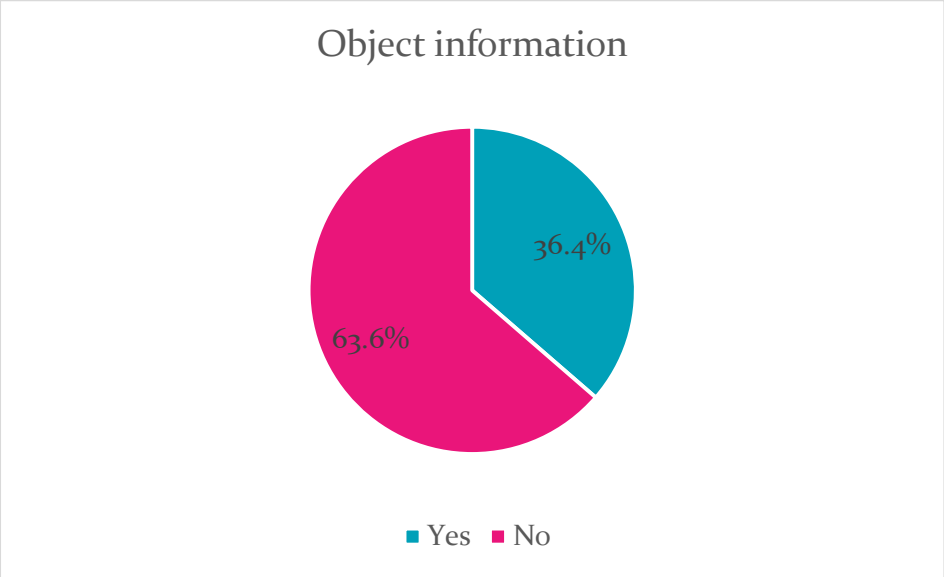


Figure 72 Object information

- Object information (IF Yes, please specify)

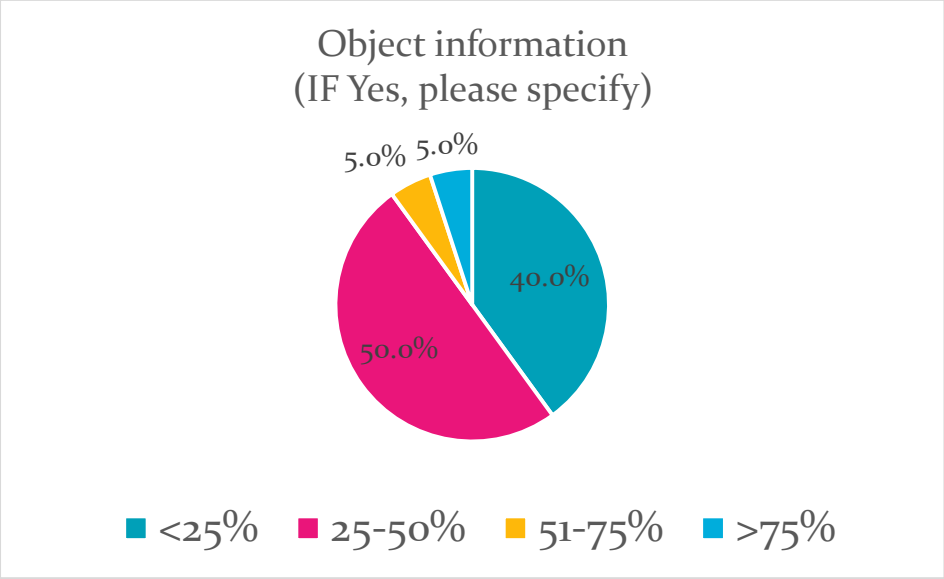


Figure 73 Object information (IF Yes, please specify)

- Automatic identification

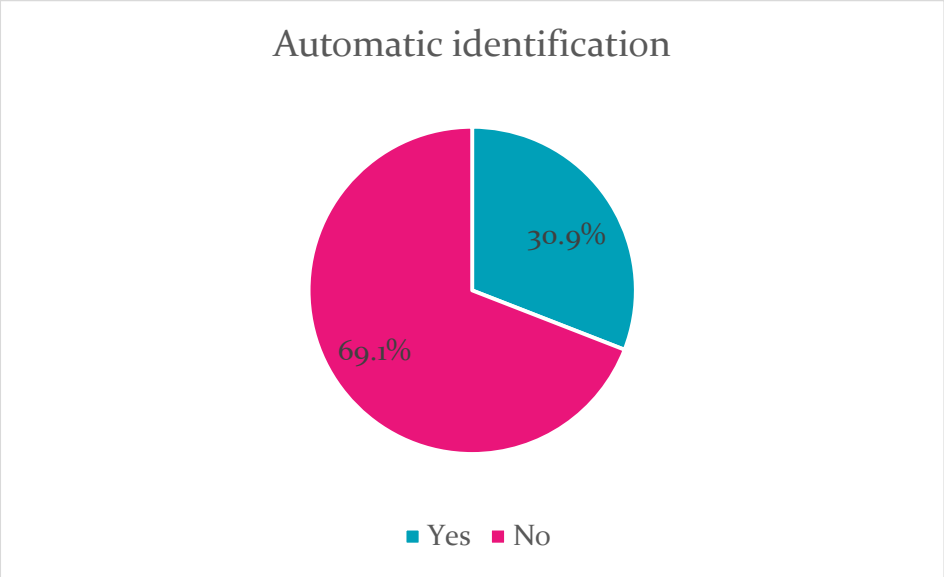


Figure 74 Automatic identification

- Automatic identification (IF Yes, please specify)

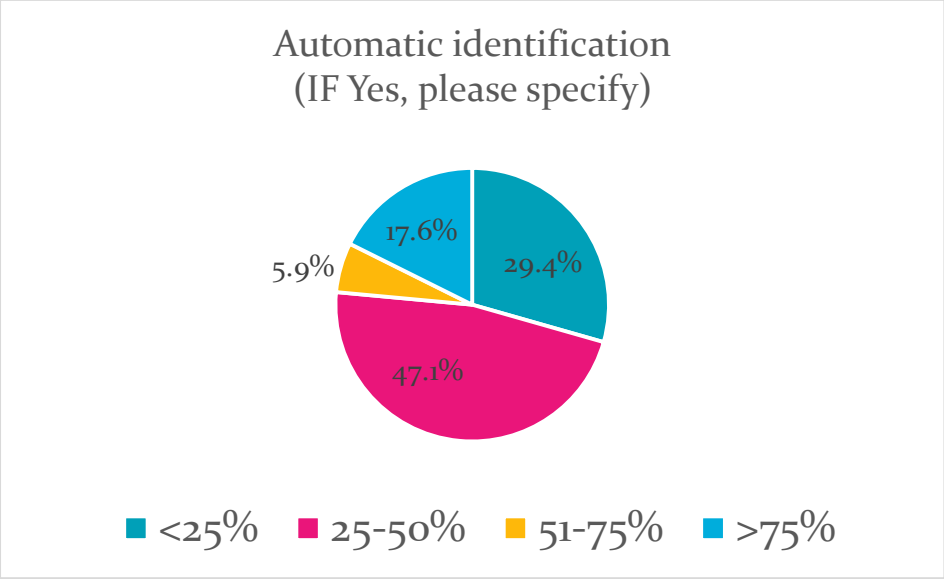


Figure 75 Automatic identification (IF Yes, please specify)

2. SMART FACTORY -INTELLIGENCE MANUFACTURING SYSTEM

A smart factory is a production environment in which the production systems and logistics systems largely organize themselves without human intervention. The smart factory relies on cyber-physical systems (CPS), which link the physical and virtual worlds by communicating through an IT infrastructure, the Internet of Things.

Industry 4.0 also involves digital modeling through the smart collection, storage, and processing of data. In this way, the smart factory concept ensures that information is delivered and resources are used more efficiently. This requires the real-time, cross-enterprise collaboration between production systems, information systems, and people.

EQUIPMENT INFRASTRUCTURE

Q2.1 How would you evaluate your equipment infrastructure when it comes to the following functionalities?

- Machines/systems can be controlled through IT

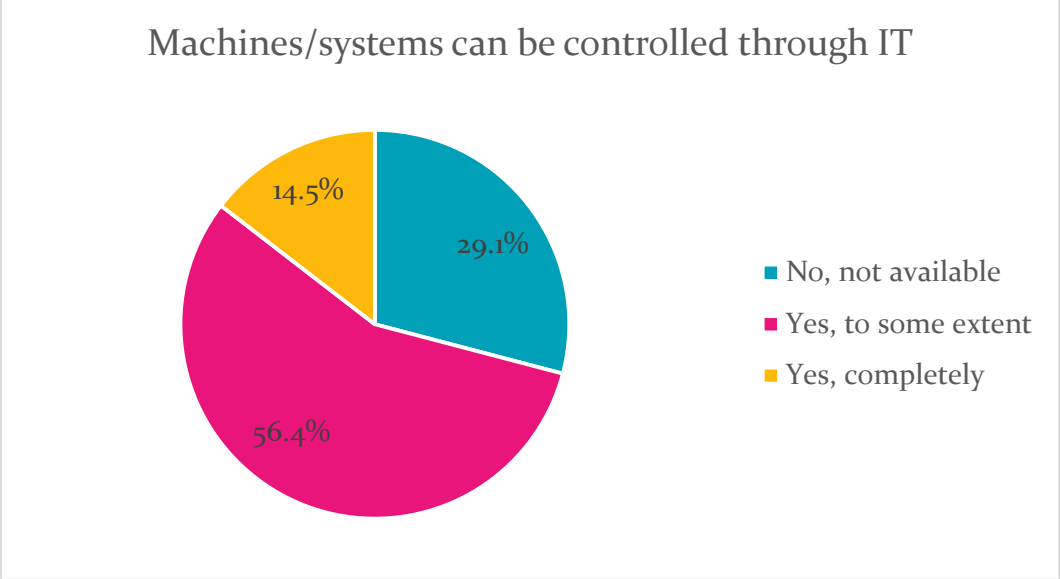


Figure 76 Machines/systems can be controlled through IT

- Machines/systems can be controlled through IT (IF Yes, please specify)

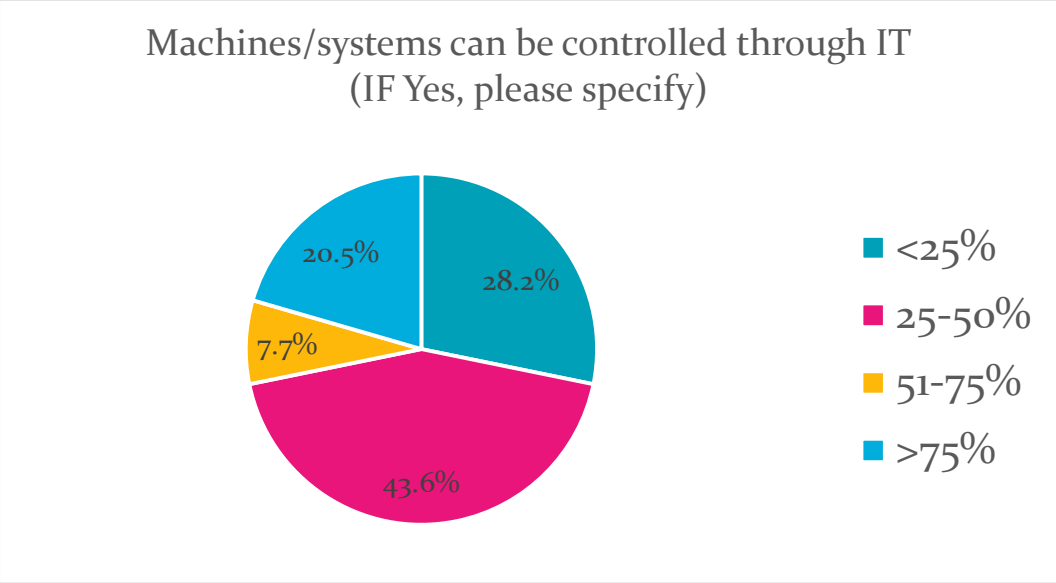


Figure 77 Machines/systems can be controlled through IT (IF Yes, please specify)

- M2M: machine-to-machine communications

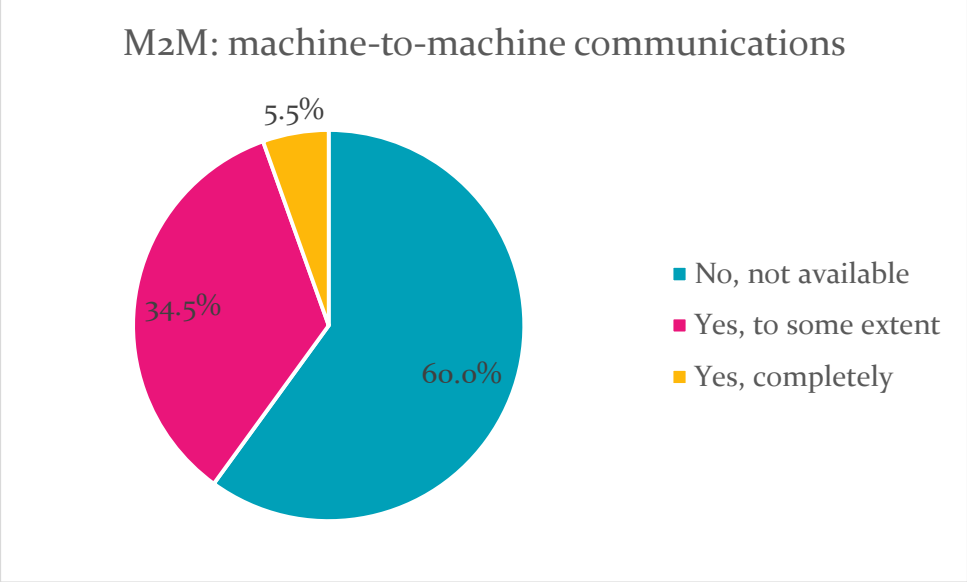


Figure 78 M2M: machine-to-machine communications

- M2M: machine-to-machine communications (IF Yes, please specify)

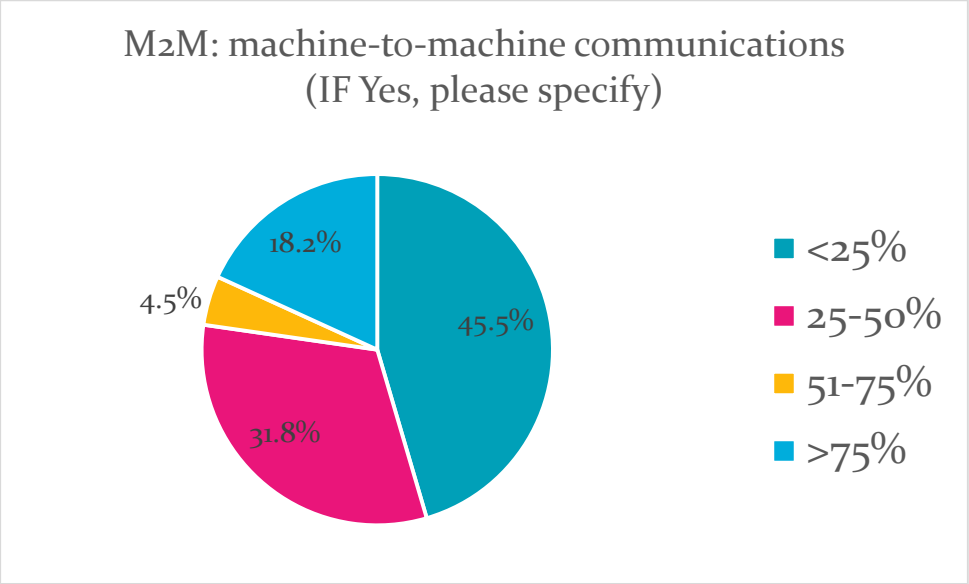


Figure 79 M2M: machine-to-machine communications (IF Yes, please specify)

- Interoperability: integration and collaboration with other machines/systems possible

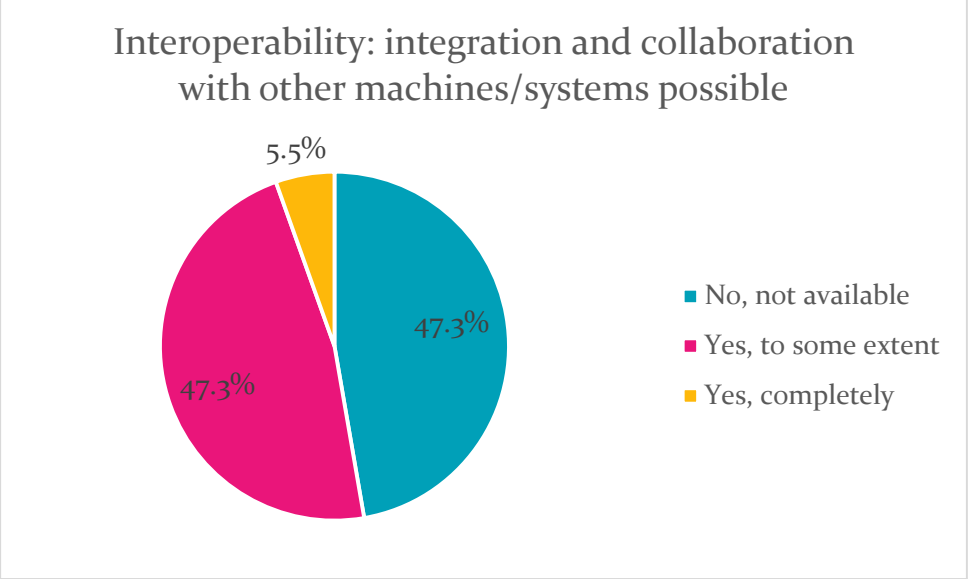


Figure 80 Interoperability: integration and collaboration with other machines/systems possible

- Interoperability: integration and collaboration with other machines/systems possible (IF Yes, please specify)

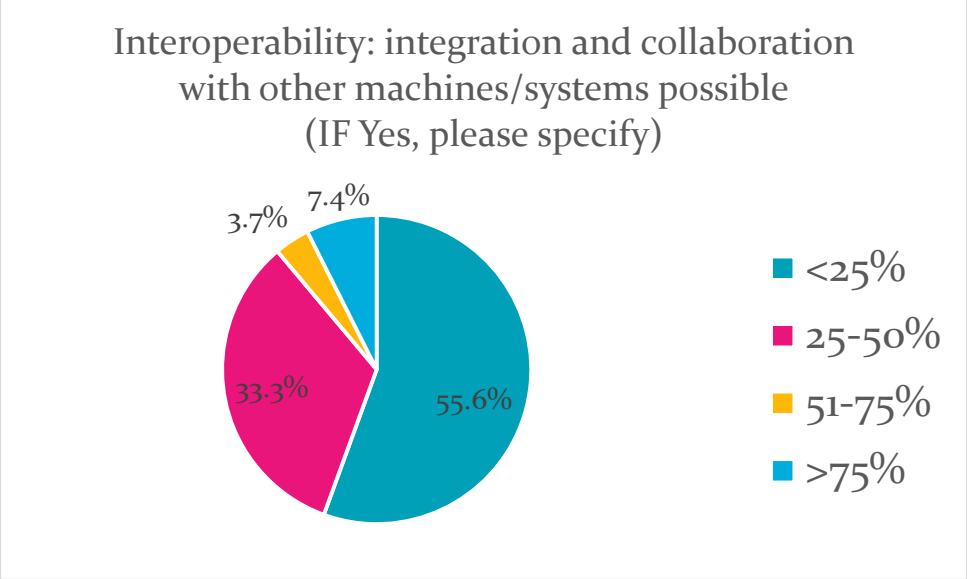


Figure 81 Interoperability: integration and collaboration with other machines/systems possible (IF Yes, please specify)

Q2.2 How would you evaluate the adaptability of your equipment infrastructure when it comes to the following functionalities?

- M2M: machine-to-machine communications

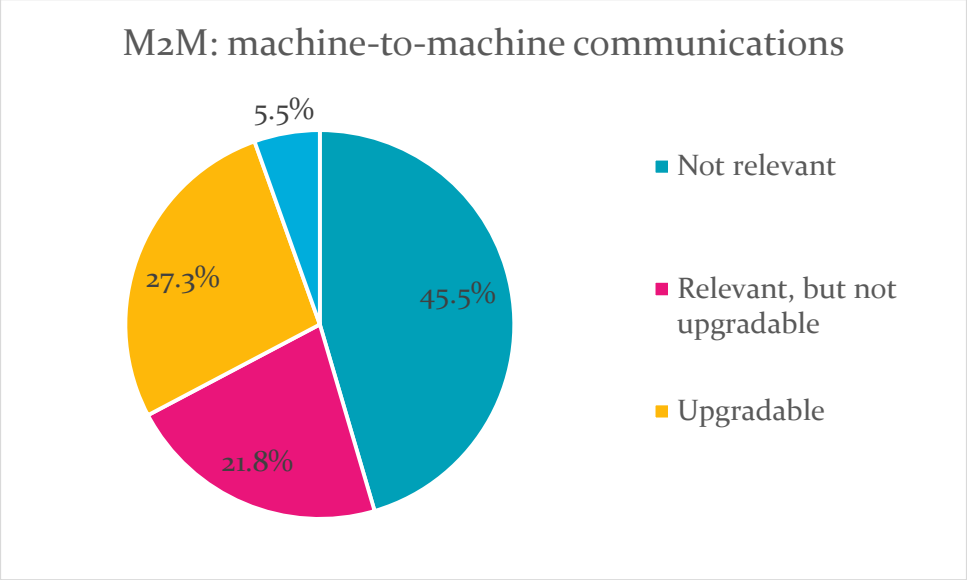


Figure 82 M2M: machine-to-machine communications

- M2M: machine-to-machine communications (IF Yes, please specify)

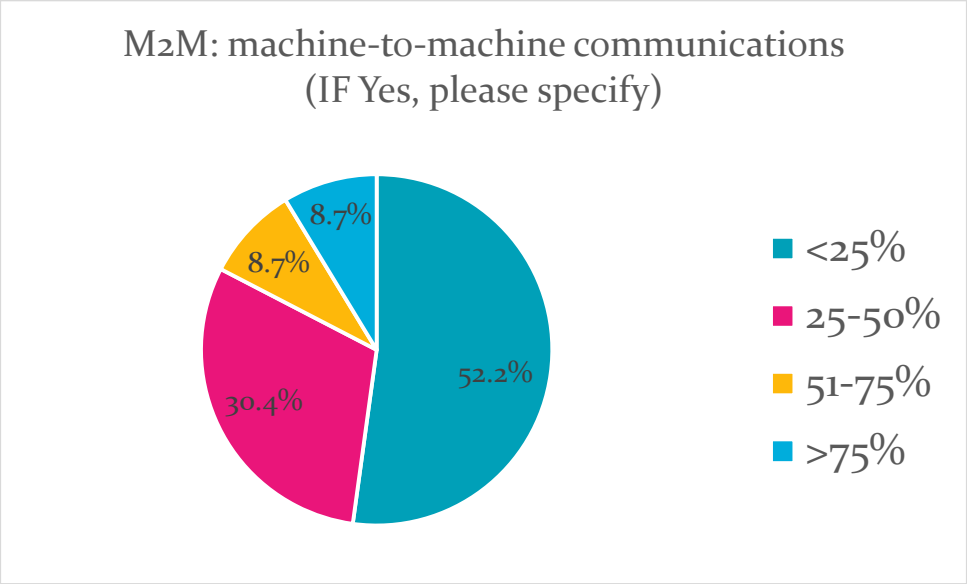


Figure 83 M2M: machine-to-machine communications (IF Yes, please specify)

- Interoperability: integration and collaboration with other machines/systems possible

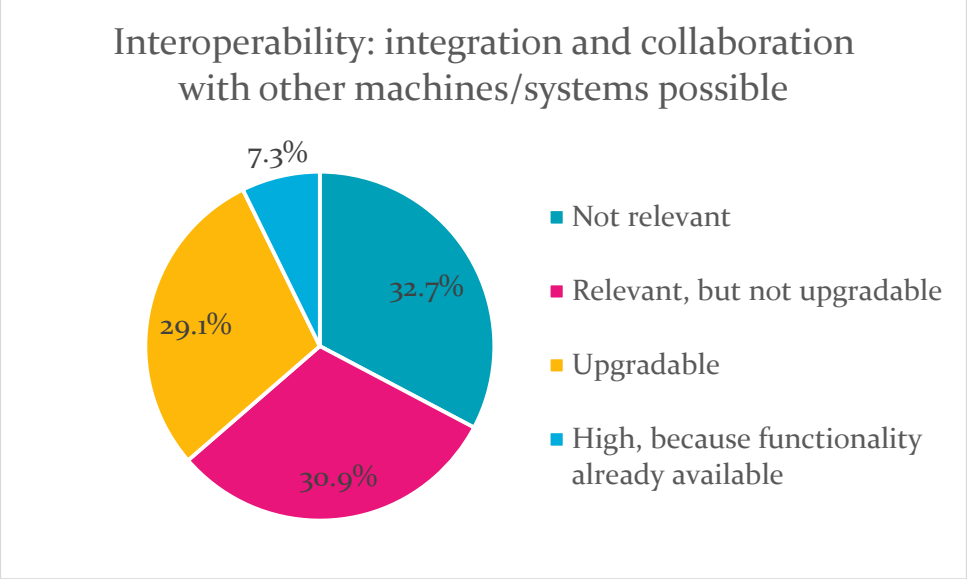


Figure 84 Interoperability: integration and collaboration with other machines/systems possible

- Interoperability: integration and collaboration with other machines/systems possible (IF Yes, please specify)

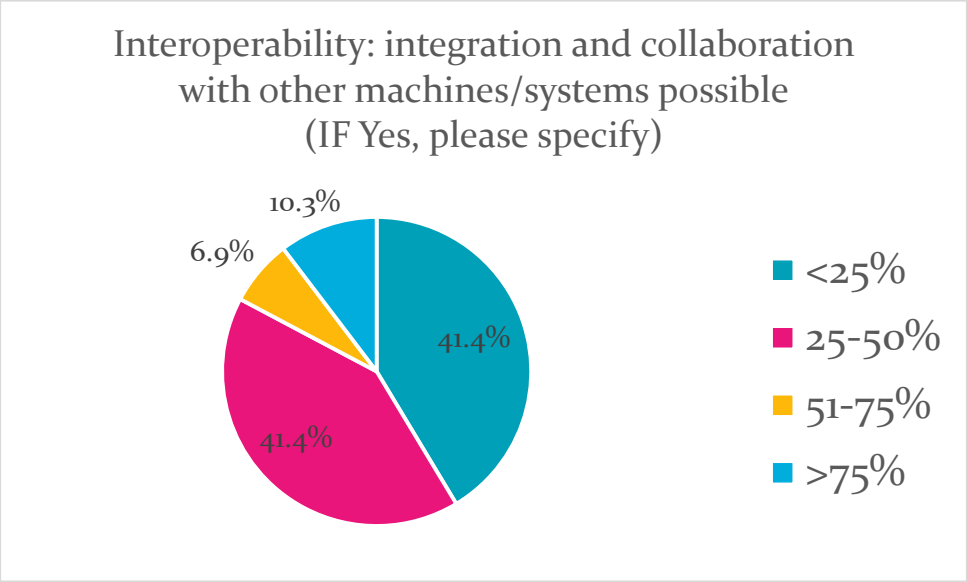


Figure 85 Interoperability: integration and collaboration with other machines/systems possible (IF Yes, please specify)

DIGITAL MODEL OF FACTORY

Q2.3 The digitization of factories makes it possible to create a digital model of the factory. Are you already collecting machine and process data during production?

- ☐ Yes, all
- ☐ Yes, some
- ☐ No

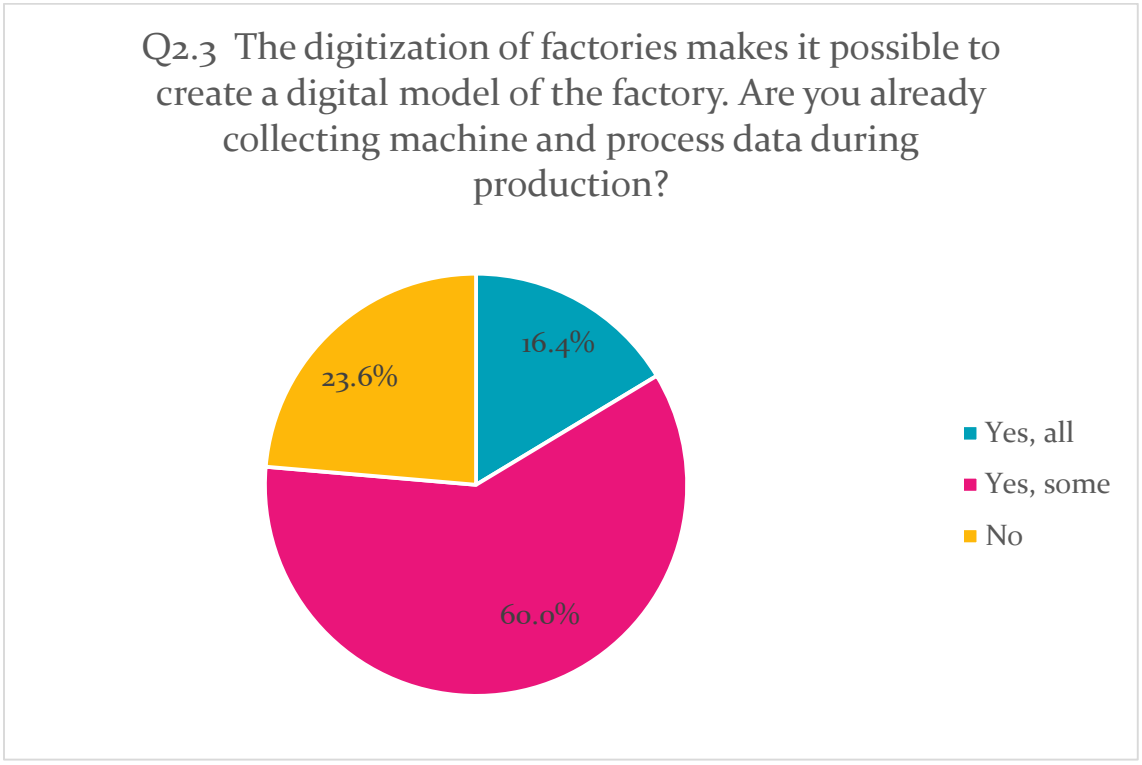


Figure 86 Q2.3 The digitization of factories makes it possible to create a digital model of the factory. Are you already collecting machine and process data during production?

IF Yes, please specify

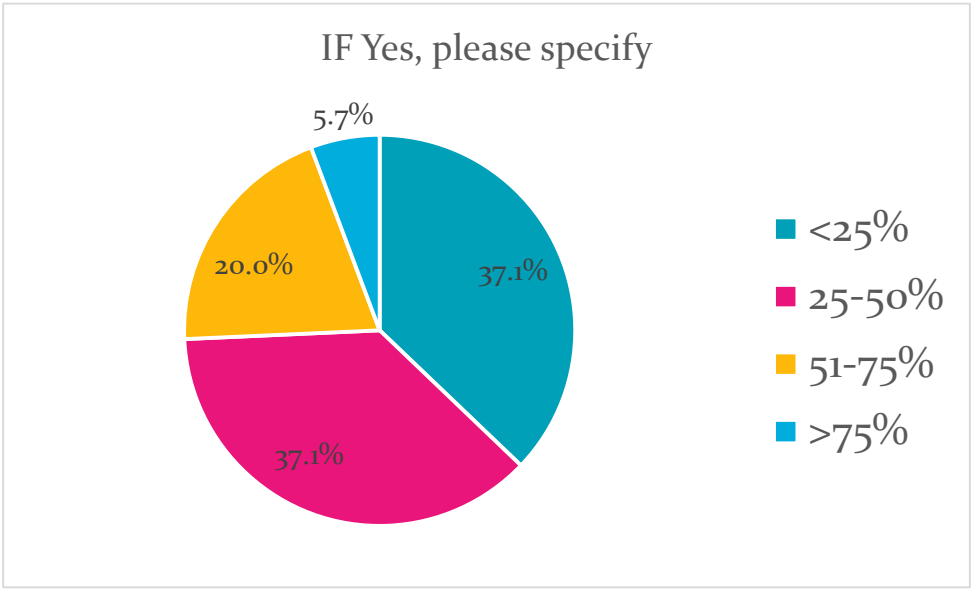


Figure 87 IF Yes, please specify

Q2.4 How is the data you collect used? (Can answer more than 1)

- ☐ Predictive maintenance
- ☐ Optimization of logistics and production processes
- ☐ Creation of transparency across production process
- ☐ Quality management
- ☐ Automatic production control through use of real-time data
- ☐ Optimization of resource consumption (material, energy)

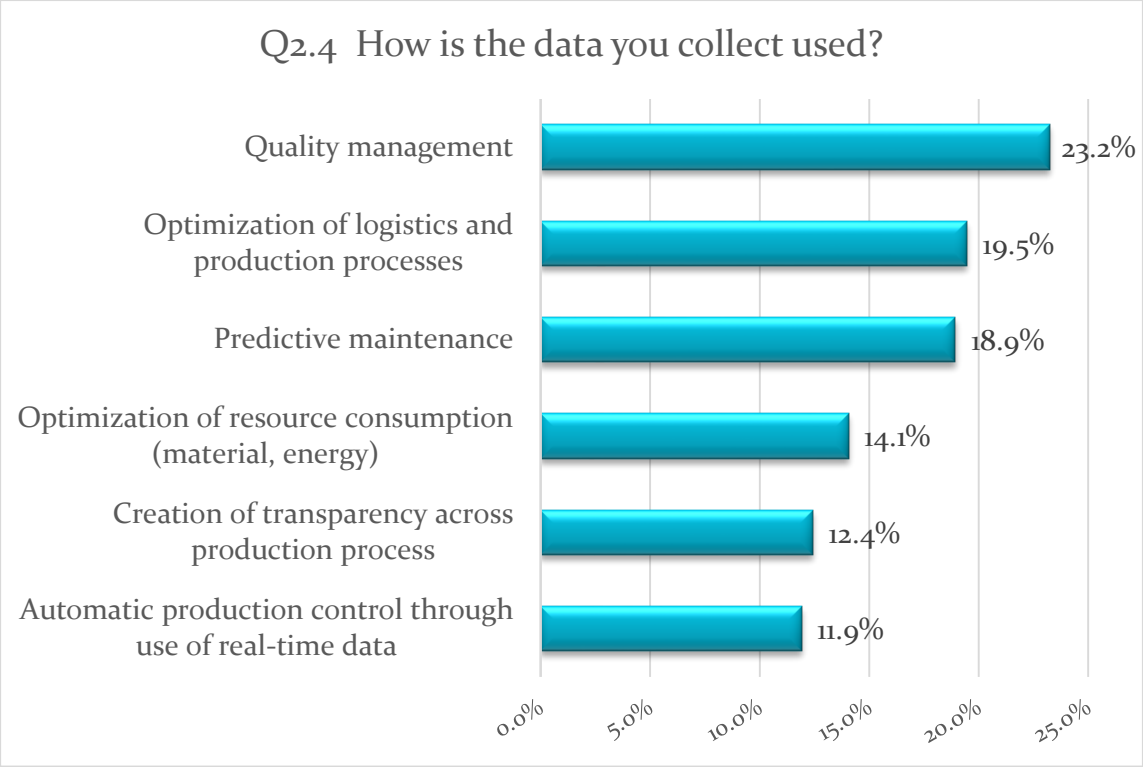


Figure 88 Q2.4 How is the data you collect used?

Q2.5 Which data about your machinery, processes, and products as well as malfunctions and their causes is collected during production, and how is it collected?

- Inventory data

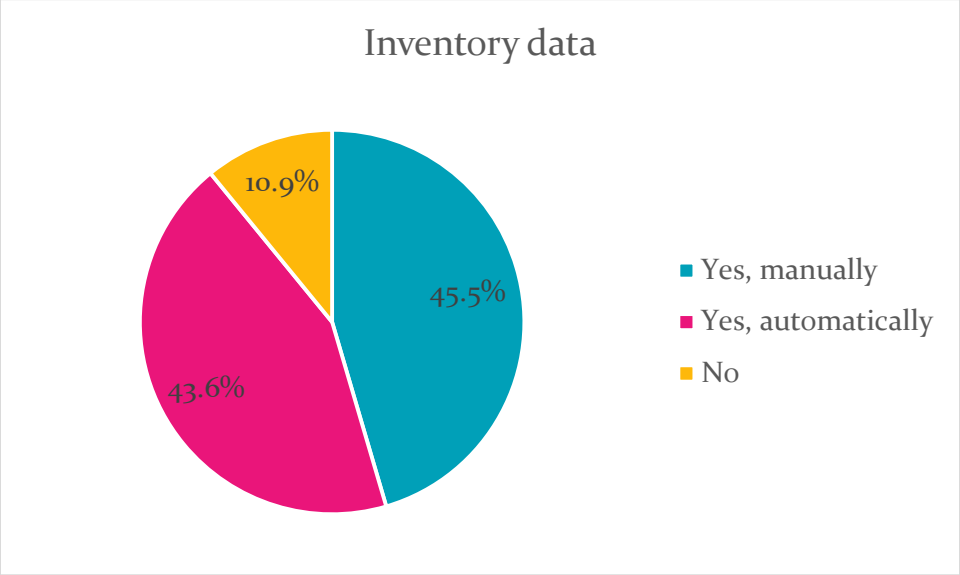


Figure 89 Inventory data

- Inventory data (IF Yes, please specify)

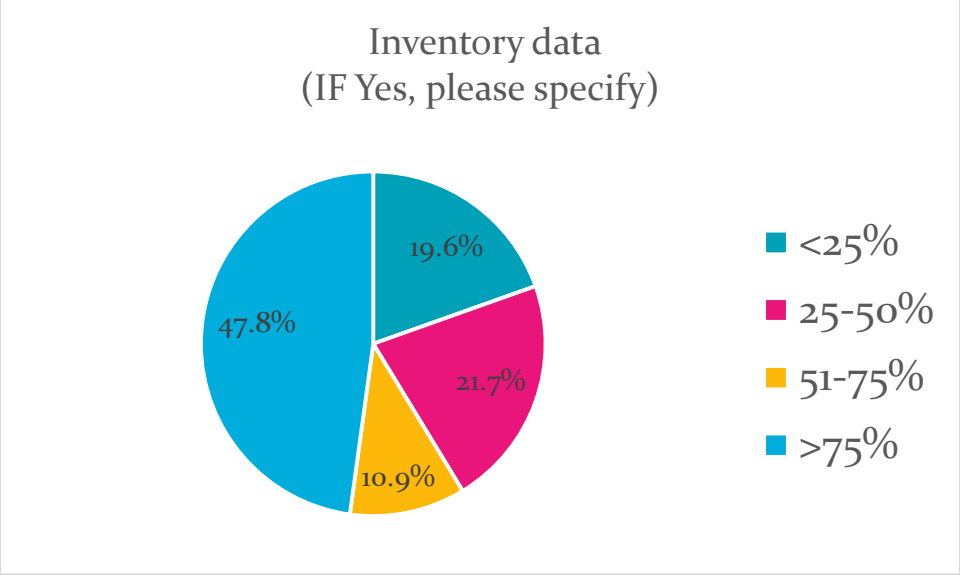


Figure 90 Inventory data (IF Yes, please specify)

- Manufacturing throughput times

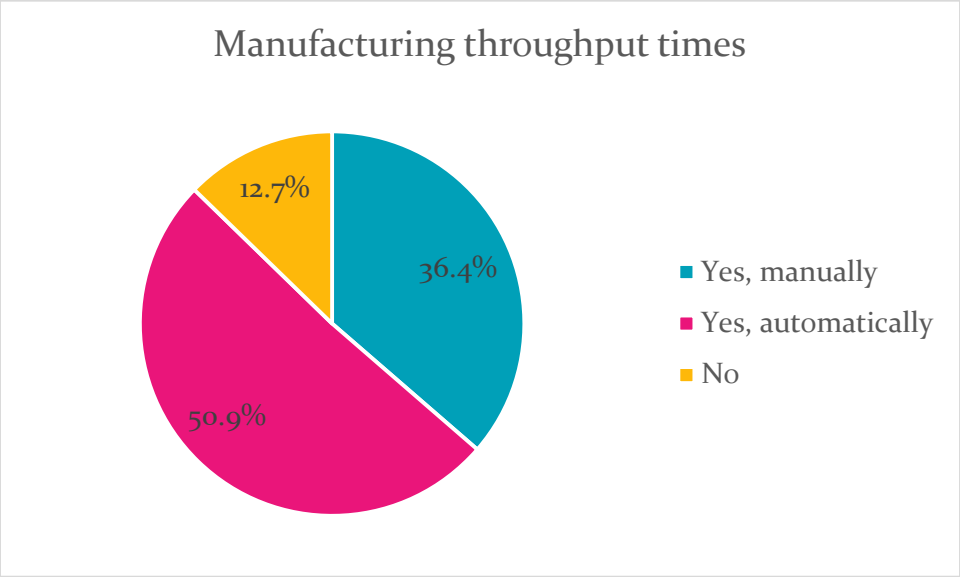


Figure 91 Manufacturing throughput times

- Manufacturing throughput times (IF Yes, please specify)

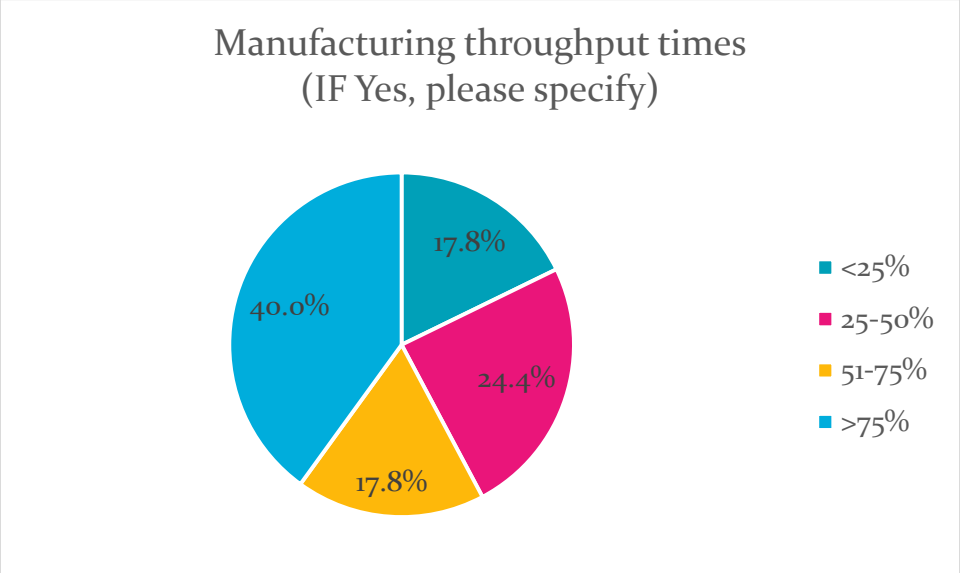


Figure 92 Manufacturing throughput times (IF Yes, please specify)

- Equipment capacity utilization

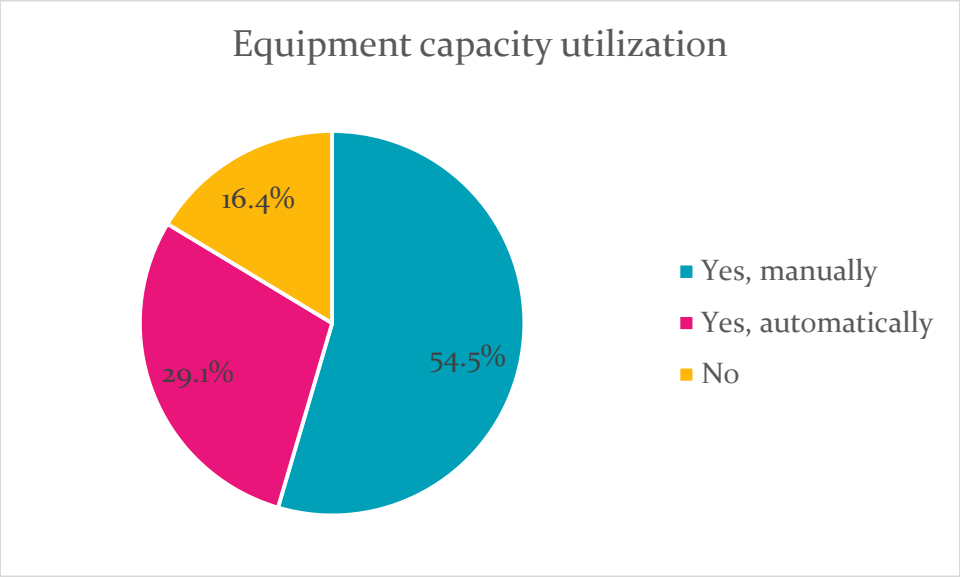


Figure 93 Equipment capacity utilization

- Equipment capacity utilization (IF Yes, please specify)

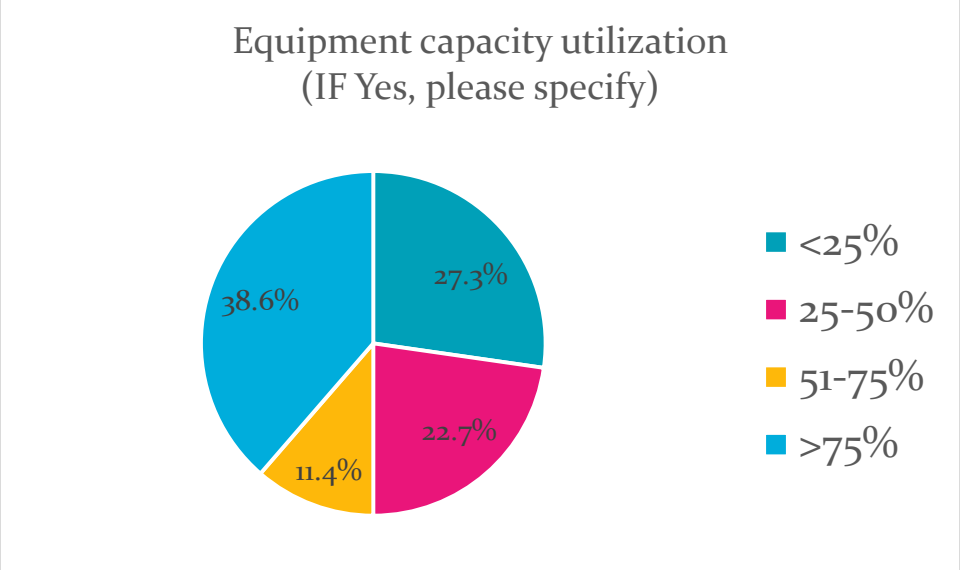


Figure 94 Equipment capacity utilization (IF Yes, please specify)

- Production residues/waste/WIP

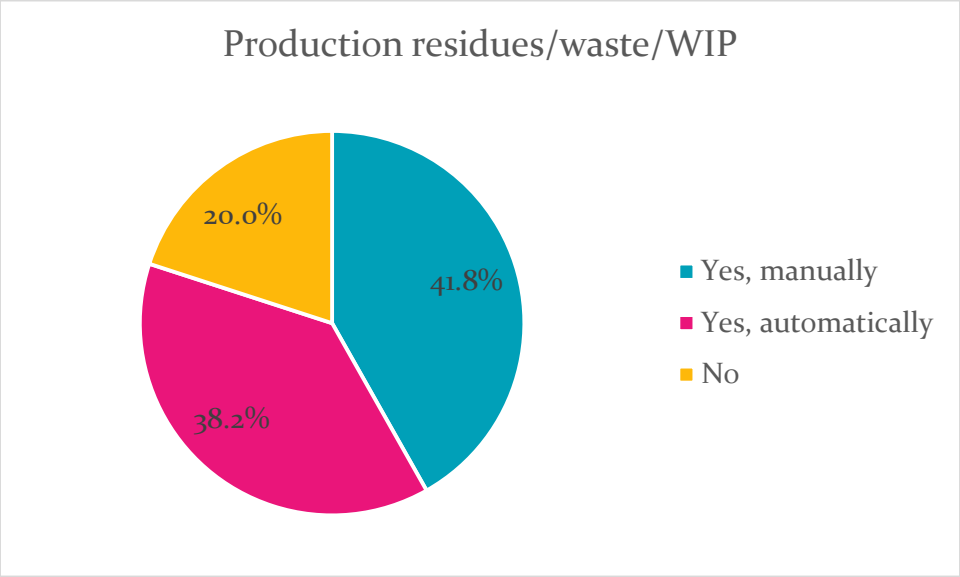


Figure 95 Production residues/waste/WIP

- Production residues/waste/WIP (IF Yes, please specify)

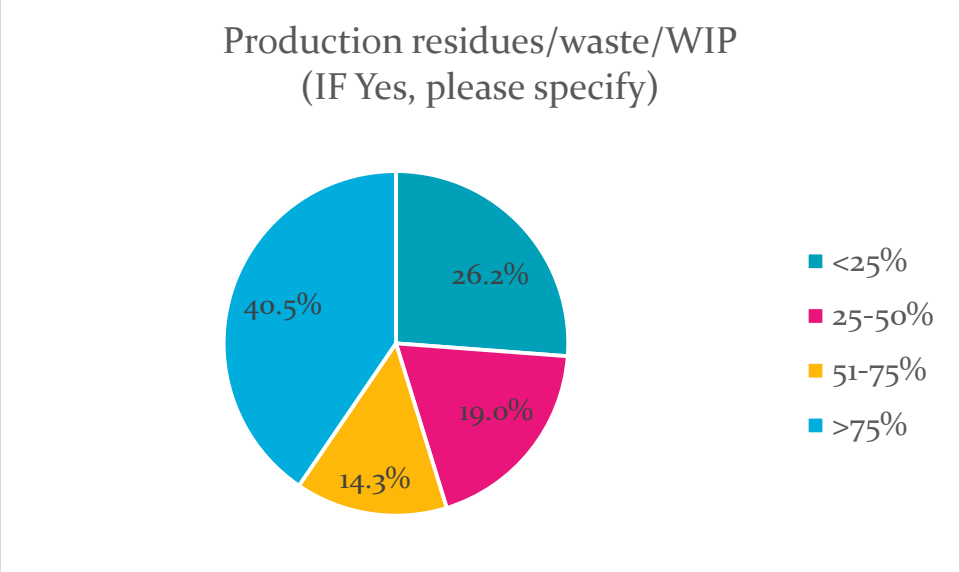


Figure 96 Production residues/waste/WIP (IF Yes, please specify)

- Quality MGMT

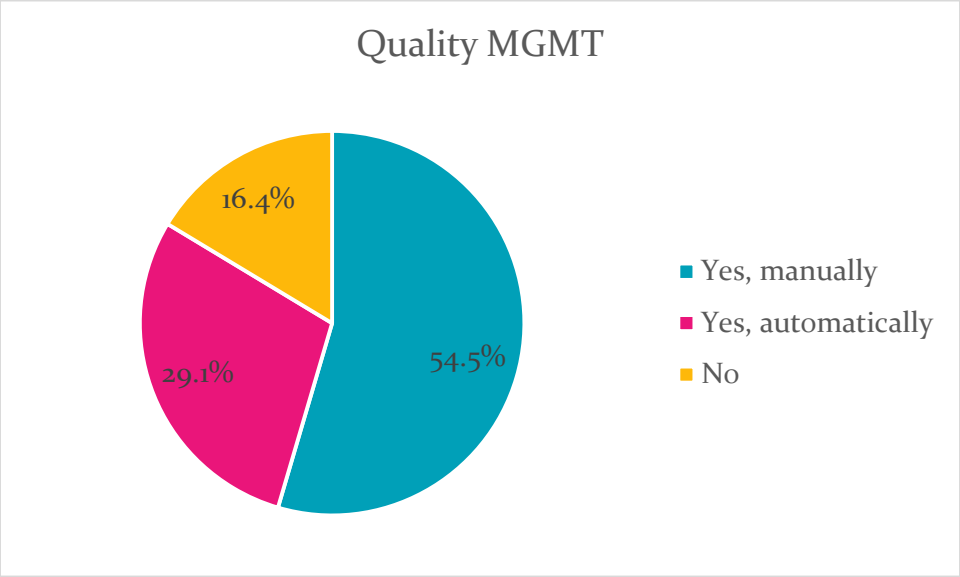


Figure 97 Quality MGMT

- Quality MGMT (IF Yes, please specify)

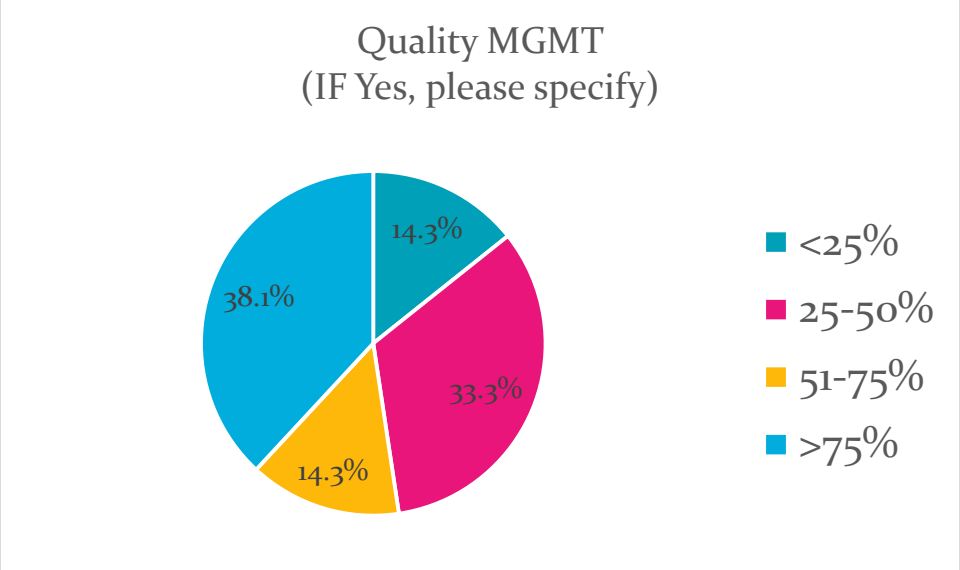


Figure 98 Quality MGMT (IF Yes, please specify)

- Employee utilization

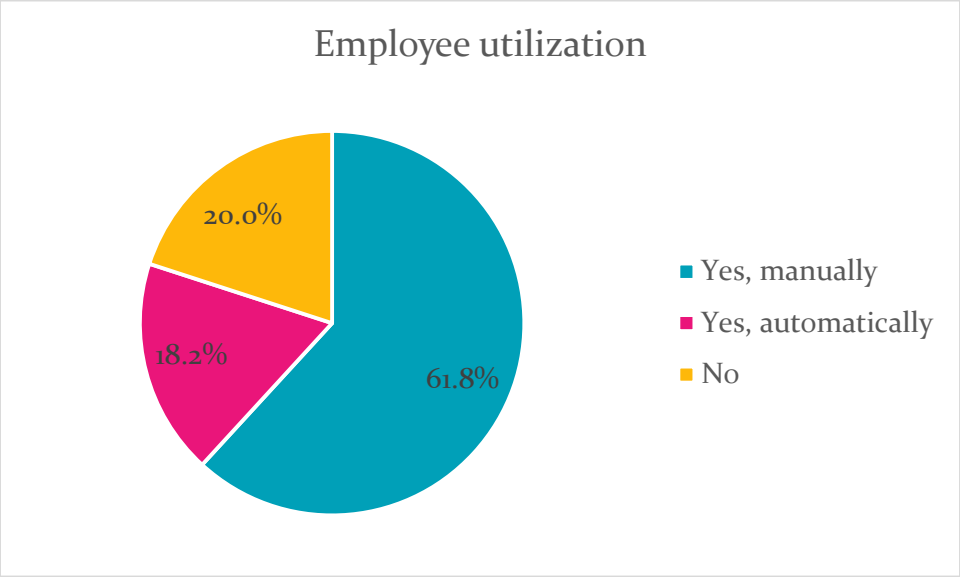


Figure 99 Employee utilization

- Employee utilization (IF Yes, please specify)

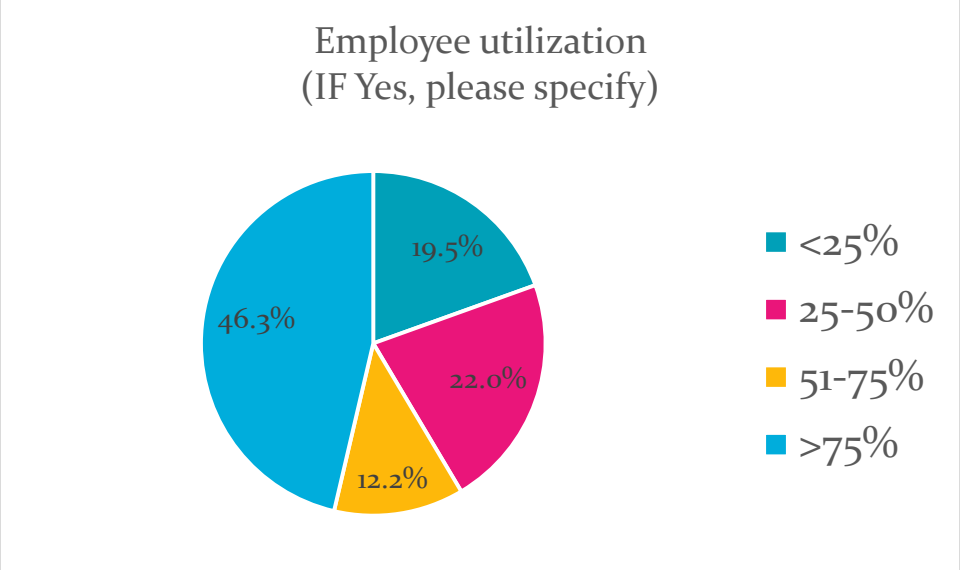


Figure 100 Employee utilization (IF Yes, please specify)

- Quality Control data

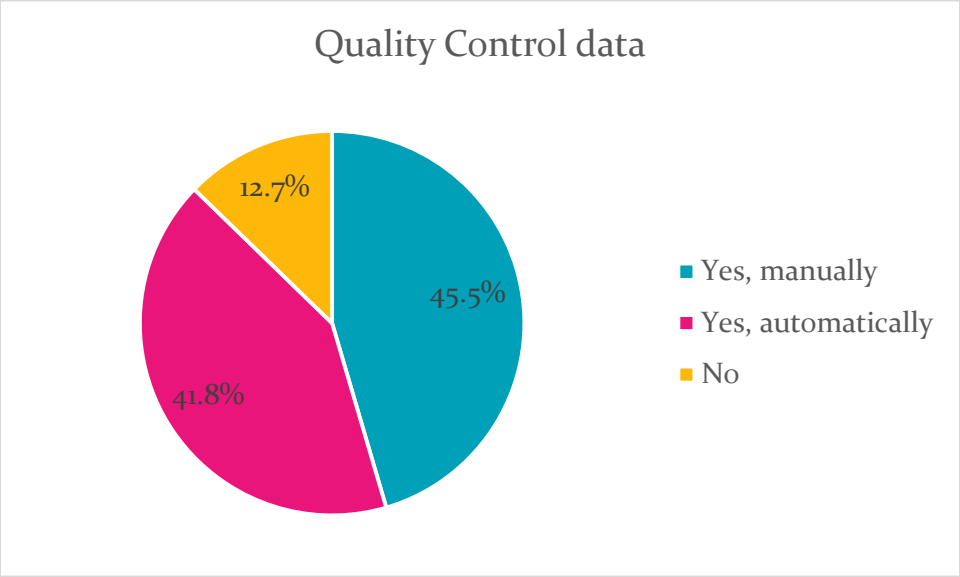


Figure 101 Quality Control data

- Quality Control data (IF Yes, please specify)

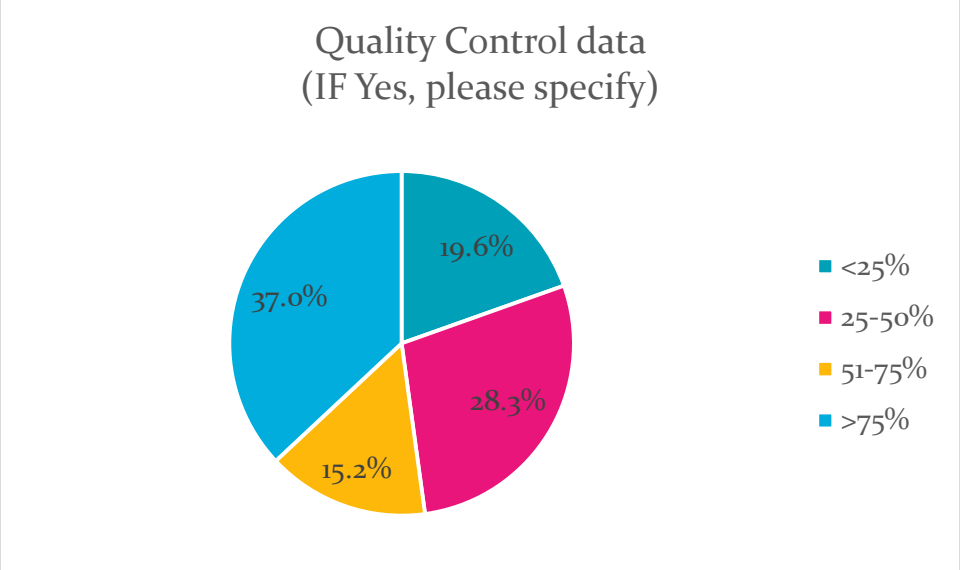


Figure 102 Quality Control data (IF Yes, please specify)

- Data about processing, process condition

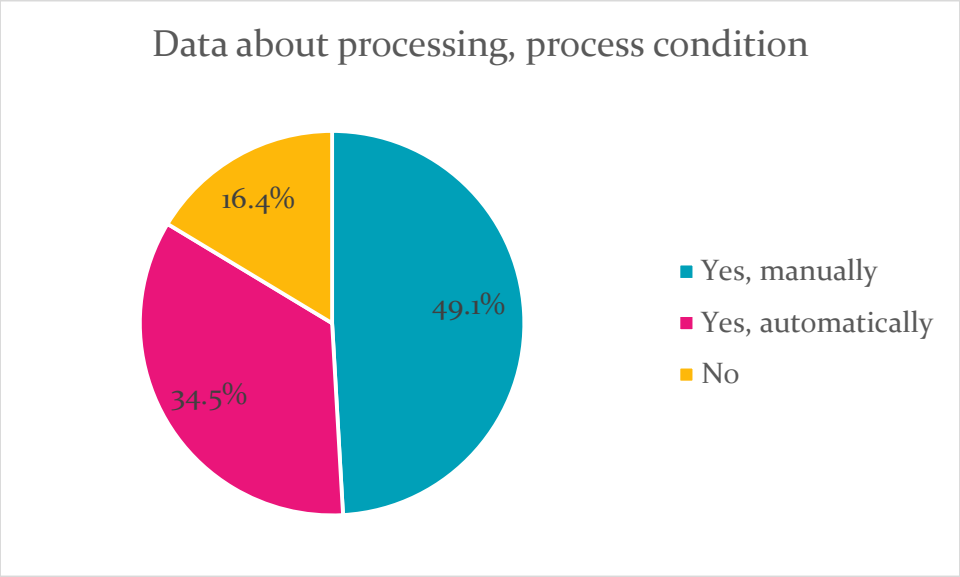


Figure 103 Data about processing, process condition

- Data about processing, process condition (IF Yes, please specify)

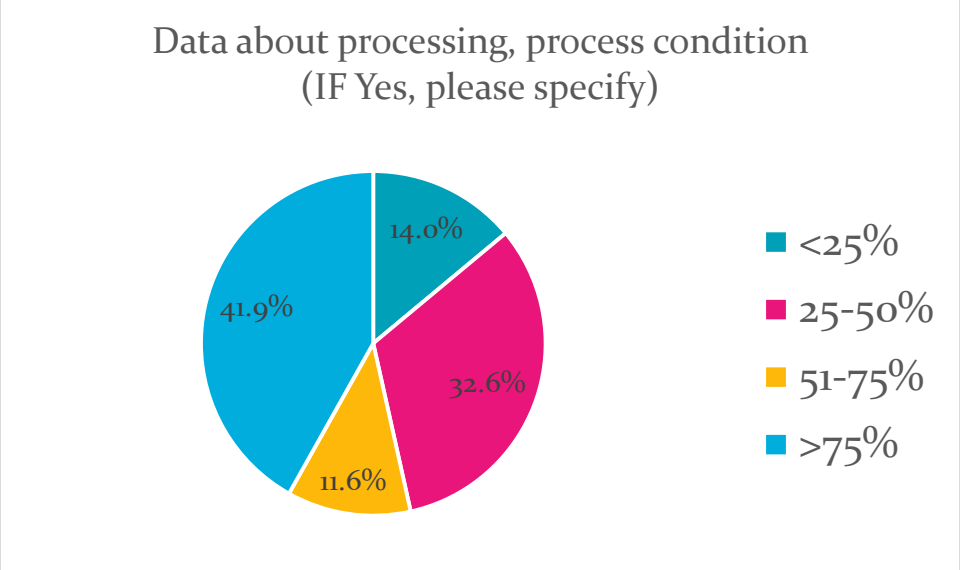


Figure 104 Data about processing, process condition (IF Yes, please specify)

- Production times

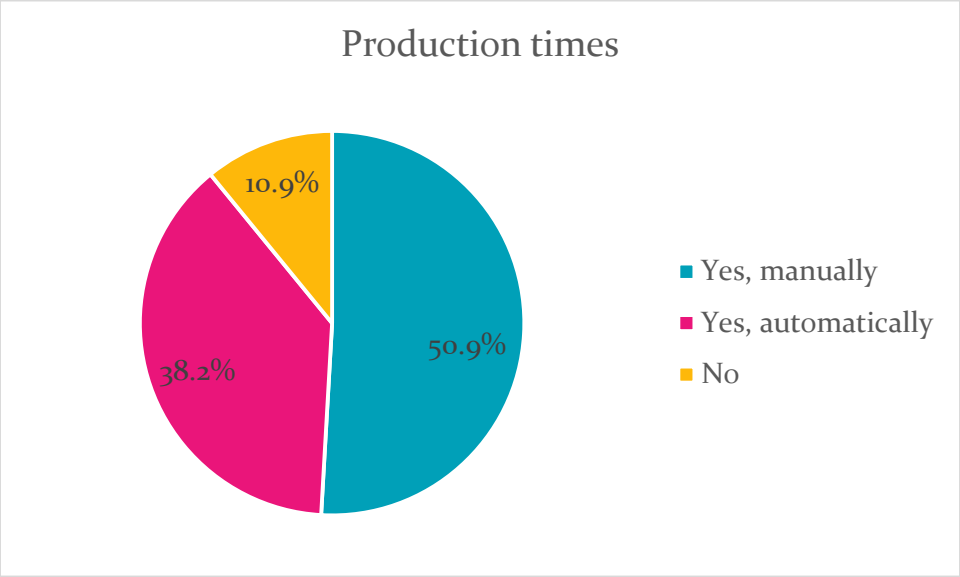


Figure 105 Production times

- Production times (IF Yes, please specify)

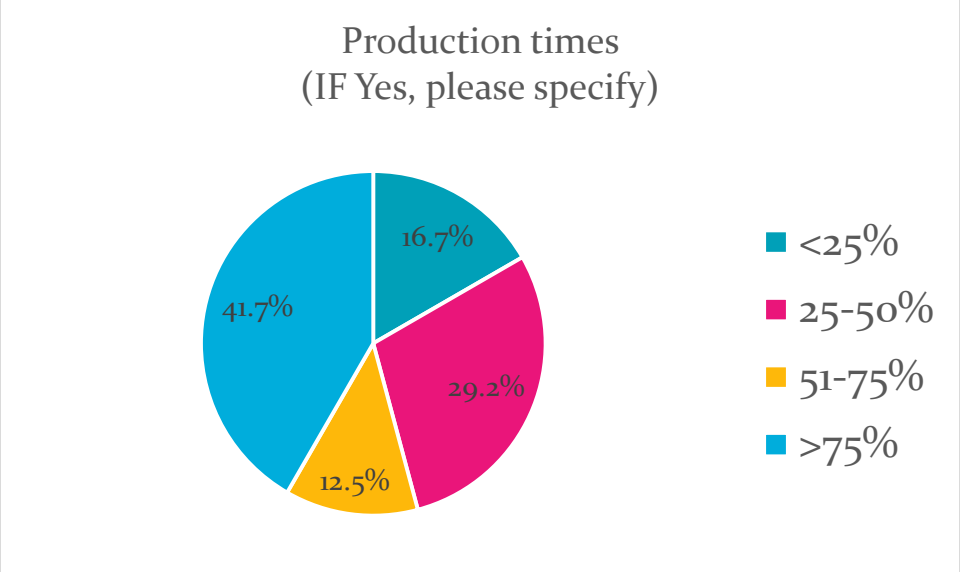


Figure 106 Production times (IF Yes, please specify)

- Overall equipment effectiveness (OEE)

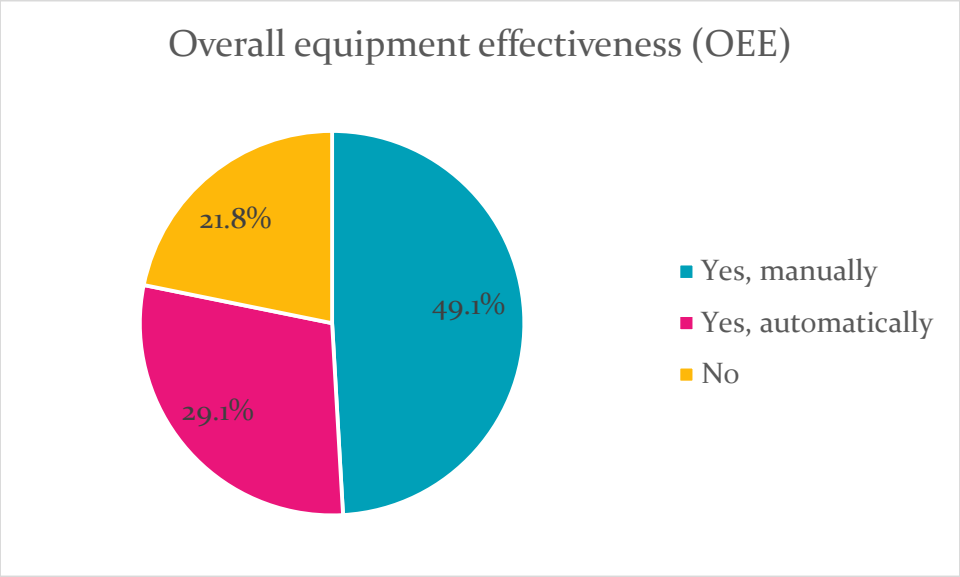


Figure 107 Overall equipment effectiveness (OEE)

- Overall equipment effectiveness (OEE) (IF Yes, please specify)

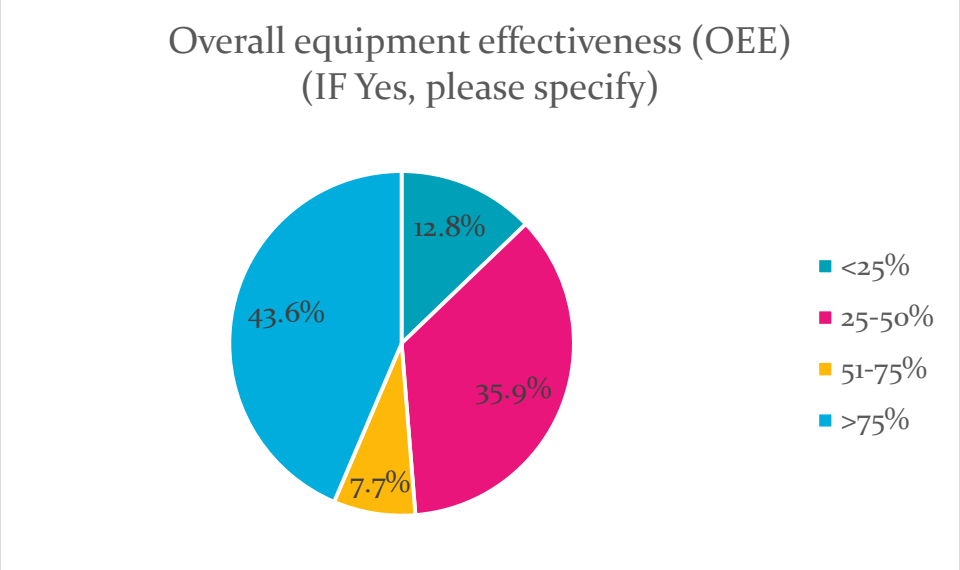


Figure 108 Overall equipment effectiveness (OEE) (IF Yes, please specify)

- Other

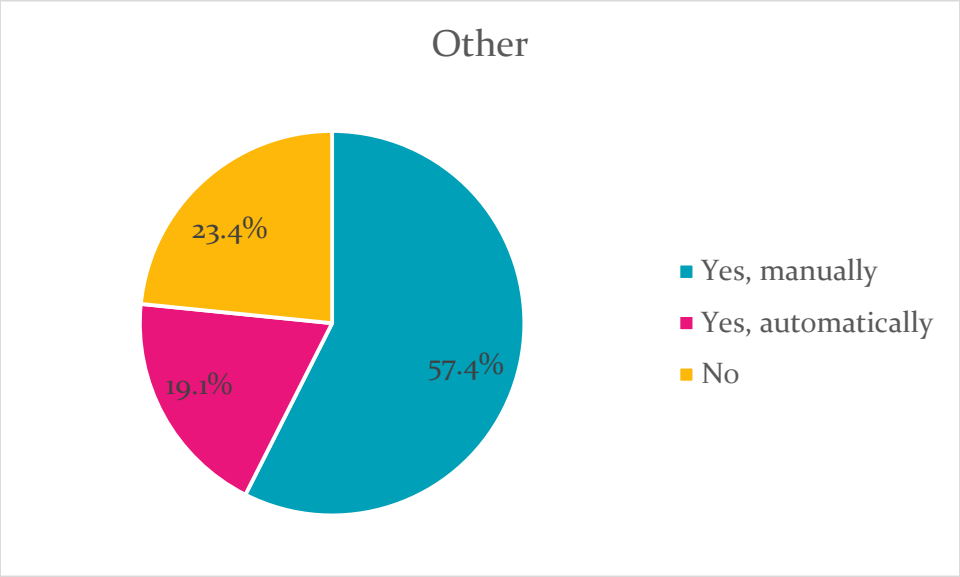


Figure 109 Other

- Other (IF Yes, please specify)

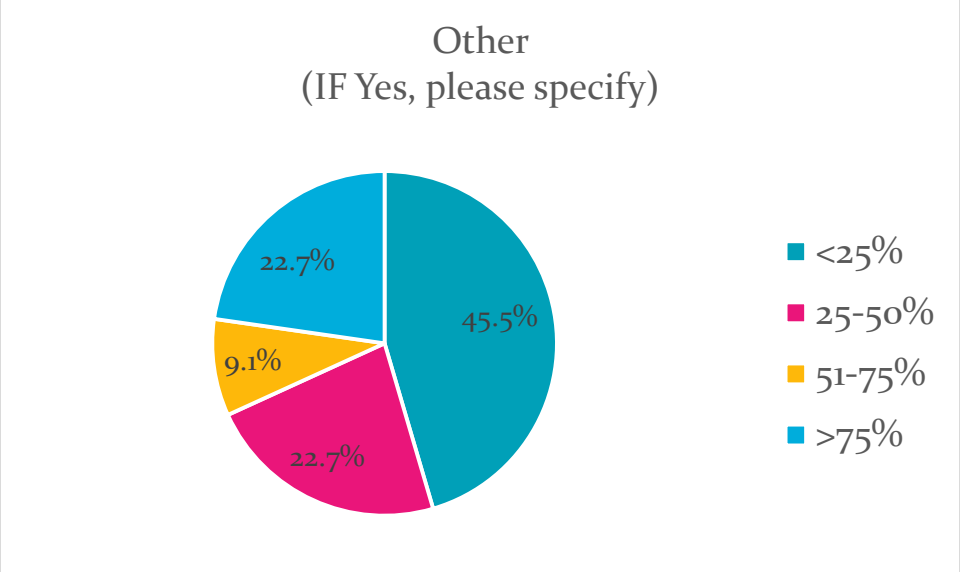


Figure 110 Other (IF Yes, please specify)

Q2.6 Which of the following systems do you use? Does the system have an interface to the leading system?

- MES – manufacturing execution system

In use

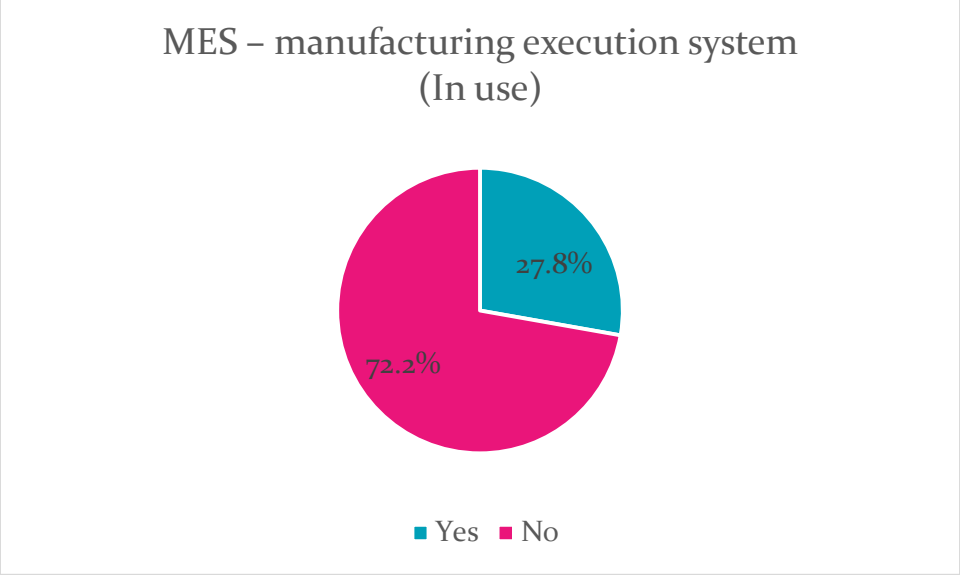


Figure 111 MES – manufacturing execution system (In use)

Interface to leading system

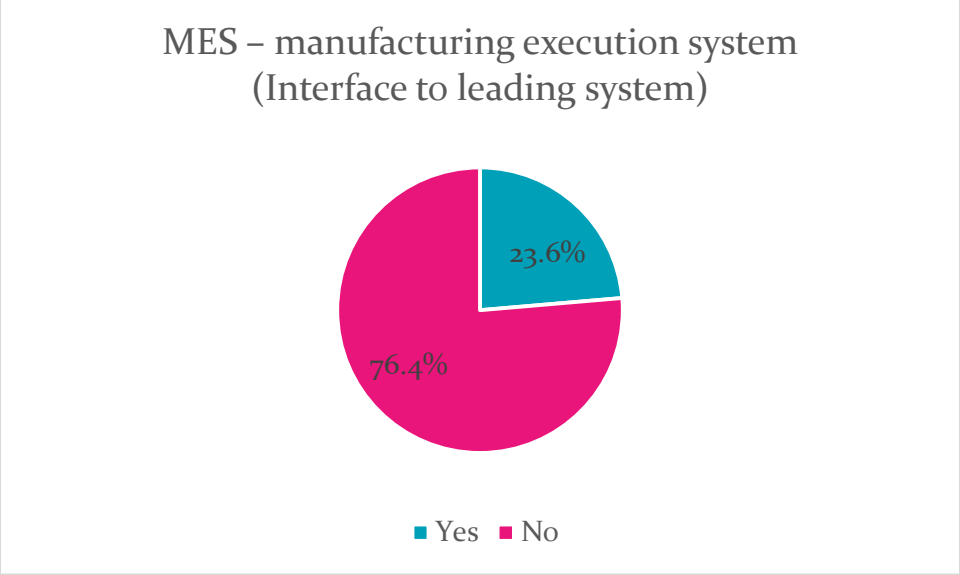


Figure 112 MES – manufacturing execution system (Interface to leading system)

- ERP – enterprise resource planning

In use

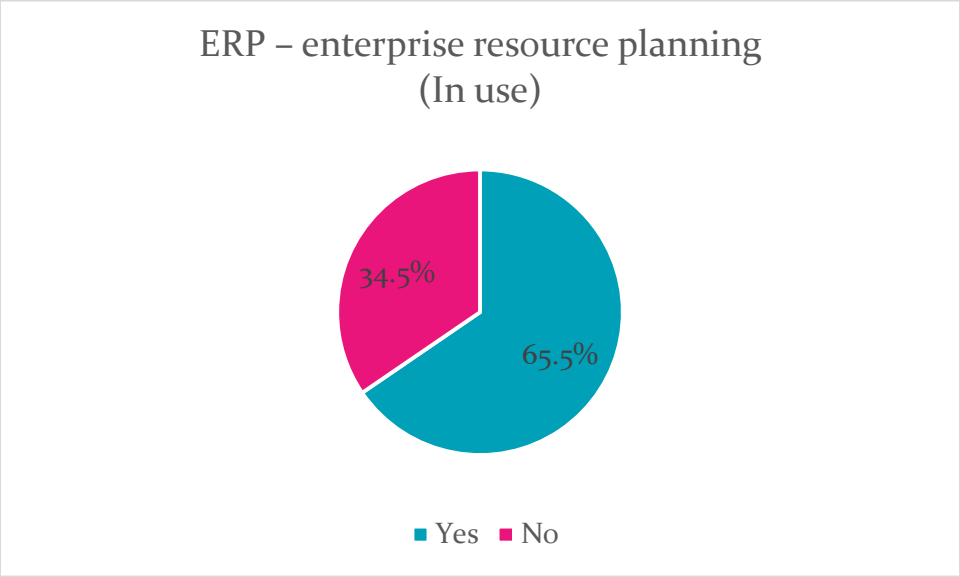


Figure 113 ERP – enterprise resource planning (In use)

Interface to leading system

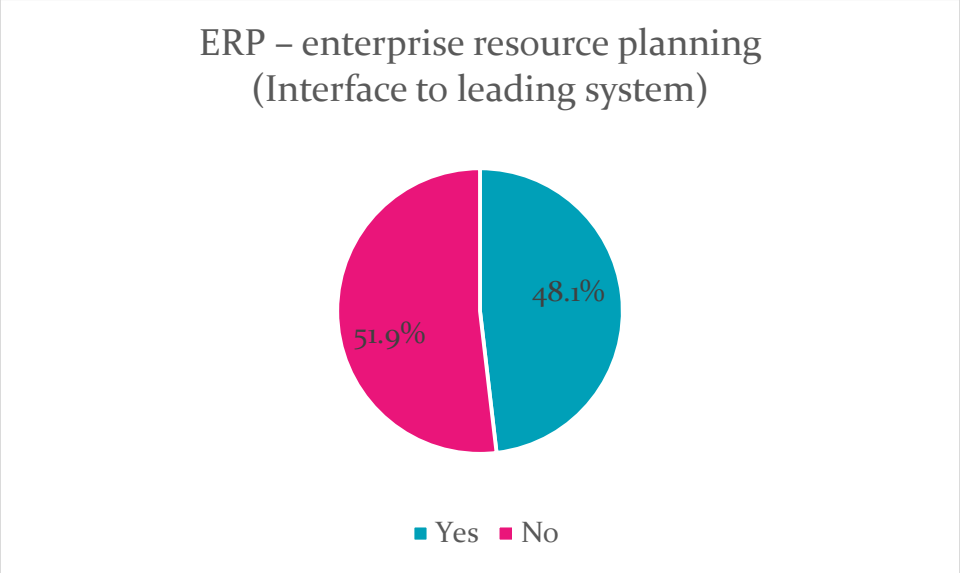


Figure 114 ERP – enterprise resource planning (Interface to leading system)

- PLM – product lifecycle management

In use

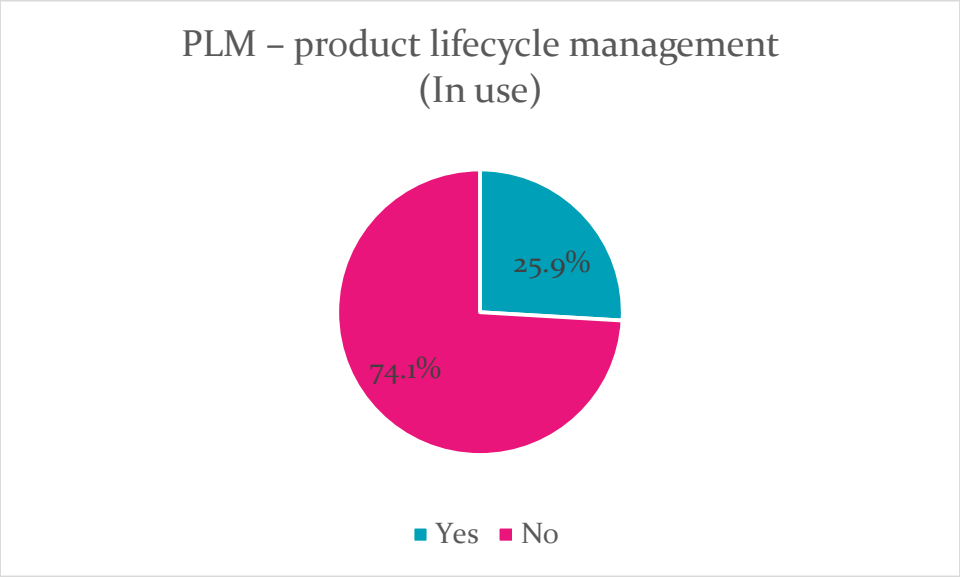


Figure 115 PLM – product lifecycle management (In use)

Interface to leading system

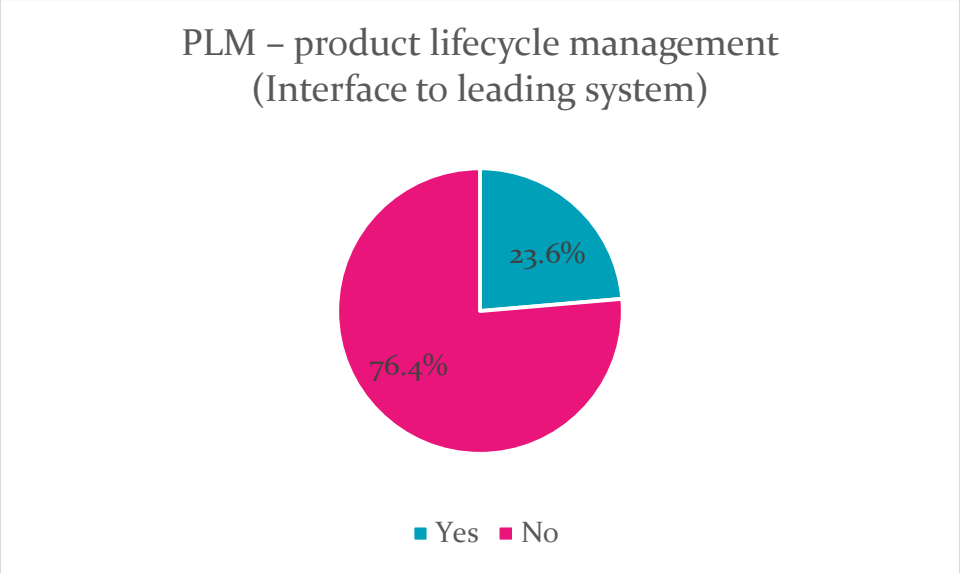


Figure 116 PLM – product lifecycle management (Interface to leading system)

- PDM – product data management

In use

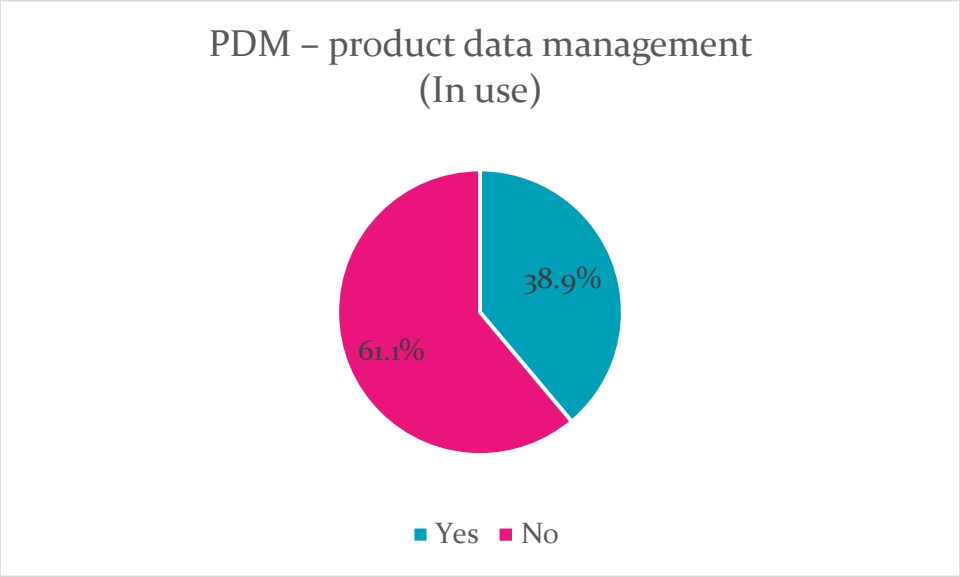


Figure 117 PDM – product data management (In use)

Interface to leading system

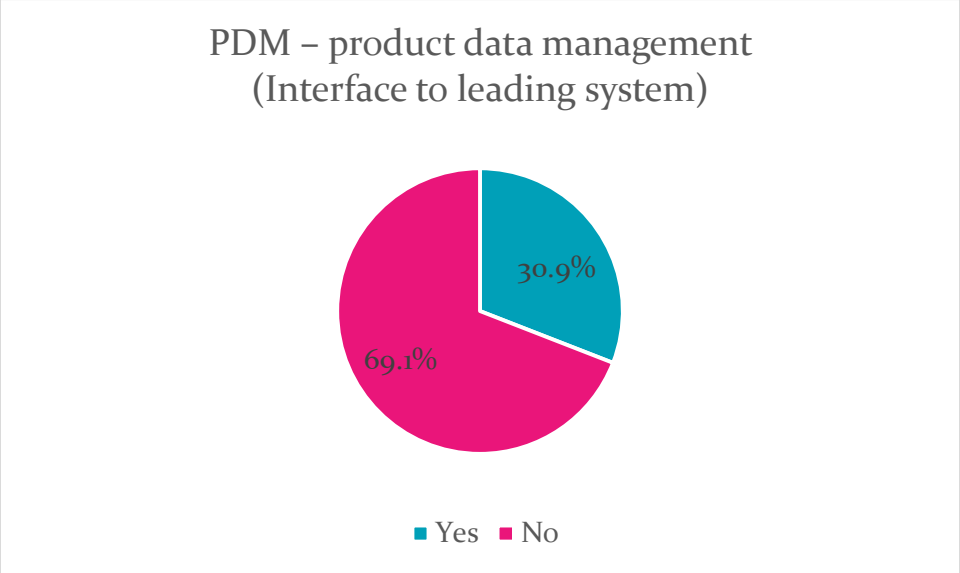


Figure 118 PDM – product data management (Interface to leading system)

- PPS – production planning system

In use

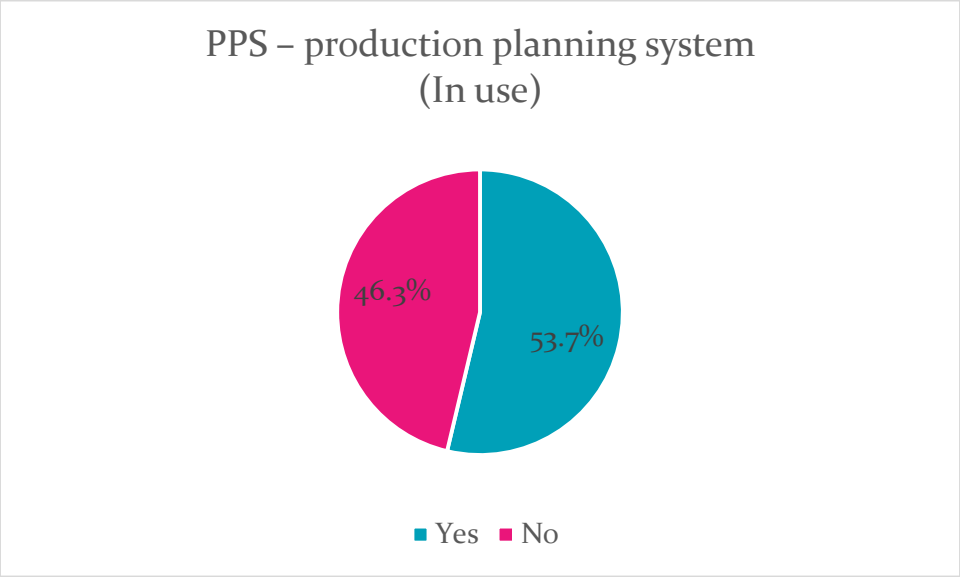


Figure 119 PPS – production planning system (In use)

Interface to leading system

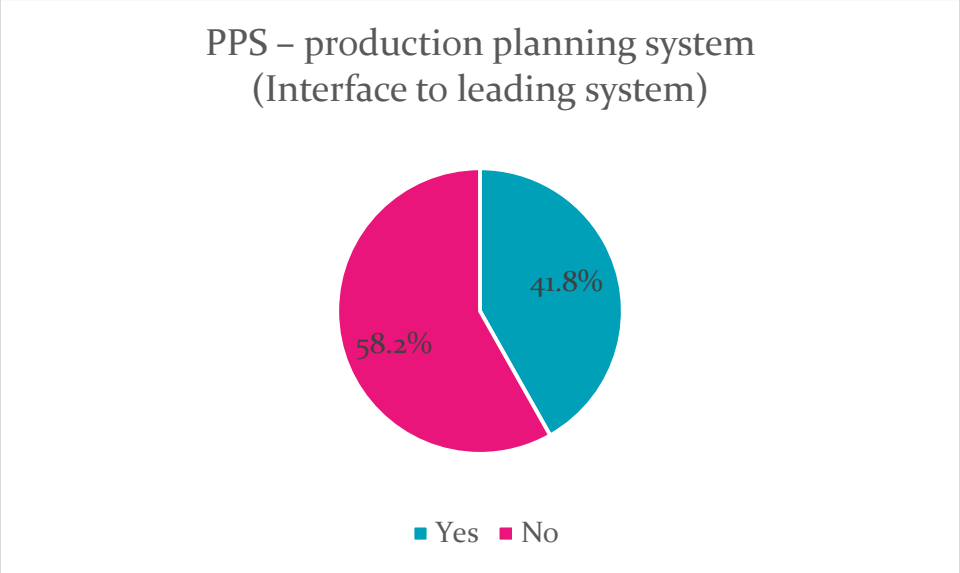


Figure 120 PPS – production planning system (Interface to leading system)

- PDA – production data acquisition

In use

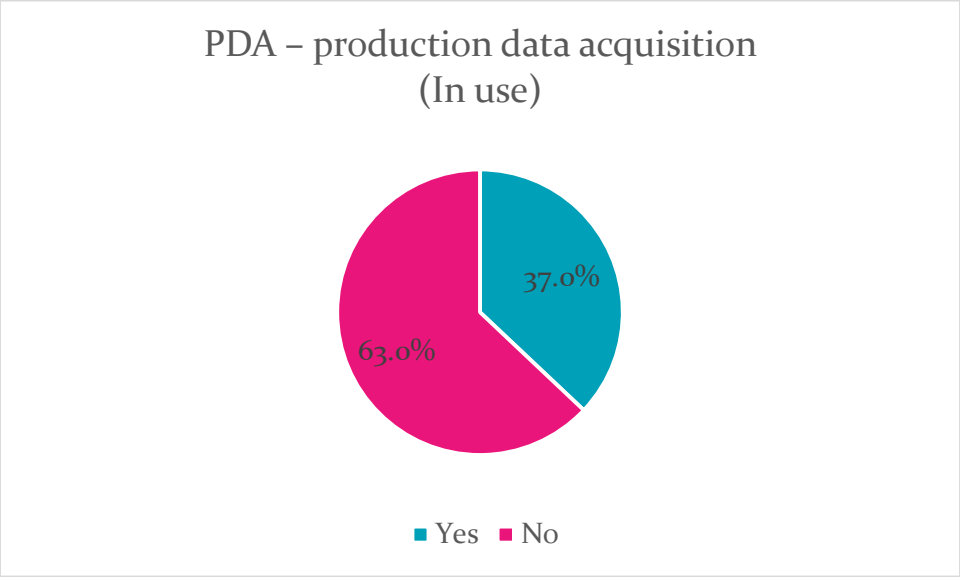


Figure 121 PDA – production data acquisition (In use)

Interface to leading system

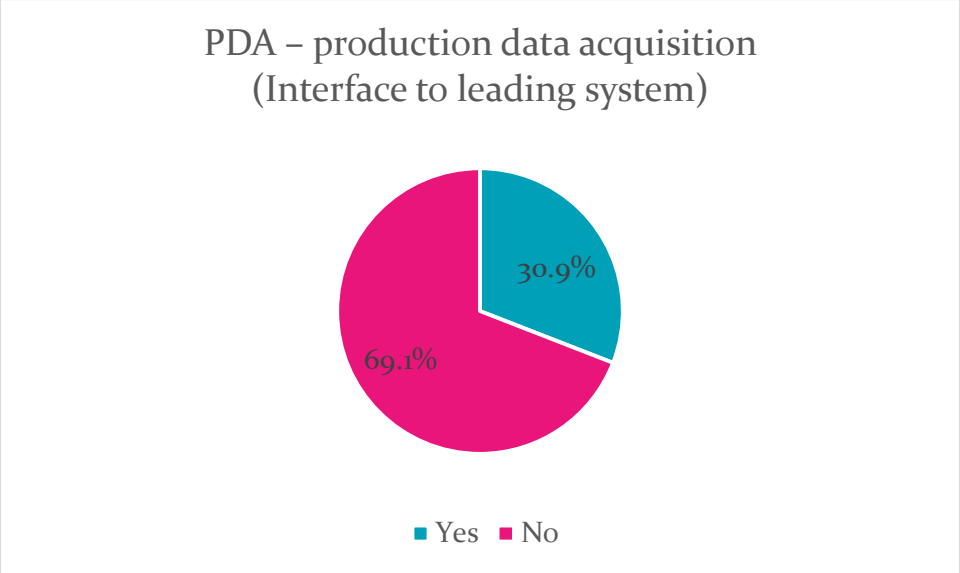


Figure 122 PDA – production data acquisition (Interface to leading system)

- MDC – machine data collection

In use

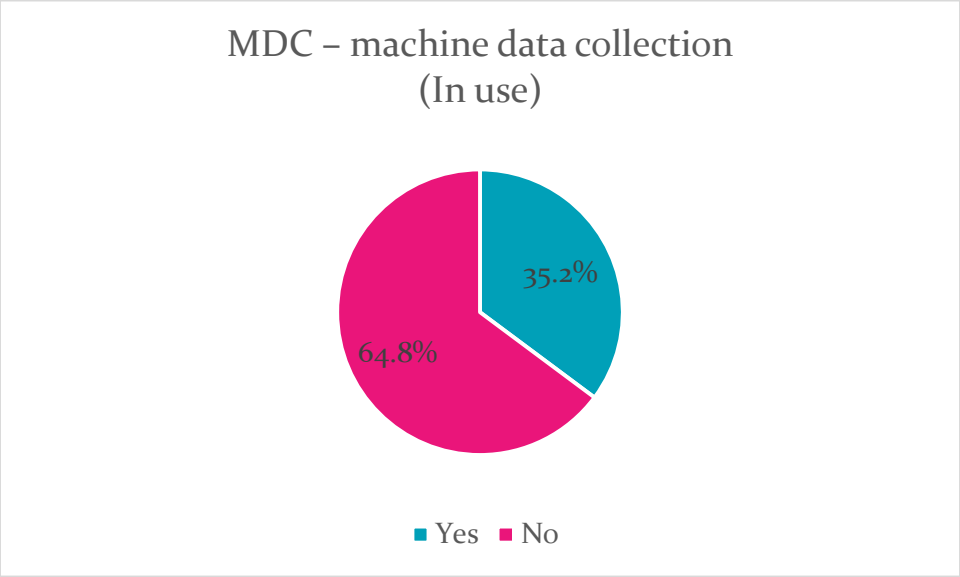


Figure 123 MDC – machine data collection (In use)

Interface to leading system

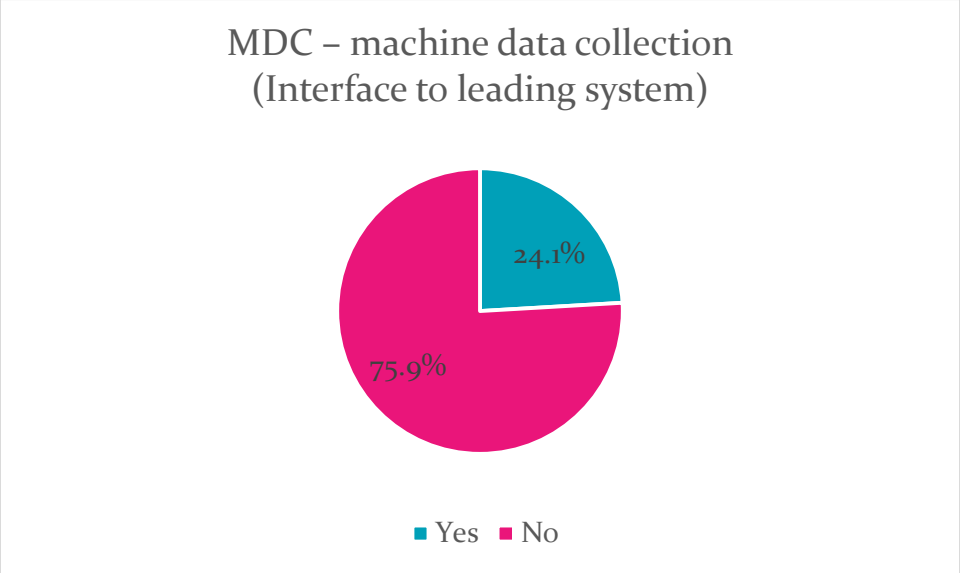


Figure 124 MDC – machine data collection (Interface to leading system)

- CAD – computer-aided design

In use

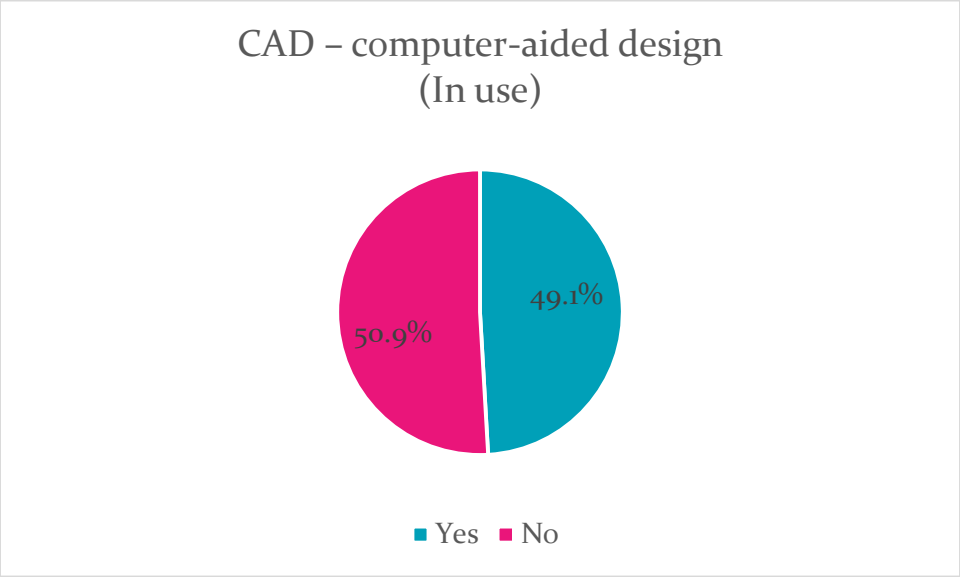


Figure 125 CAD – computer-aided design (In use)

Interface to leading system

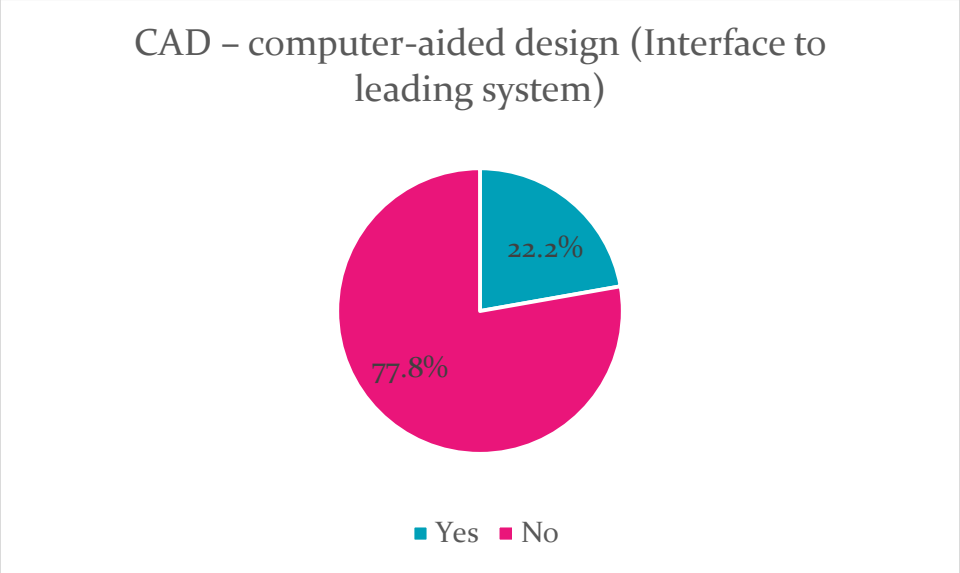


Figure 126 CAD – computer-aided design (Interface to leading system)

- SCM – supply chain management

In use

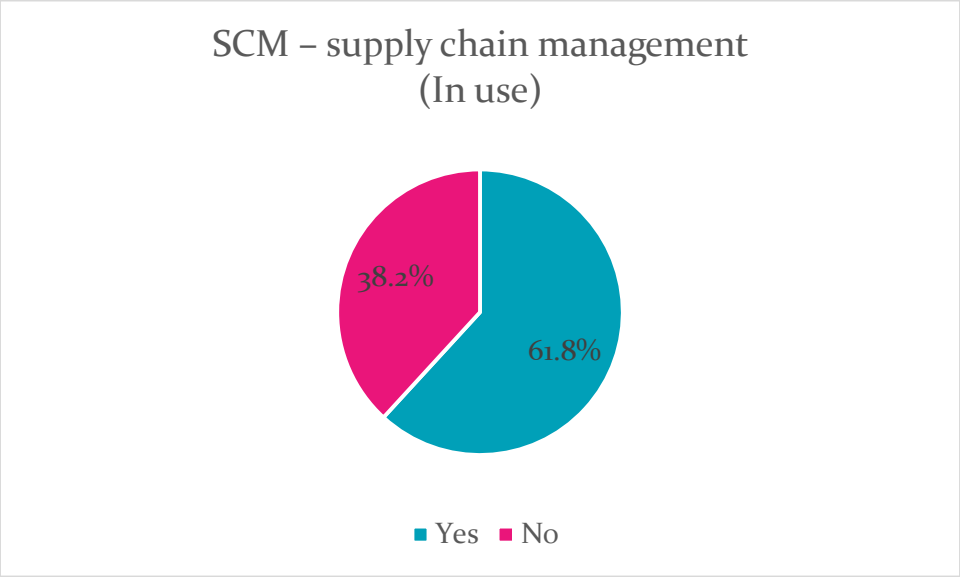


Figure 127 SCM – supply chain management (In use)

Interface to leading system

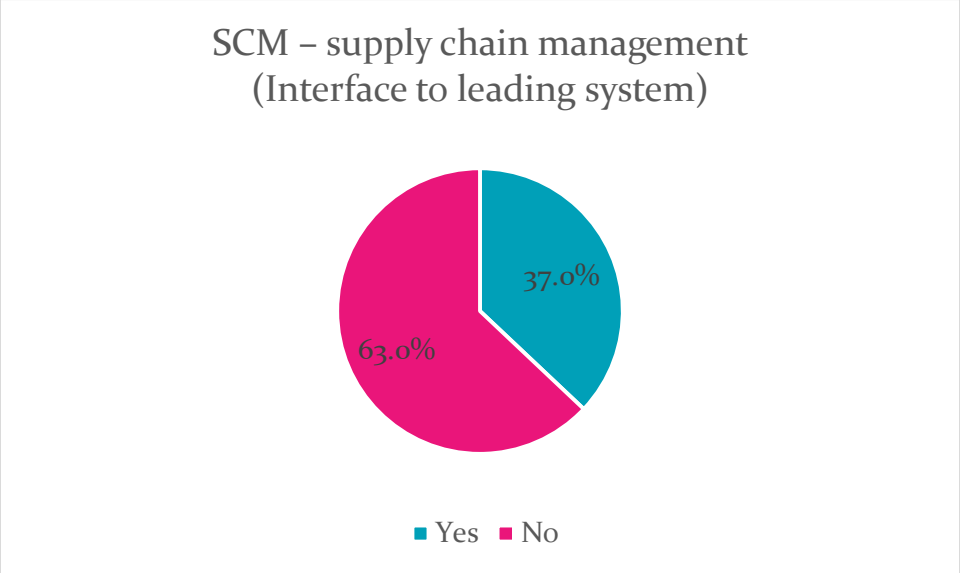


Figure 128 SCM – supply chain management (Interface to leading system)

3. SMART OPERATIONS - CONTROLLING, ADJUSTING & MONITORING PROCESS REAL TIME

One hallmark of Industry 4.0 is the enterprise-wide and cross-enterprise integration of the physical and virtual worlds. The advent of digitization and the plethora of data it has brought to production and logistics have made it possible to introduce what are in some cases entirely new forms and approaches to production planning systems (PPS) and supply chain management (SCM). The technical requirements in production and production planning necessary to realize the self-controlling workpiece are known as smart operations.

VERTICAL AND HORIZONTAL INTEGRATION

Q3.1 Where have you integrated cross-departmental information sharing into your system? Distinguish between enterprise-wide (internal) and cross-enterprise (external) information sharing.

- Research and development

Internally between departments

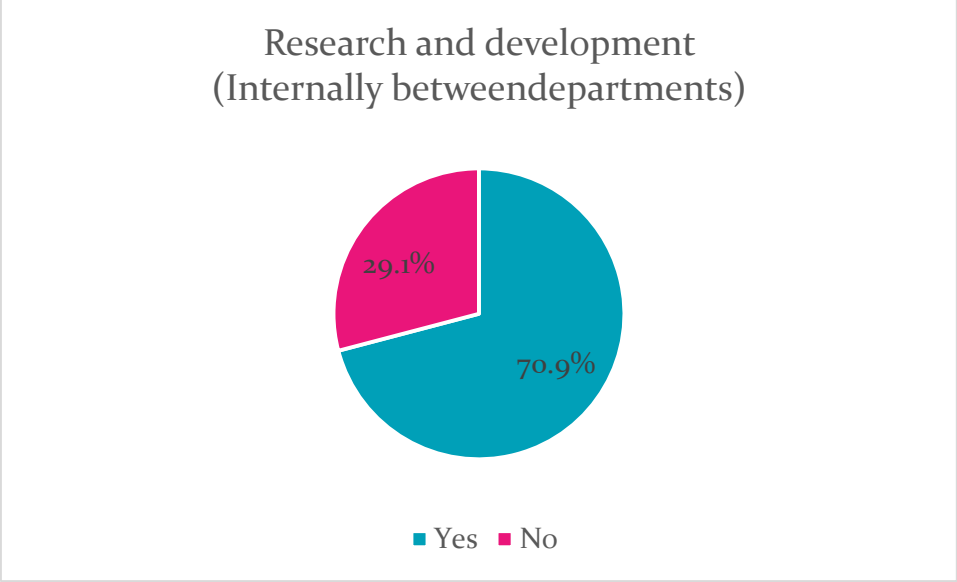


Figure 129 Research and development (Internally between departments)

Externally with customers and/or suppliers

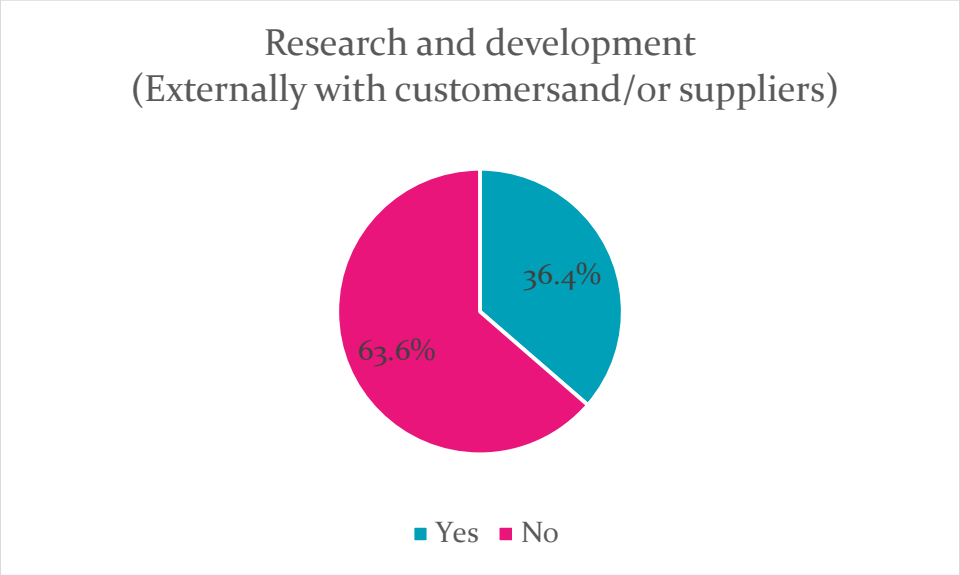


Figure 130 Research and development (Externally with customers and/or suppliers)

- Production/manufacturing

Internally between departments

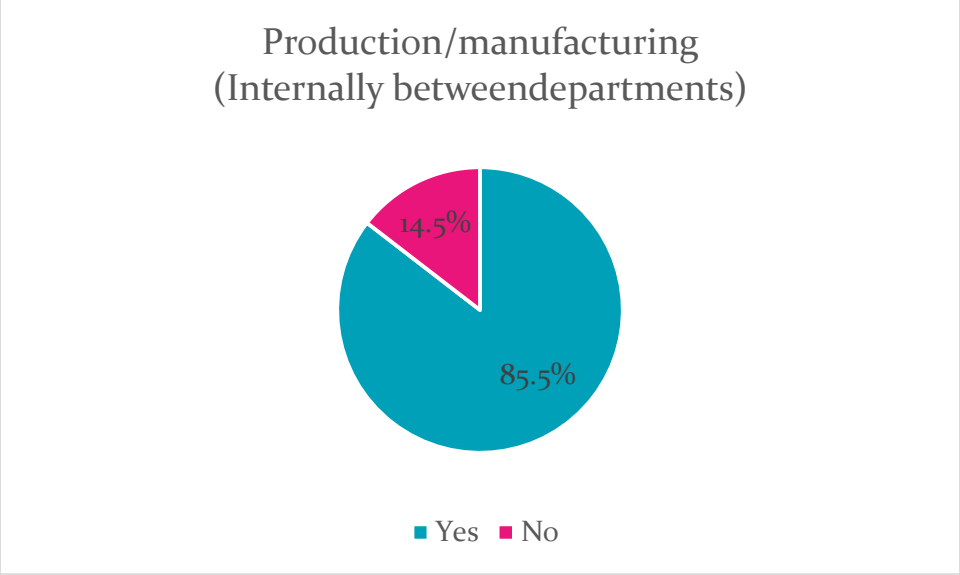


Figure 131 Production/manufacturing (Internally between departments)

Externally with customers and/or suppliers

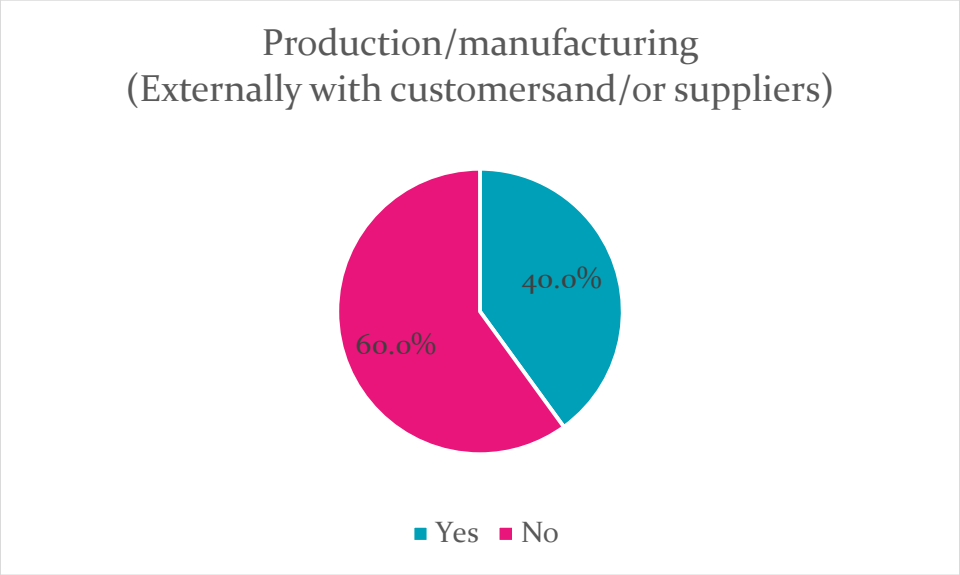


Figure 132 Production/manufacturing (Externally with customers and/or suppliers)

- Purchasing

Internally between departments

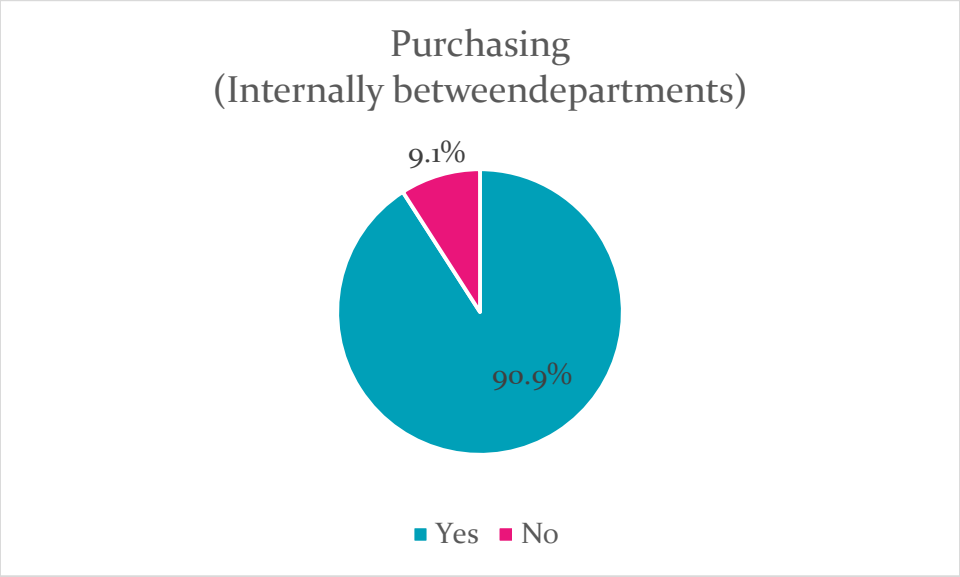


Figure 133 Purchasing (Internally between departments)

Externally with customers and/or suppliers

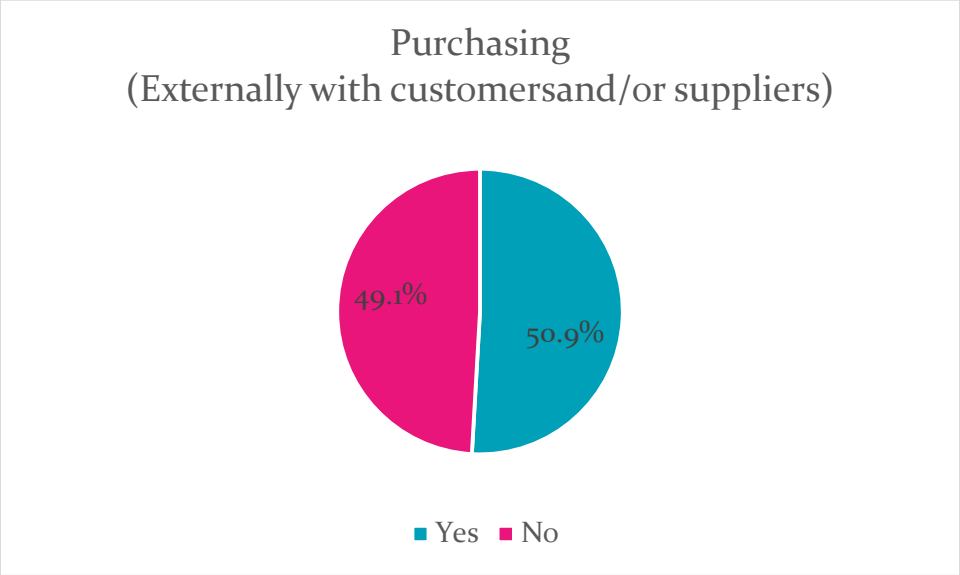


Figure 134 Purchasing (Externally with customers and/or suppliers)

- *Logistics*

Internally between departments

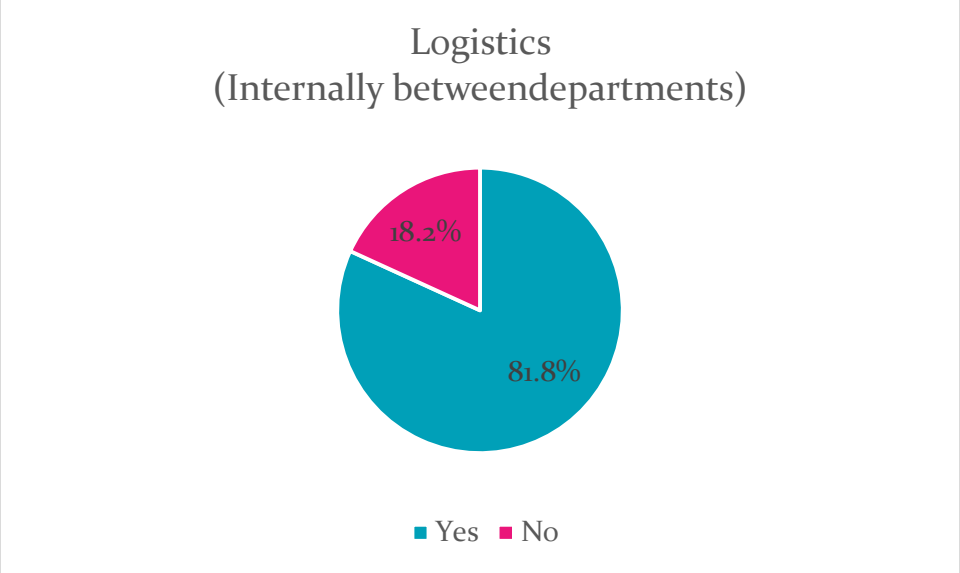


Figure 135 Logistics (Internally between departments)

- Externally with customers and/or suppliers

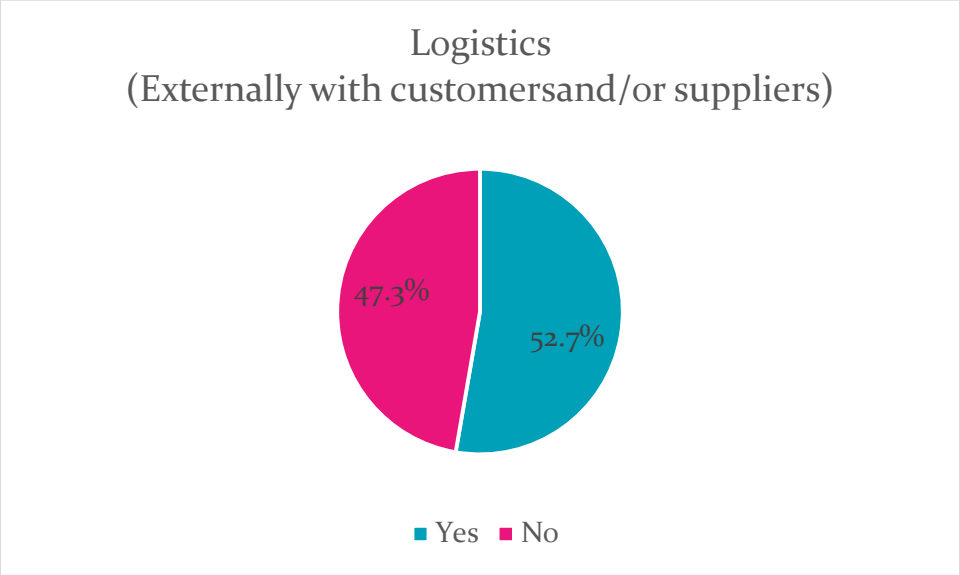


Figure 136 Logistics (Externally with customers and/or suppliers)

- Sales

Internally between departments

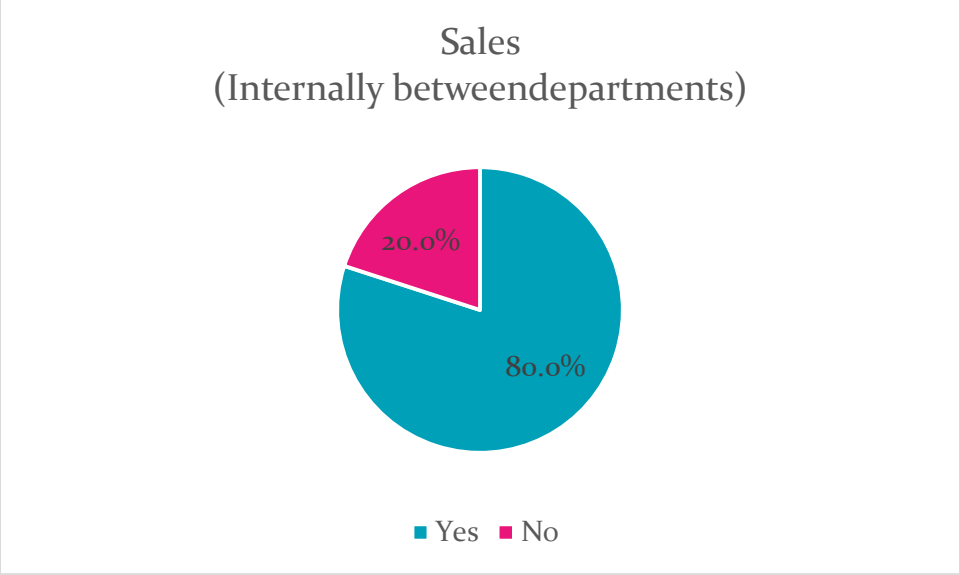


Figure 137 Sales (Internally between departments)

Externally with customers and/or suppliers

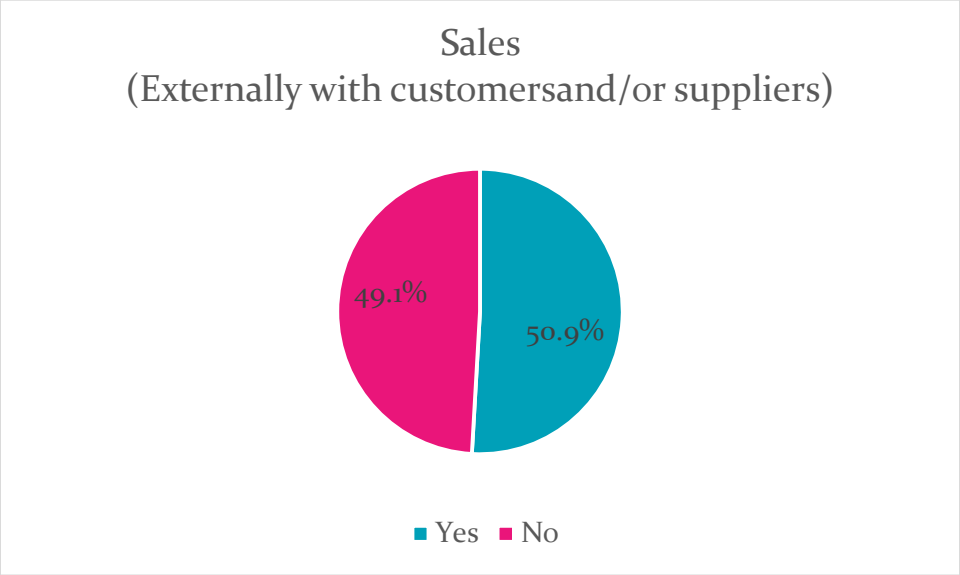


Figure 138 Sales (Externally with customers and/or suppliers)

- Finance/accounting

Internally between departments

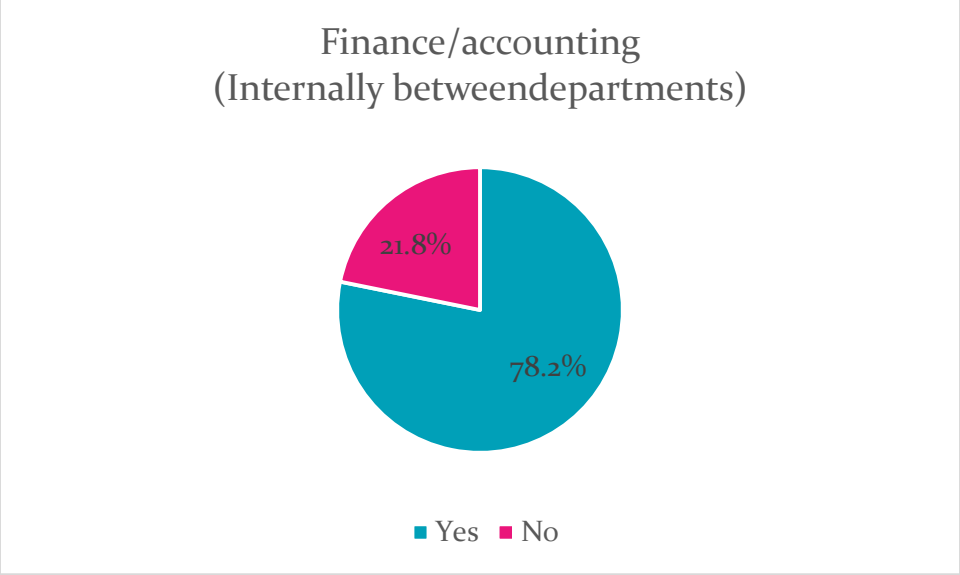


Figure 139 Finance/accounting (Internally between departments)

Externally with customers and/or suppliers

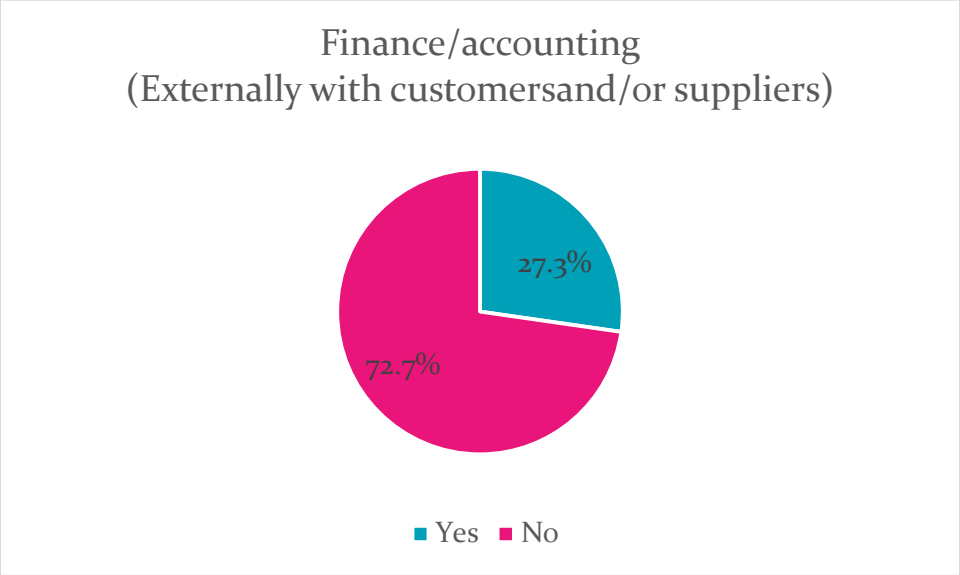


Figure 140 Finance/accounting (Externally with customers and/or suppliers)

- Service

Internally between departments

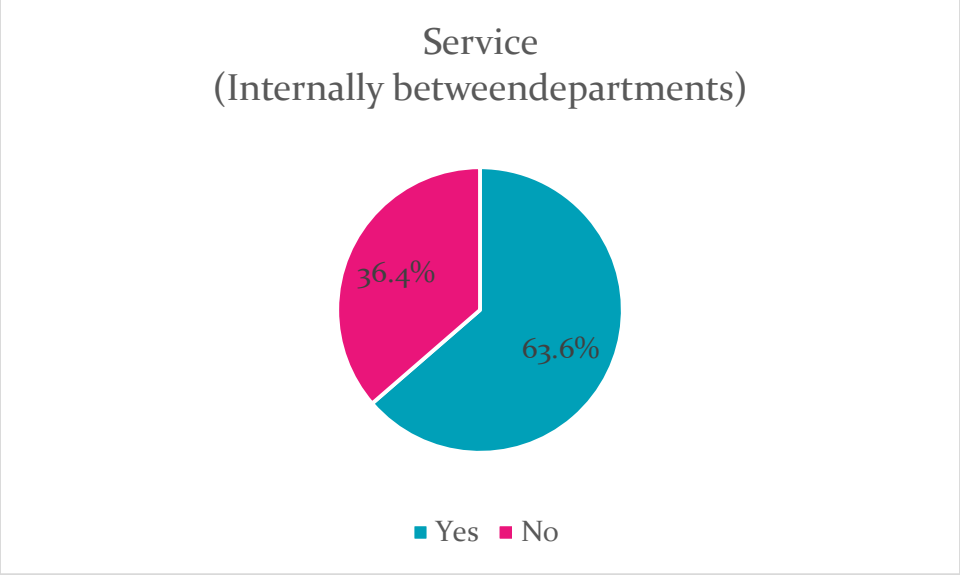


Figure 141 Service (Internally between departments)

Externally with customers and/or suppliers

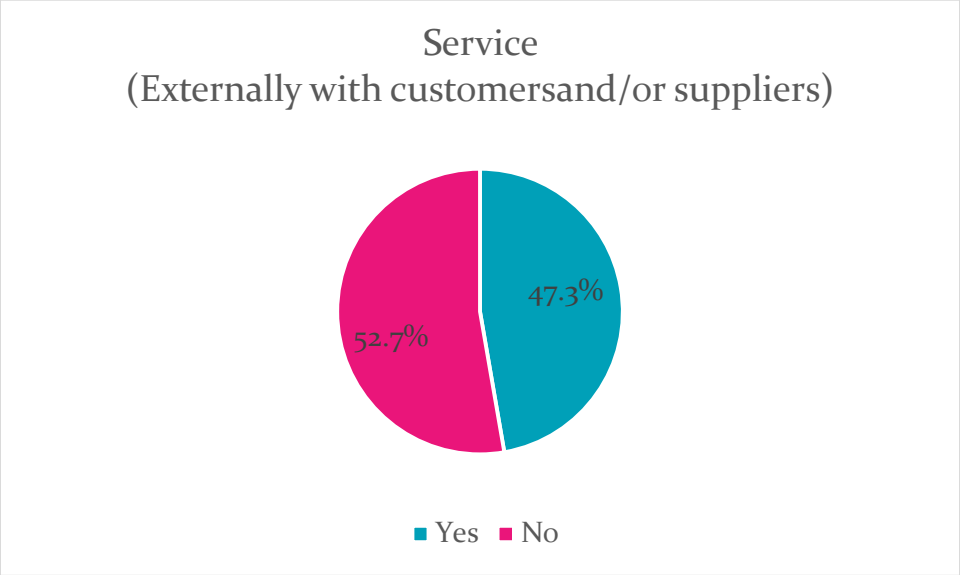


Figure 142 Service (Externally with customers and/or suppliers)

- IT

Internally between departments

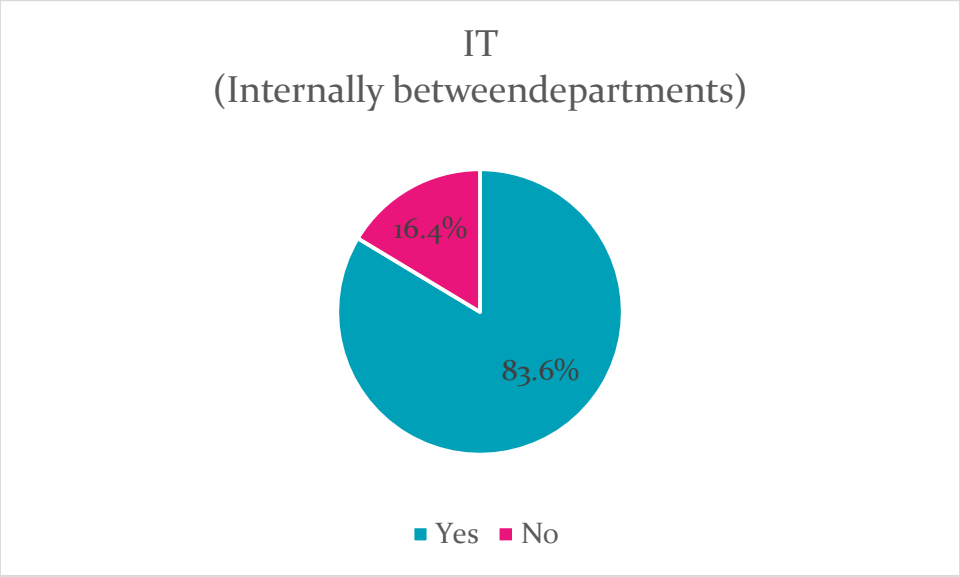


Figure 143 IT (Internally between departments)

Externally with customers and/or suppliers

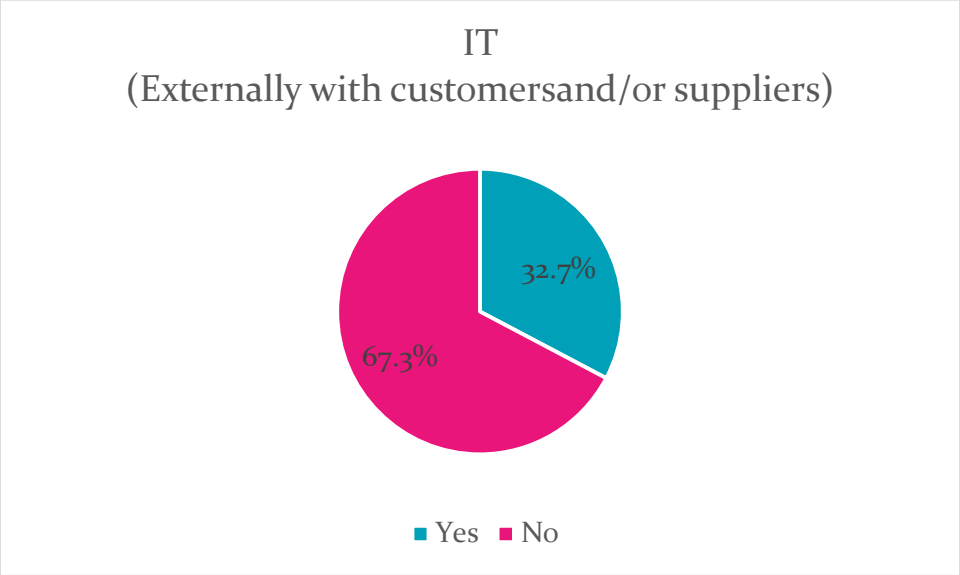


Figure 144 IT (Externally with customers and/or suppliers)

- Nowhere

Internally between departments

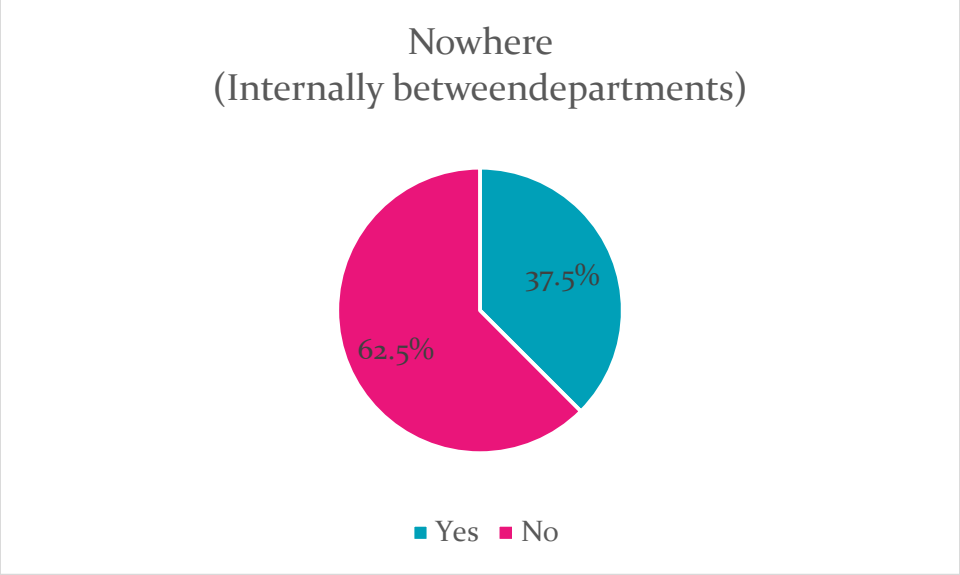


Figure 145 Nowhere (Internally between departments)

Externally with customers and/or suppliers

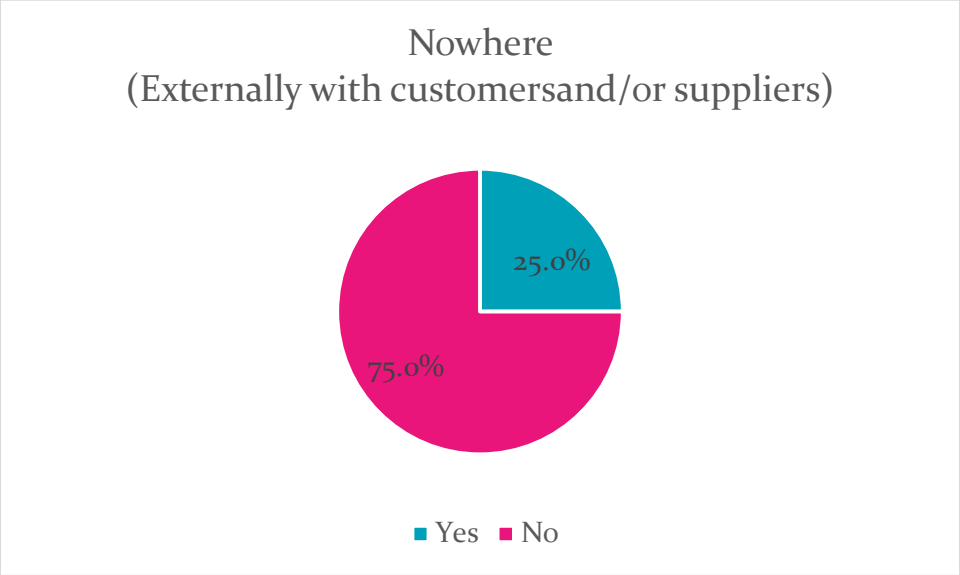


Figure 146 Nowhere (Externally with customers and/or suppliers)

DISTRIBUTED CONTROL

Q3.2 The vision of Industry 4.0 is a workpiece that guides itself autonomously through production. Does your company already have use cases in which the workpiece guides itself autonomously through production?

- ☐ Yes, cross-enterprise
- ☐ Yes, but only in selected areas
- ☐ Yes, but only in the test and pilot phase
- ☐ No

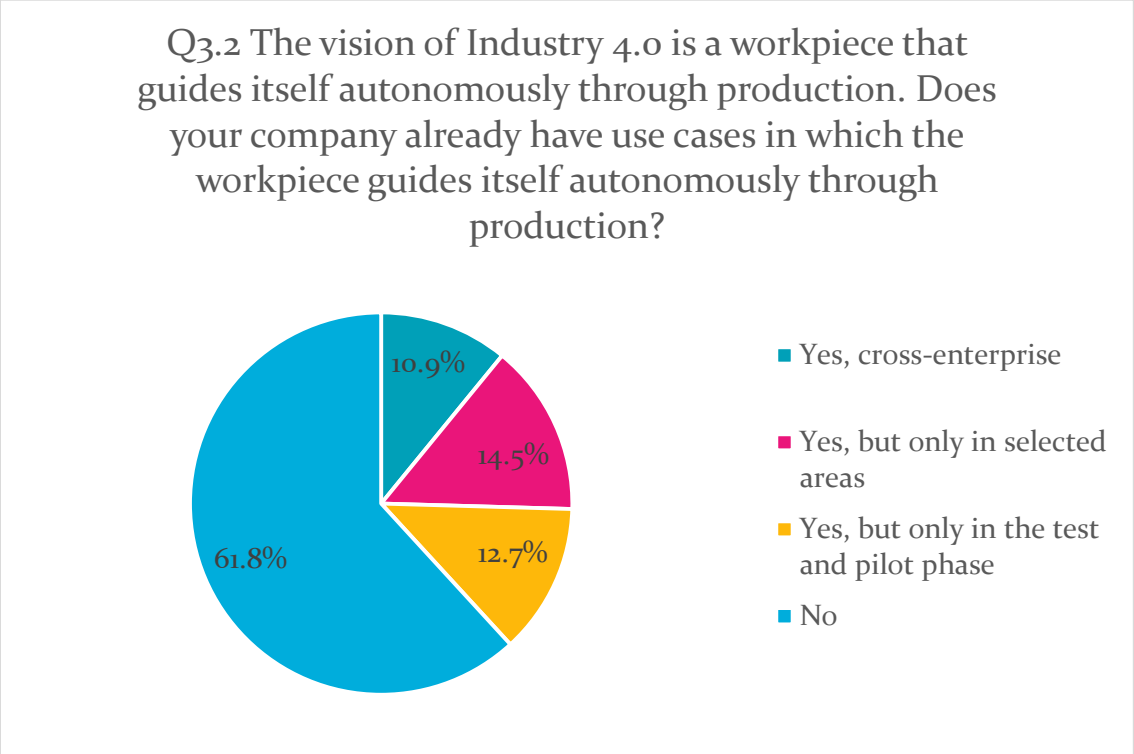


Figure 147 Q3.2 The vision of Industry 4.0 is a workpiece that guides itself autonomously through production. Does your company already have use cases in which the workpiece guides itself autonomously through production?

Q3.3 Does your company have production processes that respond autonomously/automatically in real time to changes in production conditions?

☐ Yes, cross-enterprise

☐ Yes, but only in selected areas

☐ Yes, but only in the test and pilot phase

☐ No

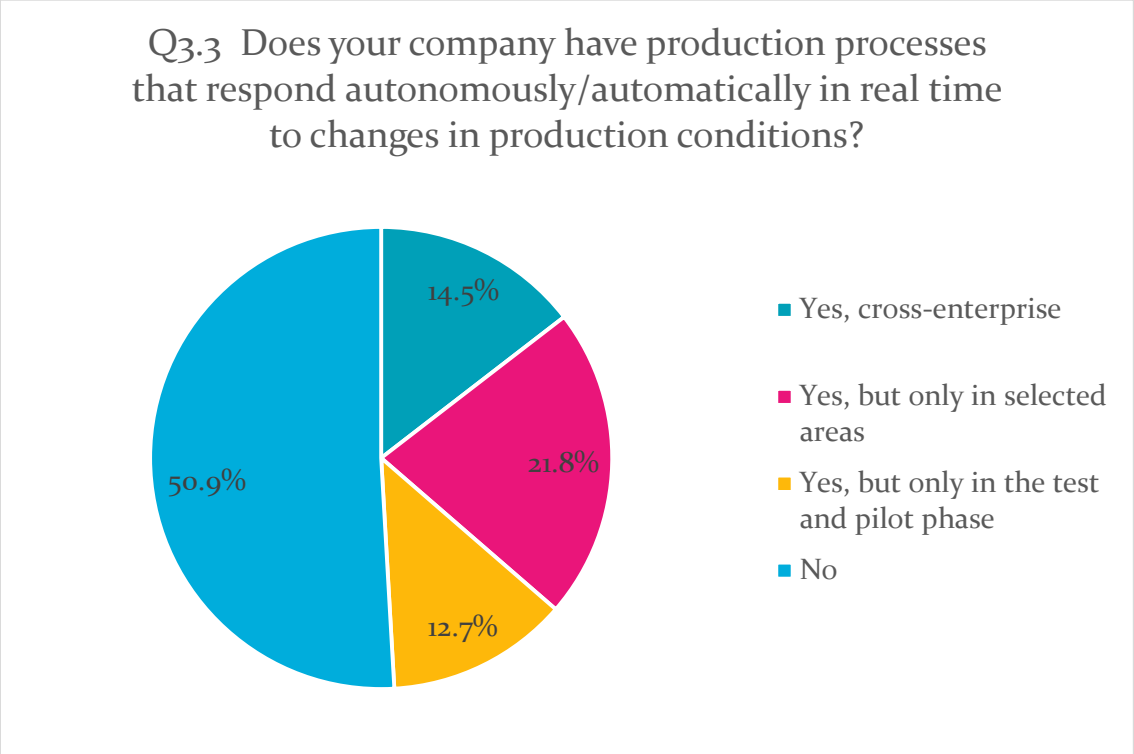


Figure 148 Q3.3 Does your company have production processes that respond autonomously/automatically in real time to changes in production conditions?

DATA AND COMMUNICATIONS SECURITY

Q3.4 How is your IT organized?

- ☐ No in-house IT department (service provider used)
- ☐ Central IT department
- ☐ Local IT departments in each area (production, product development, etc.)
- ☐ IT experts attached to each department

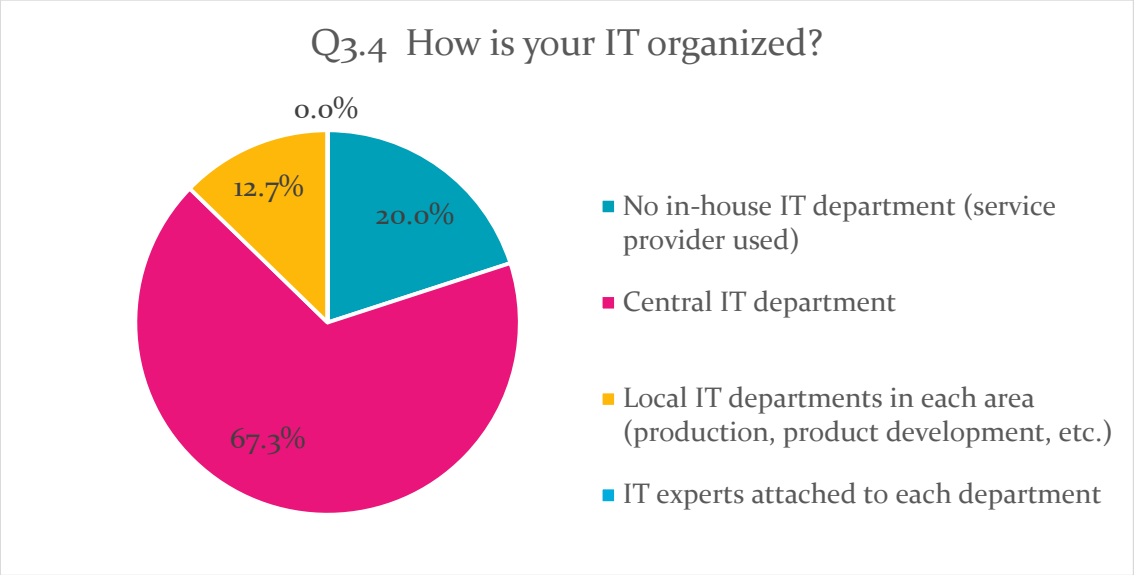


Figure 149 Q3.4 How is your IT organized?

Q3.5 How far along are you with your IT security solutions?

- Security in internal data storage

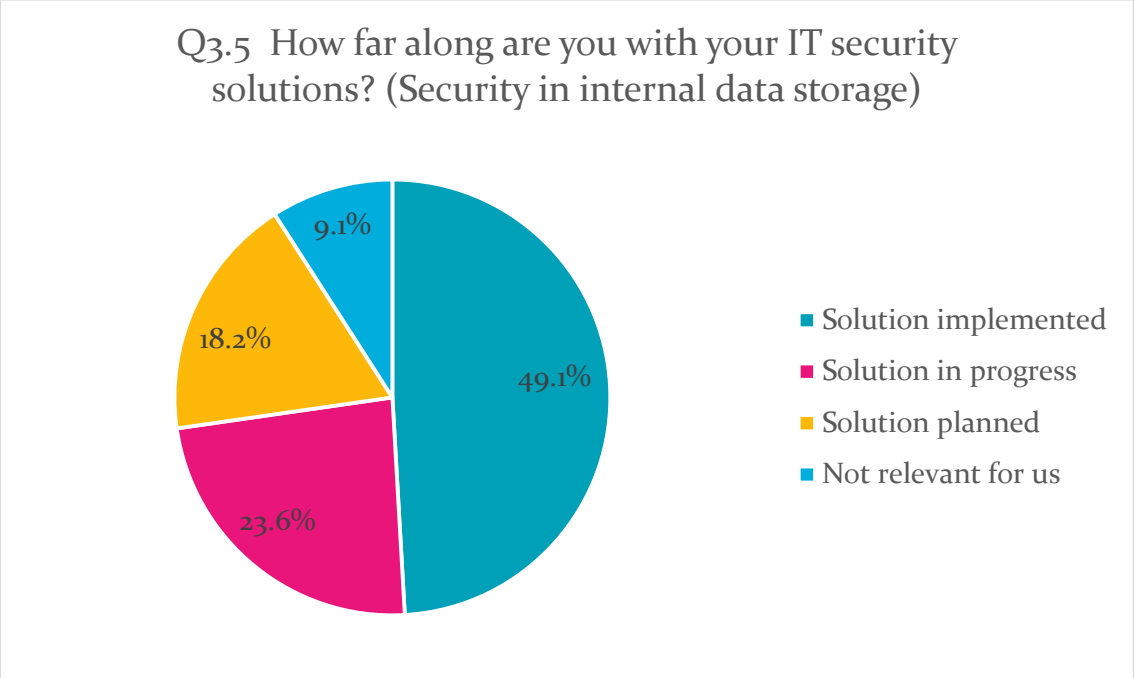


Figure 150 Q3.5 Security in internal data storage

- Security of data through cloud services

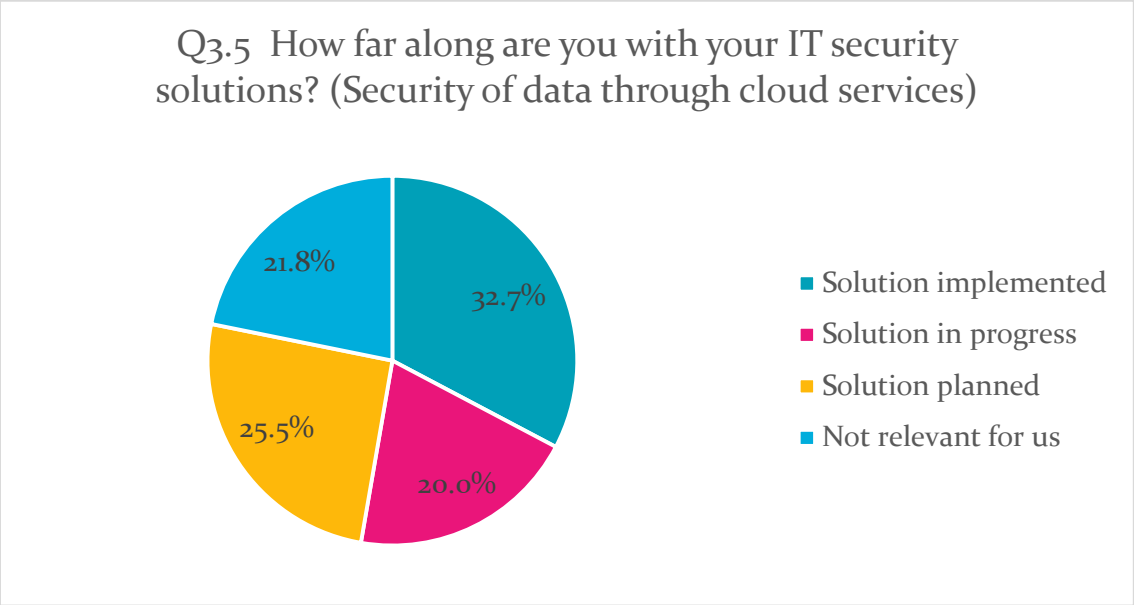


Figure 151 Security of data through cloud services

- Security of communications for in-house data exchange

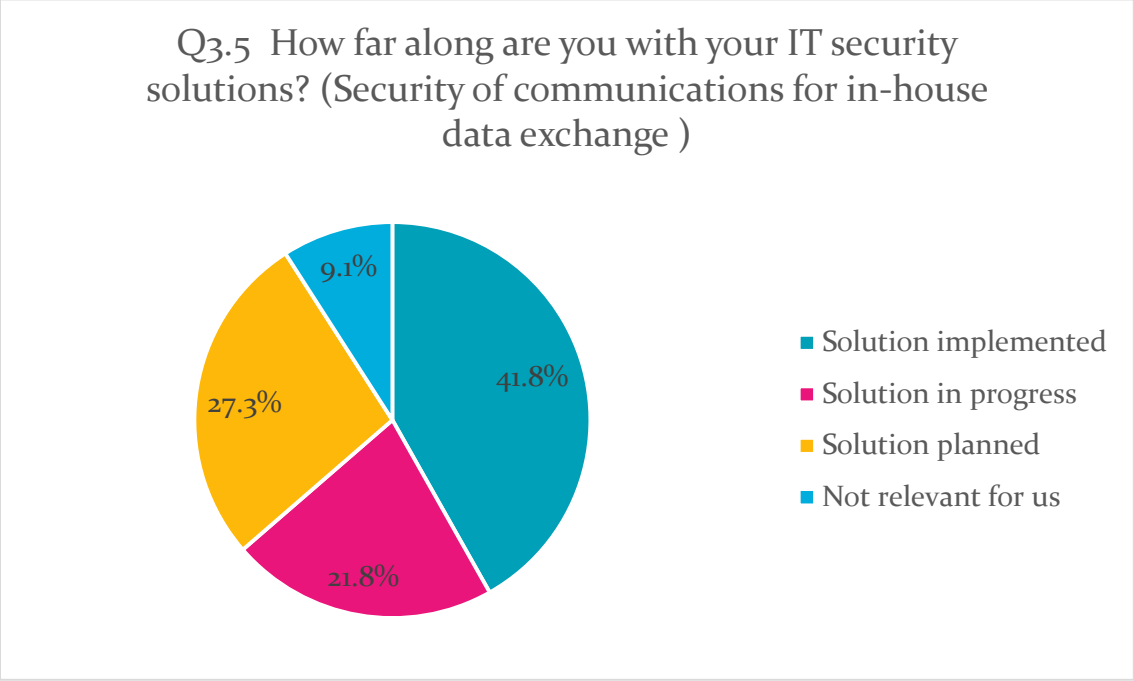


Figure 152 Security of communications for in-house data exchange

- Security of communications for data exchange with business partners

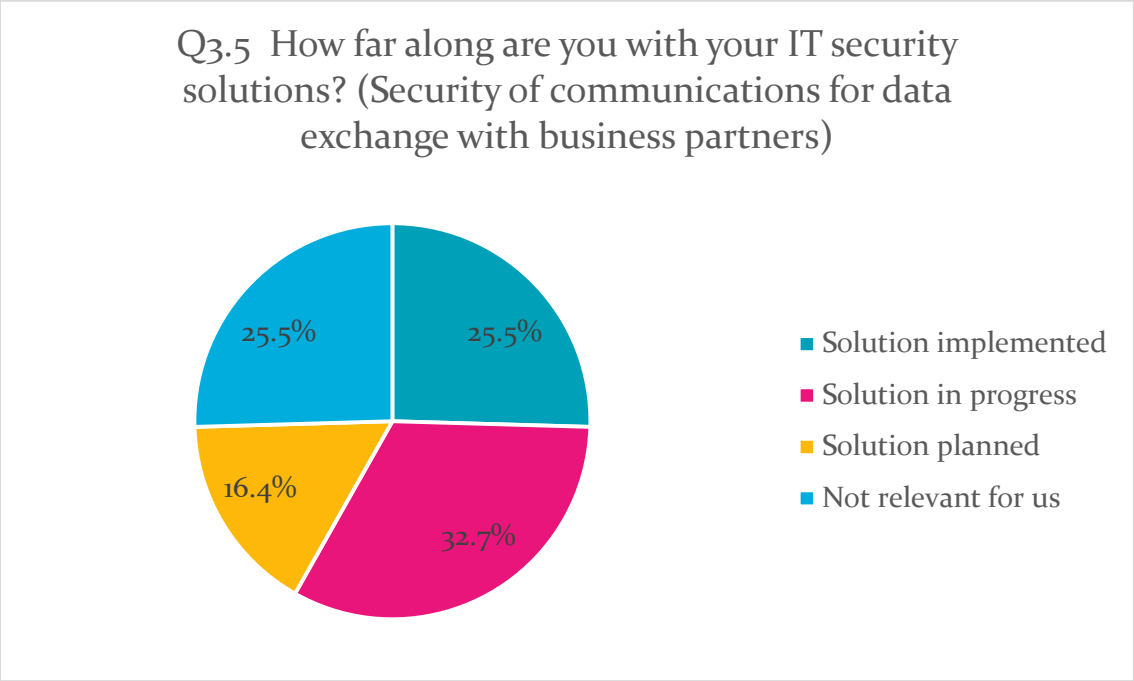


Figure 153 Security of communications for data exchange with business partners

Q3.6 Are you already using cloud services?

- Cloud-based software

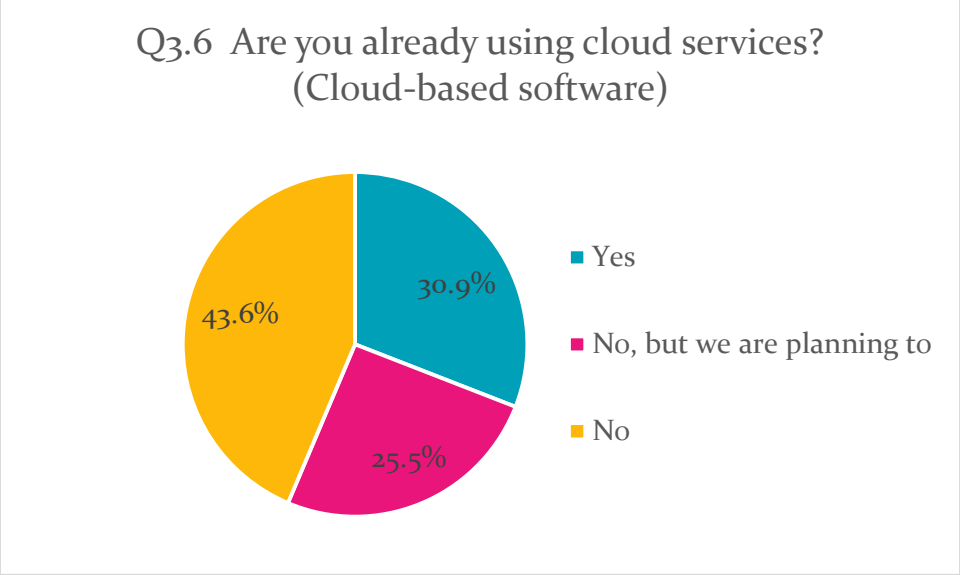


Figure 154 Cloud-based software

- For data analysis

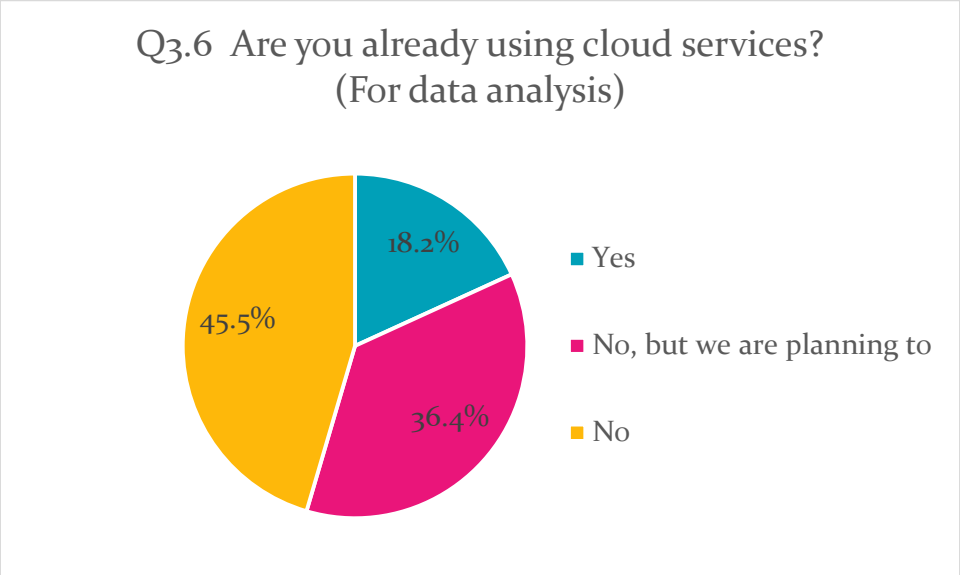


Figure 155 For data analysis

- For data storage

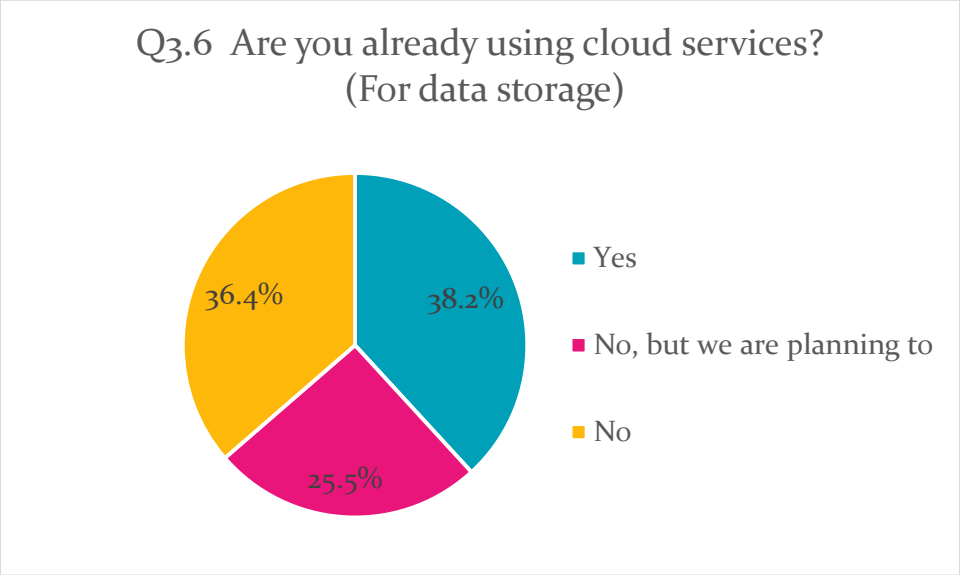


Figure 156 For data storage

Q3.7 How would you rate the degree of the digitization of your vertical value chain (from product development to production)?

☐ 1 (No digitization at all - No automated exchange of information along the vertical value chain (e.g. manual machine programming based on paper plans. We plan to analyze and monitor those data in the next 3-5 years)

☐ 2 (Low digitization –some data flow exchange through internal IT within organization)

☐ 3 (Medium digitization –only data flow along within organization and will implement it throughout vertical value chain in the next 1-3 years)

☐ 4 (High digitization –data flow along the vertical value chain e.g. integration of ERP in the past 1-2 years)

☐ 5 (Complete digitization – Continuous data flow along the vertical value chain e.g. direct controlling of machines via CAD models, integration of ERP in the past 2-5 years)

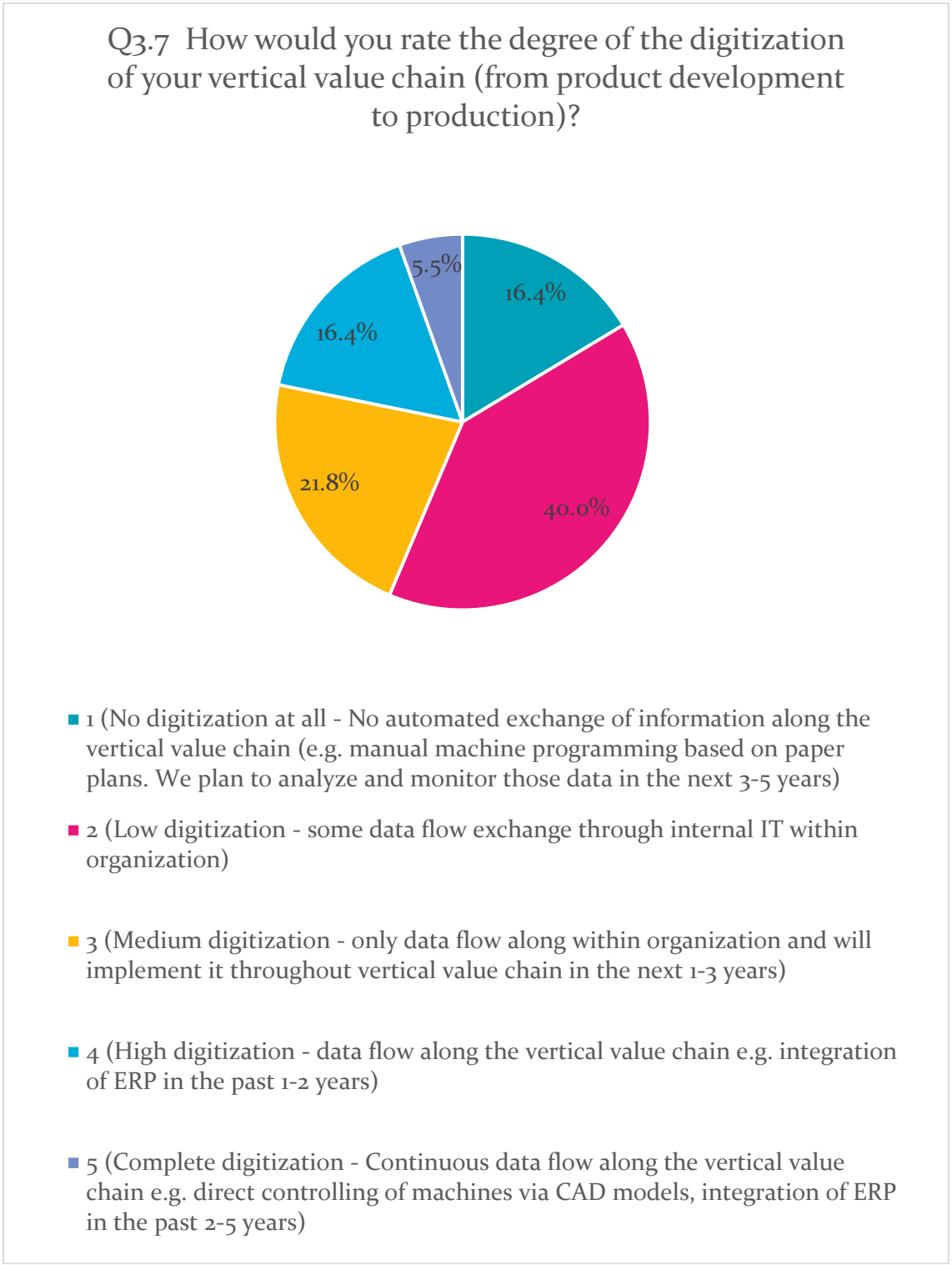


Figure 157 Q3.7 How would you rate the degree of the digitization of your vertical value chain (from product development to production)?

Q3.8 To which extent do you have a real-time view on your production and can dynamically react on changes in demand?

☐ 1 (Not at all – Batch production for large lot sizes without insight into production status. No ability to react flexible on changes in demand)

☐ 2 (Low Virtual Factory – Batch production for large lot sizes with ability to react flexible on changes in demand, but No Real-time view on productions and no capabilities to dynamically change schedules)

☐ 3 (Medium Virtual Factory –Real-time view on some productions with capabilities to change schedules)

☐ 4 (High Virtual Factory –Real-time view on main productions with capabilities to dynamically change schedules)

☐ 5 (Virtual Factory – Real-time view on all productions with capabilities to dynamically change schedules)

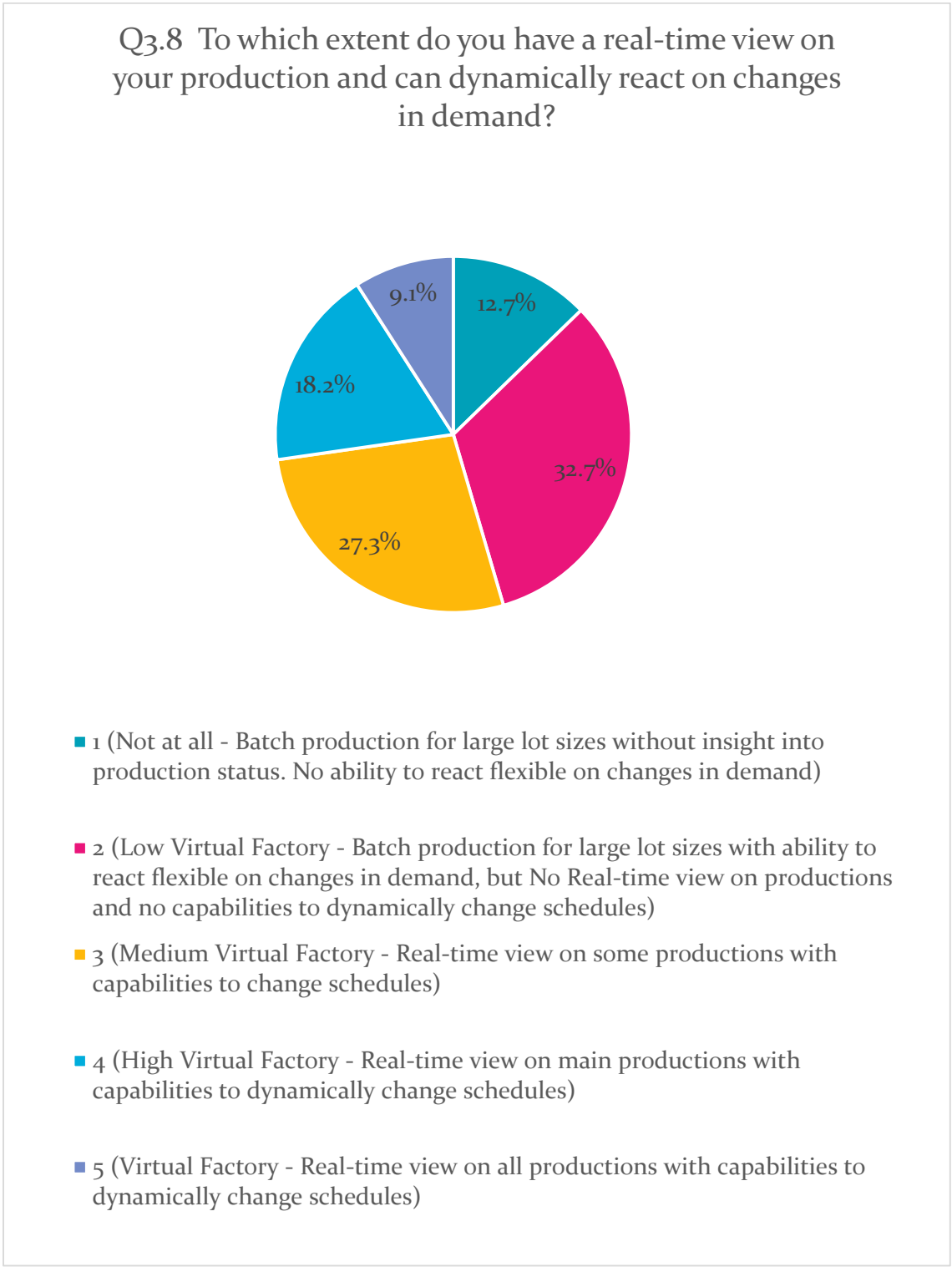


Figure 158 Q3.8 To which extent do you have a real-time view on your production and can dynamically react on changes in demand?

Q3.9 To which degree do you have an end-to-end IT enabled planning and steering process from sales forecasting, over production to warehouse planning and logistics?

☐ 1 (Isolated planning processes – Neither IT-enabled nor integrated along the value chain (e.g. planning based on past experiences)

☐ 2 (Low Connected system – Comprising information from actual sale/contract to production planning)

☐ 3 (Connected system – Comprising information from sales forecasts to production planning)

☐ 4 (Integrated planning system – Comprising information from sales forecasts to production planning, warehousing)

☐ 5 (Fully Integrated end-to-end planning system – Comprising real-time information along the entire value chain from sales forecasts to production planning and Logistics)

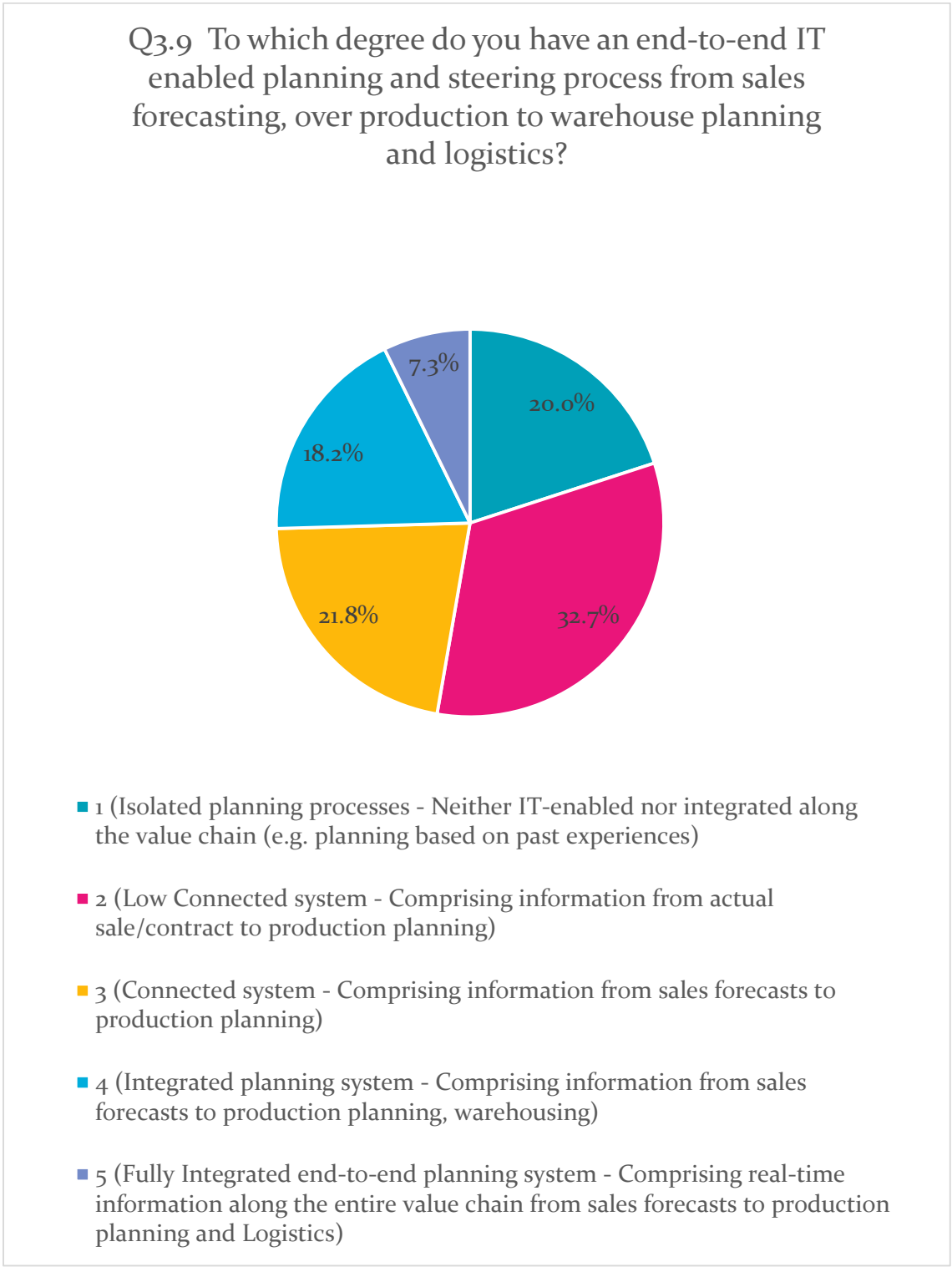


Figure 159 Q3.9 To which degree do you have an end-to-end IT enabled planning and steering process from sales forecasting, over production to warehouse planning and logistics?

Q3.10 How advanced is the digitization of your production equipment (sensors, IoT connection; digital monitoring, control, optimization & automation)?

☐ 1 (Purely physical factory – Production equipment is entirely cut off from IT systems and no real-time information can be gathered)

☐ 2 (Low digitized factory – Interconnected production equipment allows for IT-access and information is fed into some machine in the factory)

☐ 3 (Medium digitized factory – Interconnected production equipment allows for IT-access and information is fed for some part of the production in the factory)

☐ 4 (High digitized factory – Interconnected production equipment allows for IT-access and information is fed into a virtual representation only for the main productions of factory)

☐ 5 (Fully digitized factory – Interconnected production equipment allows for IT-access and information is fed into a virtual representation of the factory)

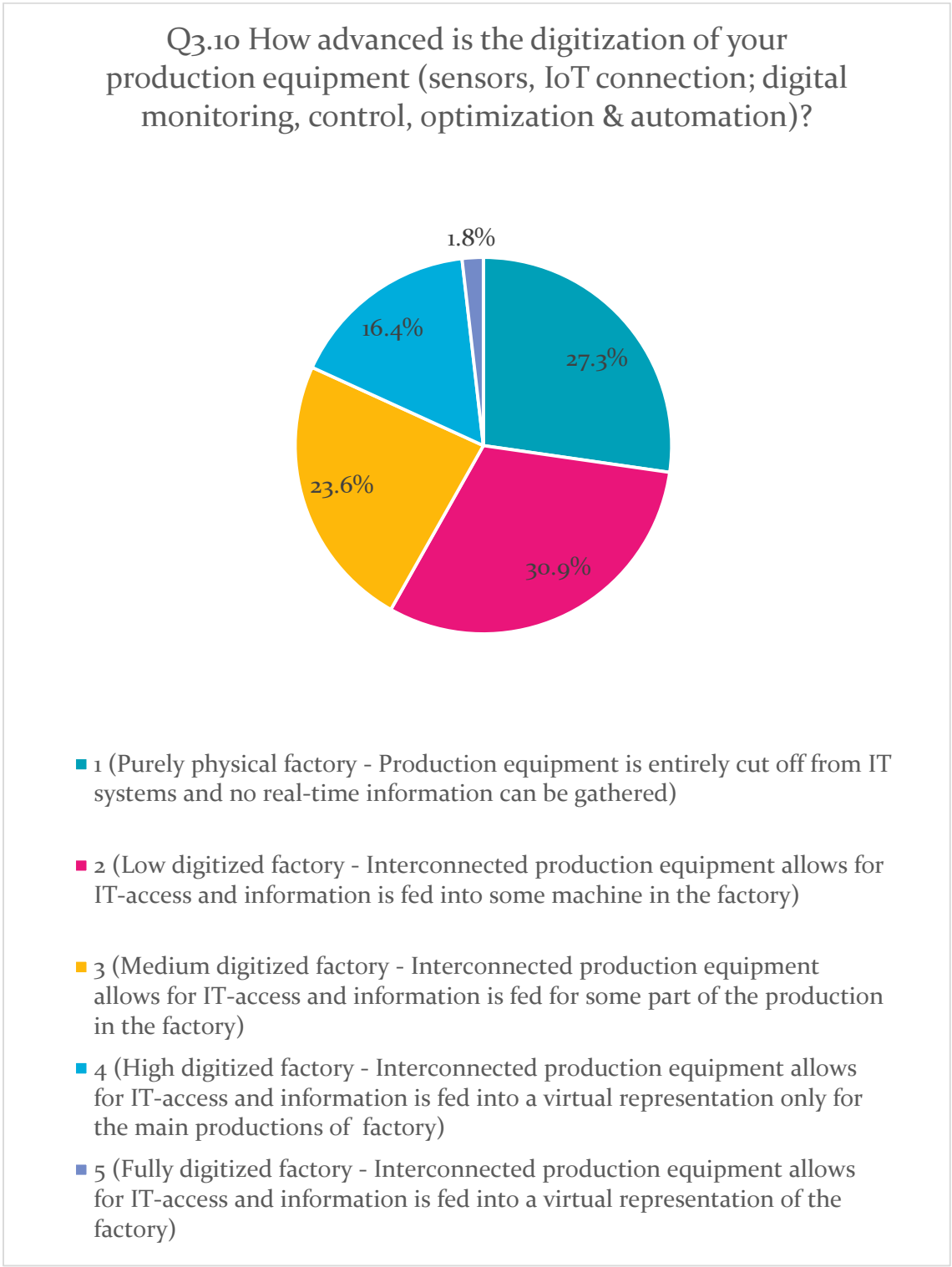


Figure 160 Q3.10 How advanced is the digitization of your production equipment (sensors, IoT connection; digital monitoring, control, optimization & automation)?

Q3.11 How would you rate the degree of digitization of your horizontal value chain (from customer order over supplier, production and logistic to service)?

☐ 1 (No digitization at all – No automated exchange of information along the horizontal value chain, e.g. no connection to supplier's IT)

☐ 2 (Low digitized factory – some automated exchange of information to supplier's IT or customer's IT)

☐ 3 (Medium digitization–data flow along the horizontal value chain with integration of logistic)

☐ 4 (High digitization–Continuous data flow along the horizontal value chain with integration of logistic)

☐ 5 (Complete digitization–Continuous data flow along the horizontal value chain with integration of logistic service into internal IT)

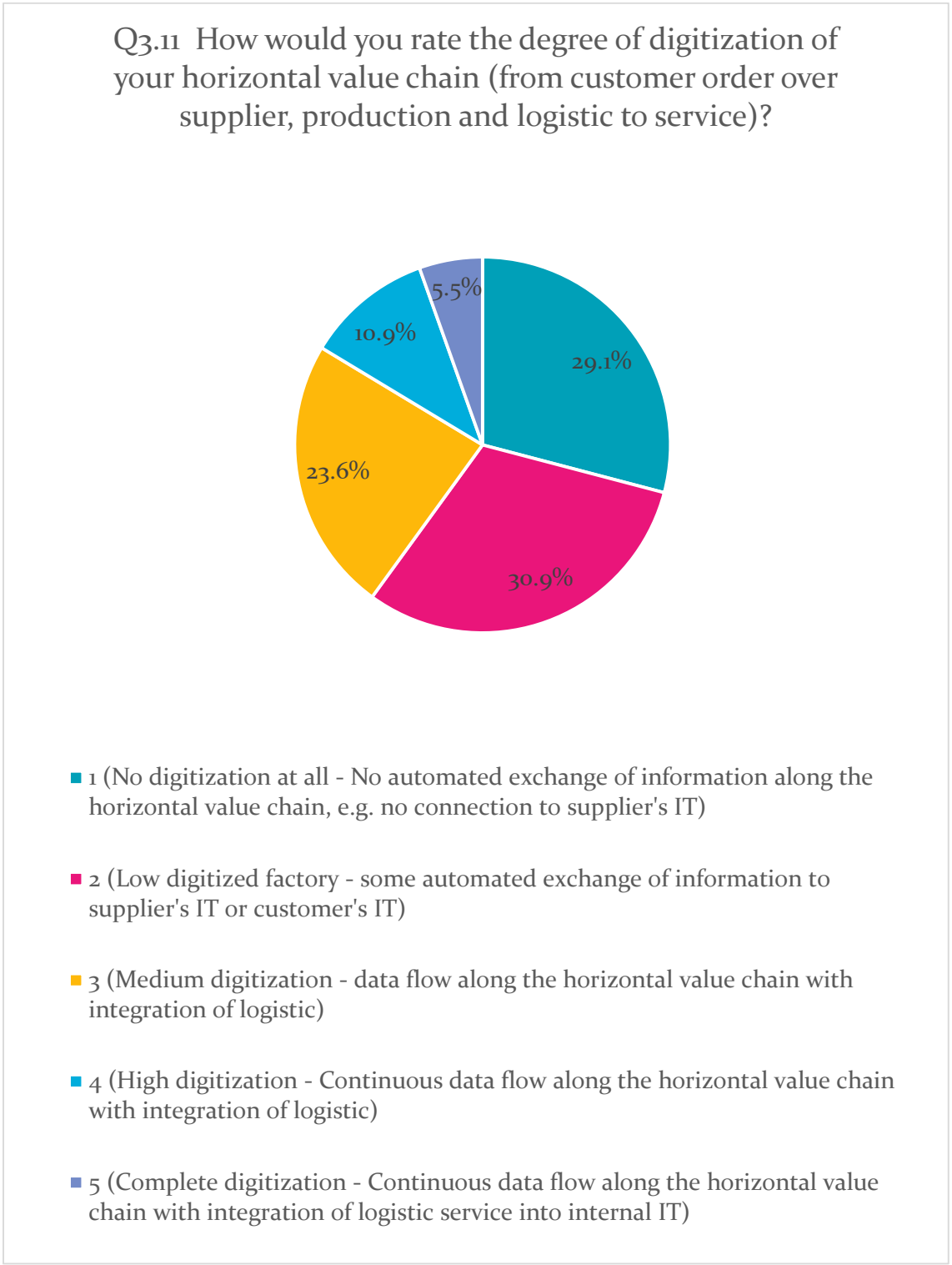


Figure 161 Q3.11 How would you rate the degree of digitization of your horizontal value chain (from customer order over supplier, production and logistic to service)?

4. DATA-DRIVEN SERVICES-INTEGRATED BUSINESS AND OPERATIONAL DATA MANAGEMENT

The objective of data-driven services is to align future business models and enhance the benefit to the customer. The after-sales and services business will be based more and more on the evaluation and analysis of collected data and rely on enterprise-wide integration. The physical products themselves must be equipped with physical IT so they can send, receive, or process the information needed for the operational processes. This means they have a physical and digital component, which in turn are the basis for digitized services in the usage phase of the products.

Q4.1 The process data gathered in production and in the usage phase enable new services. Do you offer such services?

- ☐ Yes, and we are integrated with our customers
- ☐ Yes, but without integration with our customers
- ☐ No

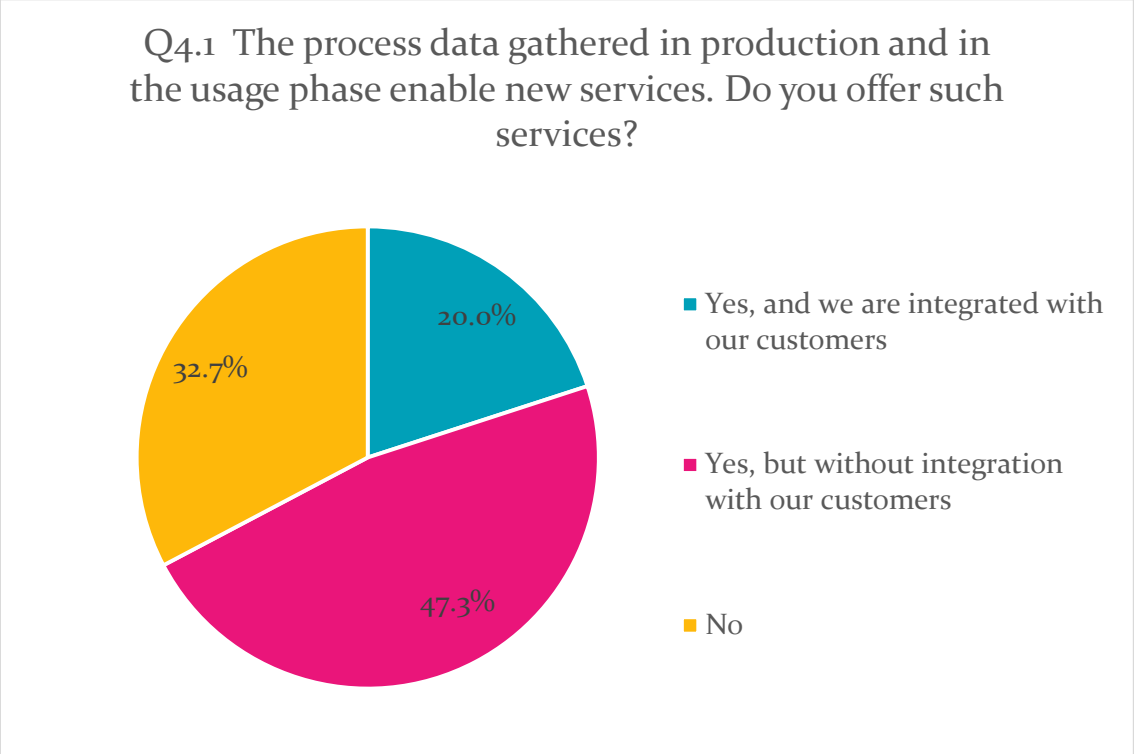


Figure 162 Q4.1 The process data gathered in production and in the usage phase enable new services. Do you offer such services?

Q4.2 What share of your revenues come from these new data-driven services?? Often, data that is collected is just stored and then not used any further. What share of the data you collect are you already using?

- ☐ 0%
- ☐ 0% to 20%
- ☐ 21% to 50%
- ☐ Over 50%

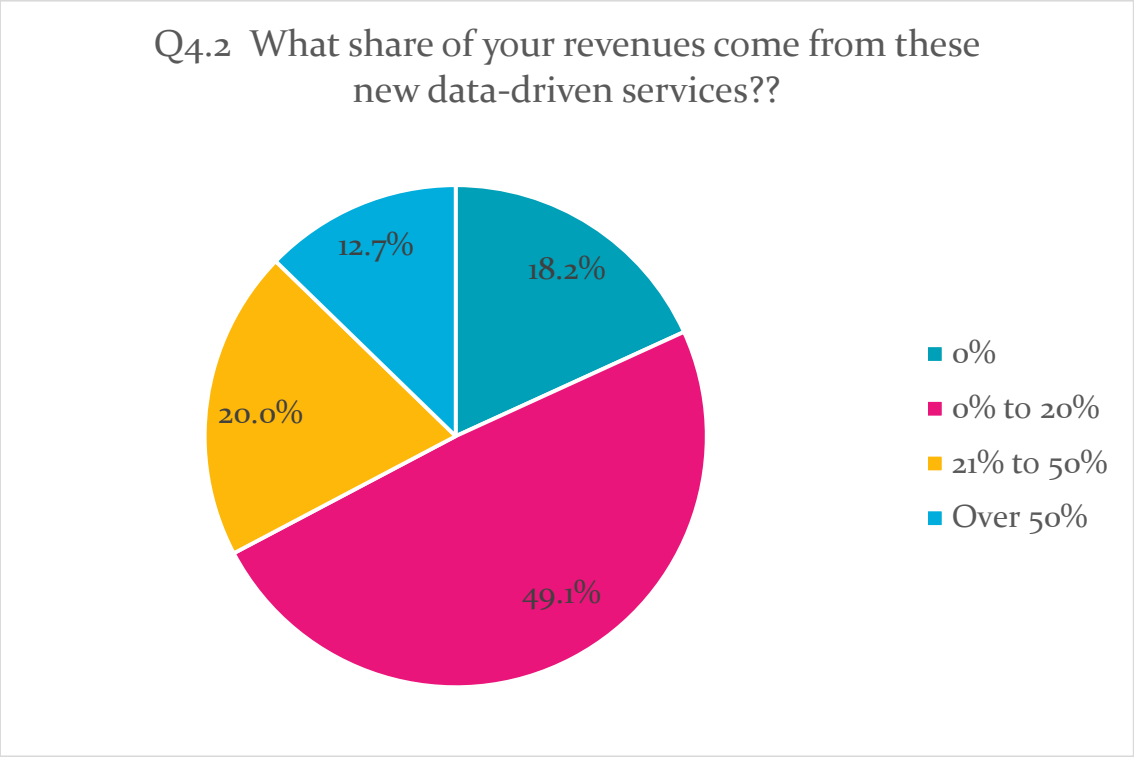


Figure 163 Q4.2 What share of your revenues come from these new data-driven services?? Often, data that is collected is just stored and then not used any further. What share of the data you collect are you already using?

Q4.3 Do you analyze the data you collect from the usage phase?

- ☐ Yes
- ☐ No – we collect the data but do not analyze it
- ☐ No – we do not collect data in the usage phase

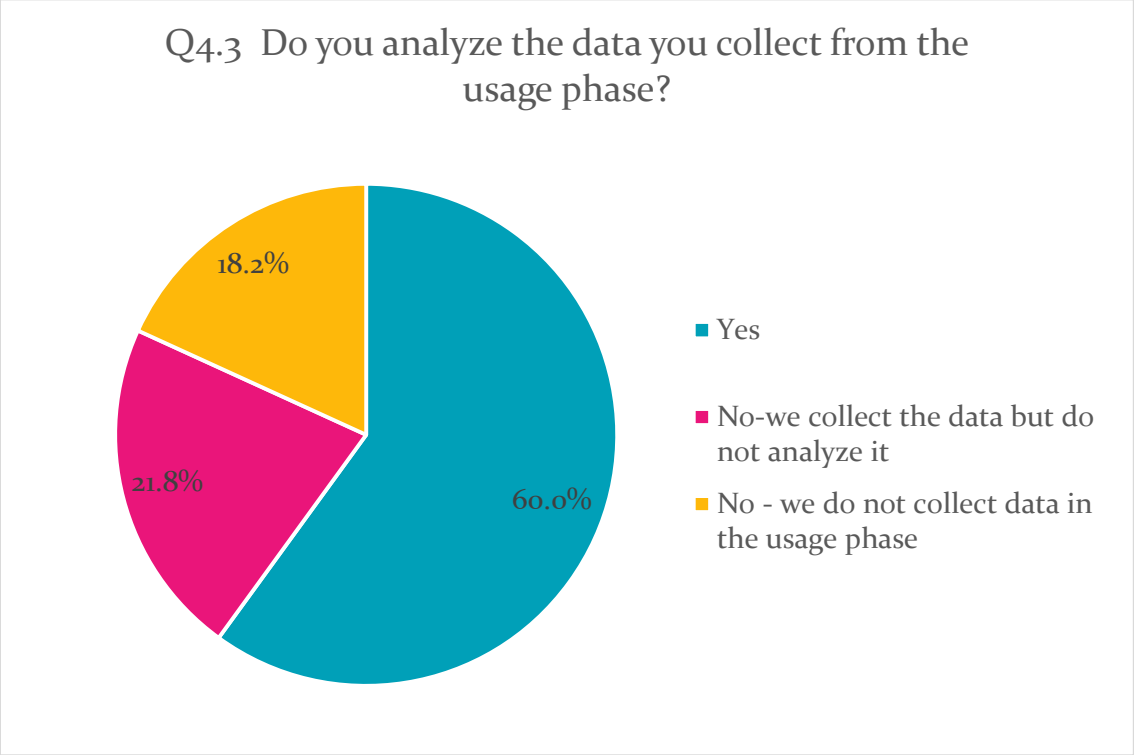


Figure 164 Q4.3 Do you analyze the data you collect from the usage phase?

Q4.4 To which extent do you use multiple integrated sales channels to sell your products to your customers?

- ☐ 1 (One channel - Traditional sales force approach, e.g. local sales force)
- ☐ 2 (One Channel – Integration of digital and non-digital sales)
- ☐ 3 (Several Channel –various digital and non-digital sales channels, e.g., sales force, web-shop, sales platforms)
- ☐ 4 (Multi Channel – Integration of various digital and non-digital sales channels, e.g., sales force, web-shop, sales platforms)
- ☐ 5 (Multi/ Omni-Channel – Integration of various digital and non-digital sales channels, e.g. store, sales force, web-shop, sales platforms)

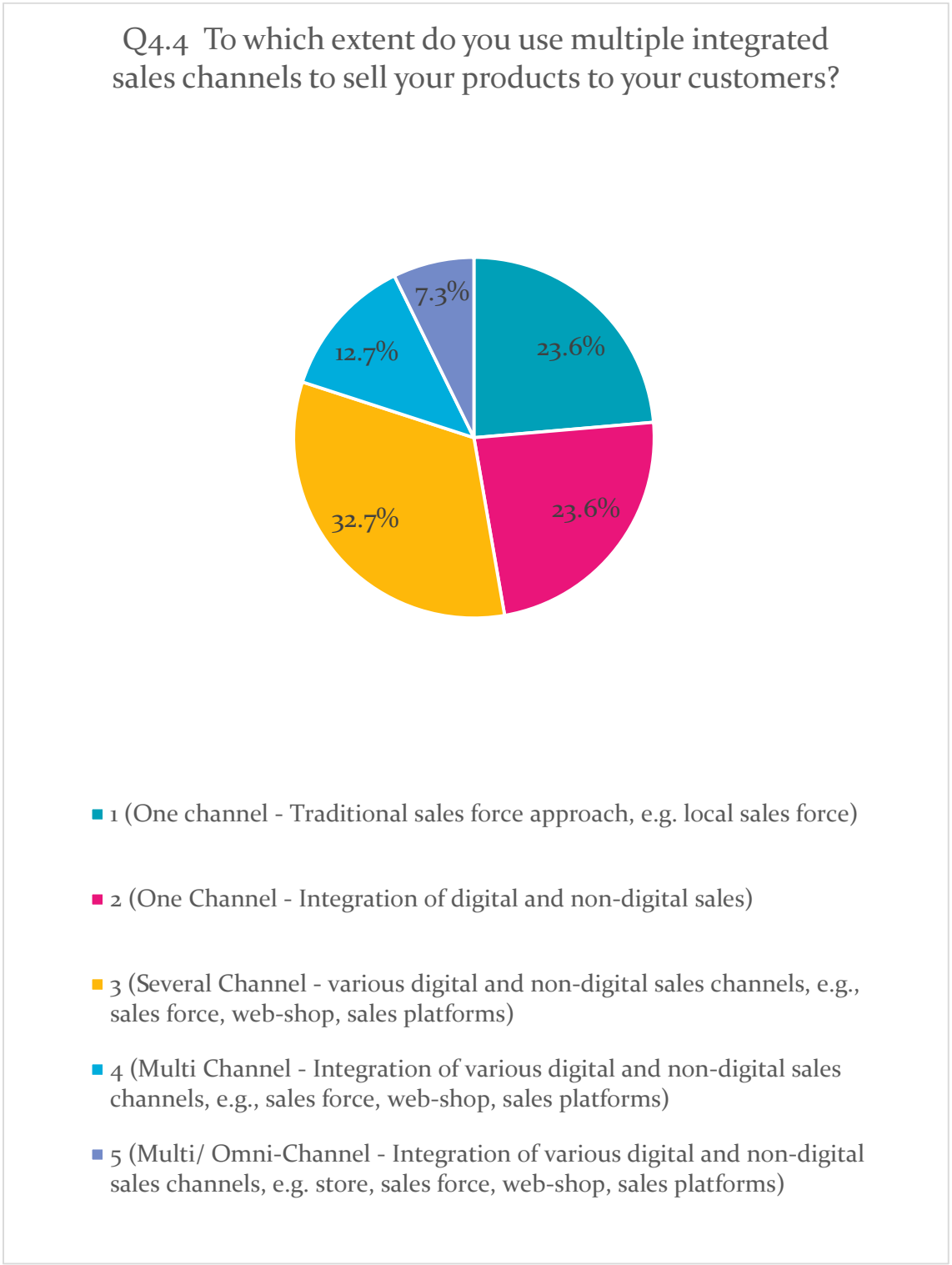


Figure 165 Q.4.4 To which extent do you use multiple integrated sales channels to sell your products to your customers?

Q4.5 How far do you integrate multiple channels (website, blogs, forums, social media platforms etc.) into your customer interactions for communicating news, receiving feedback, managing claims etc.?

☐ 1 (One-way communication – Usage of traditional communication channels for information purposes only (e.g. corporate website, newsletters)

☐ 2 (One-way communication – Usage of traditional communication channels to response to customer from e.g. corporate website)

☐ 3 (Reactive communication – Usage of digital channels to response to customer, e.g. use previous information from customers to product development)

☐ 4 (Proactive communication – Usage of digital channels to acquires customer interaction, e.g. some integrating customers into product development)

☐ 5 (Interactive communication – Usage of multiple digital channels to foster customer interaction, e.g. integrating customers into product development via social media platforms)

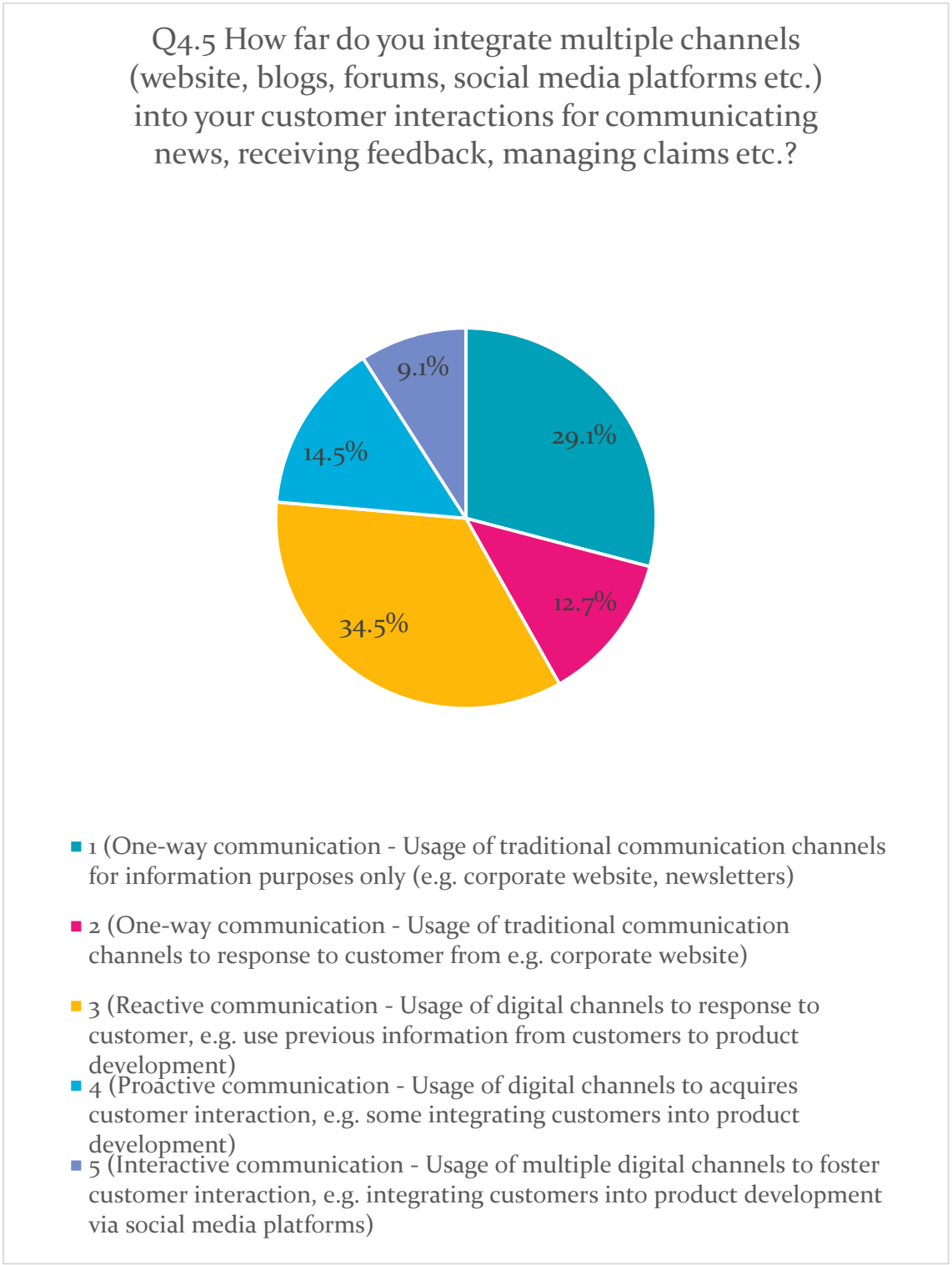


Figure 166 Q4.5 How far do you integrate multiple channels (website, blogs, forums, social media platforms etc.) into your customer interactions for communicating news, receiving feedback, managing claims etc.?

Q4.6 How advanced is the digital enablement of your sales force (mobile devices, access to all relevant system anywhere and anytime, full sales process possible at client site)?

☐ 1 (Traditional sales approach - Sales force works 'offline' without access to relevant systems, e.g. using centrally distributed paper documents)

☐ 2 (Connected sales approach - Sales force works 'online' with access to relevant systems, e.g. using centrally digitized document)

☐ 3 (Digital sales approach - Sales force is supported by digital devices and distribute to all relevant processes and systems using centrally integrated IT)

☐ 4 (High Digital sales approach - Sales force is supported by digital devices and access to all relevant processes and systems to customer and product data using horizontally integrated IT with customers and suppliers)

☐ 5 (Digital sales approach - Sales force is supported by digital devices and access to all relevant processes and systems at real-time access to customer and product data, possibility to configure personalized products & dynamically create orders etc)

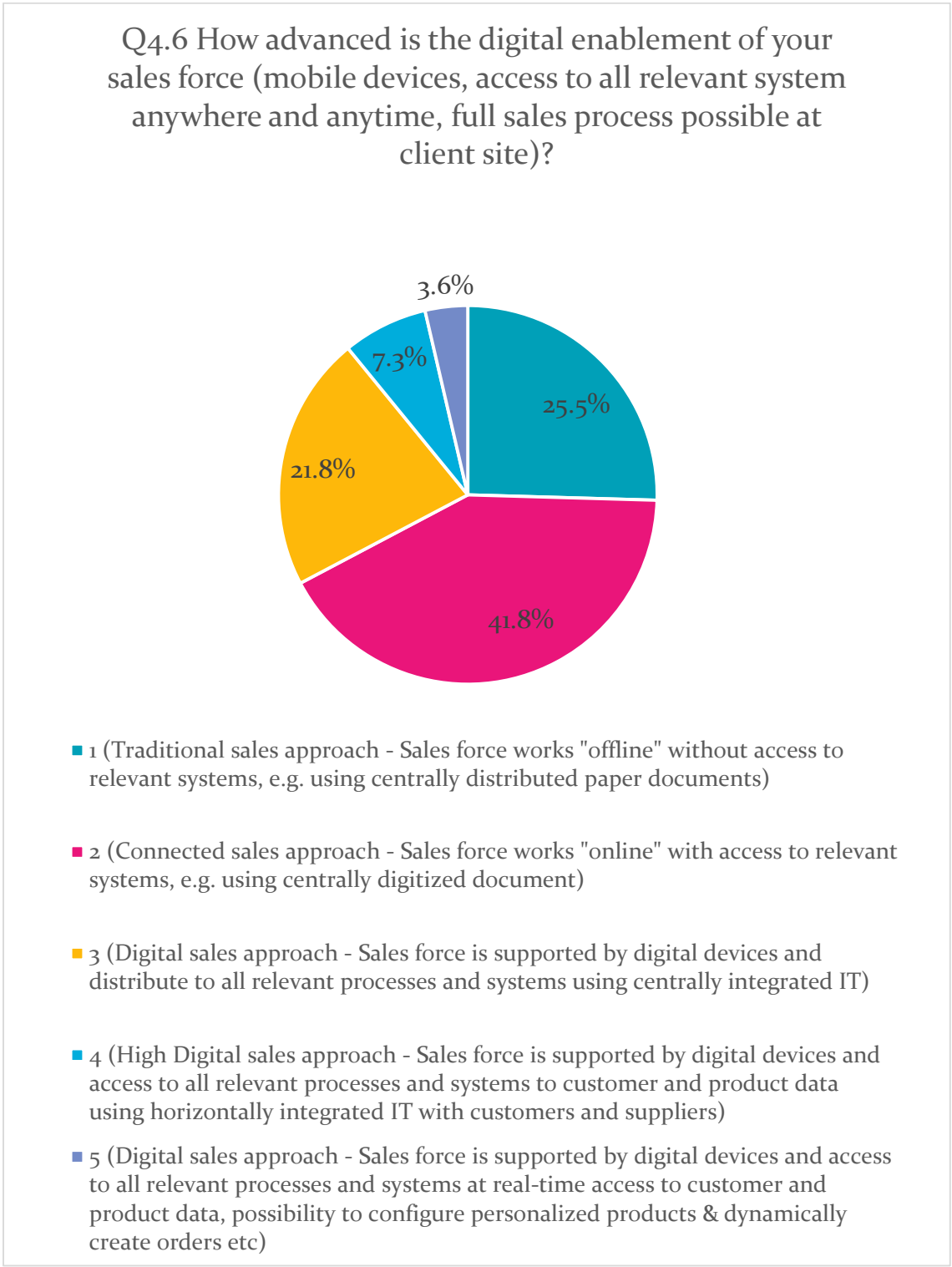


Figure 167 Q4.6 How advanced is the digital enablement of your sales force (mobile devices, access to all relevant system anywhere and anytime, full sales process possible at client site)?

Q4.7 To which extent do you analyze customer data to increase customer insight (e. g. personalized offers to customers based on their personal situation, preferences, location, credit score; consideration of usage data for design & engineering etc.)?

☐ 1 (Trivial data usage - Information is kept decentralized and in an unsystematic way by single units and is not analyzed further for, e.g. sales orders in excel sheets)

☐ 2 (Non trivial data usage – Some Information is kept centralized and in an systematic way by single units and is analyzed further for, e.g. sales orders in both files and excel sheets)

☐ 3 (Medium data usage - Main data collection are kept centralized and in an systematic way by single units and is analyzed further for, e.g. sales orders)

☐ 4 (High data usage – Most data collection are kept centralized in integrated systems to review products, sales and customer experience)

☐ 5 (Substantial data usage - Extensive data collection at all touch points that is fed into integrated systems to monitor, review and optimize products, sales and customer experience)

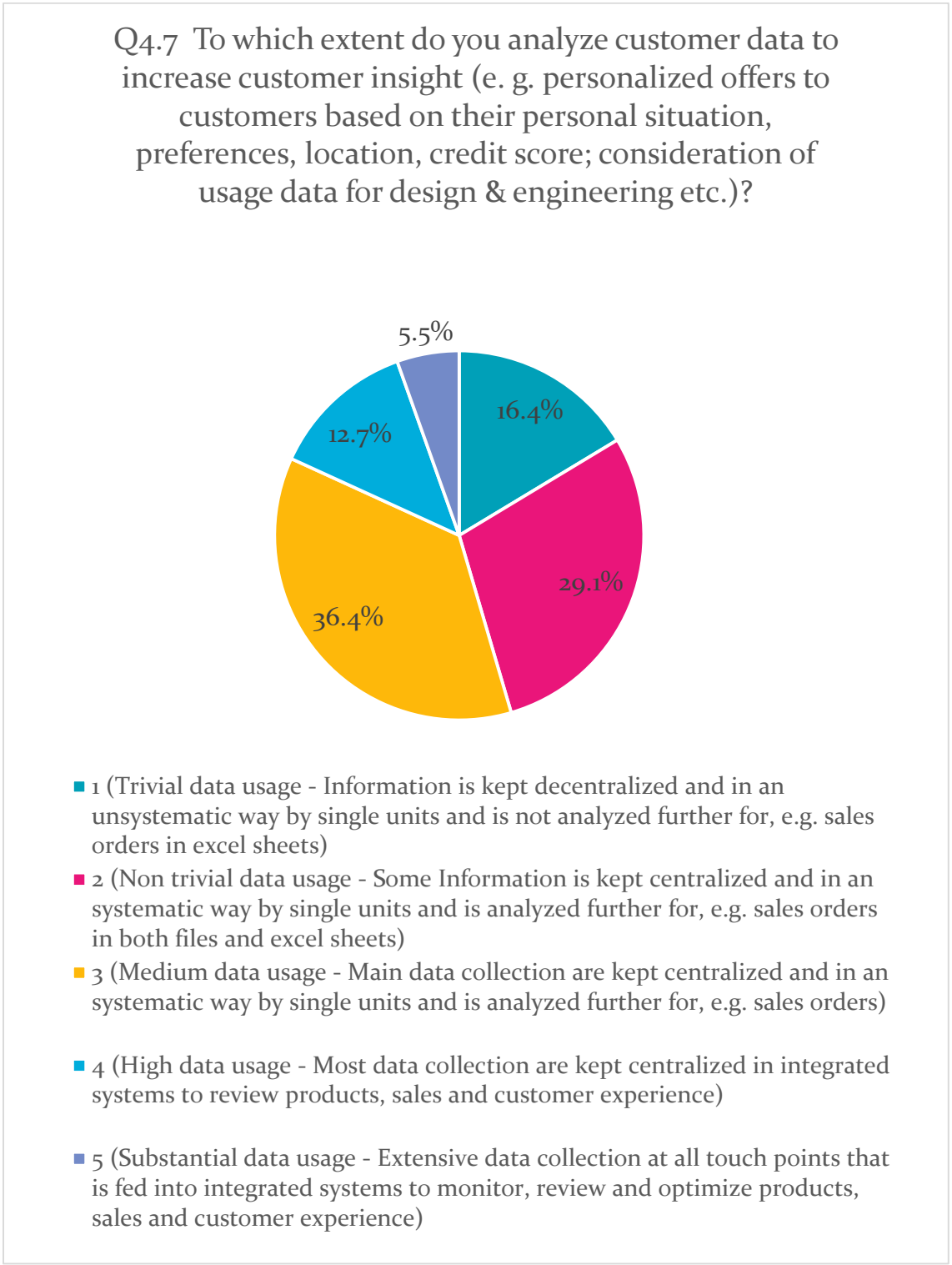


Figure 168 Q4.7 To which extent do you analyze customer data to increase customer insight (e. g. personalized offers to customers based on their personal situation, preferences, location, credit score; consideration of usage data for design & engineering etc.)?

Q4.8 How far do you want to collaborate with partners regarding your approach of accessing customers (exchange of customer insights, coordination of marketing activities etc.)?

☐ 1 (Not at all - No collaboration with partners in approaching customers, e.g. separate customer databases and no coordination of marketing or sales activities)

☐ 2 (Somewhat – Some collaboration with partners in approaching customers for coordination of marketing or sales activities)

☐ 3 (Medium - Some collaboration with partners in approaching customers databases for some coordination of marketing or sales activities and production activities)

☐ 4 (Somewhat Unified approach – Customer access approach is partly backed up along with the partner network, e.g. common customer ID with partners and use of partner data)

☐ 5 (Unified approach – Customer access approach is completely backed up along with the partner network, e.g. common customer ID with partners and use of partner data)

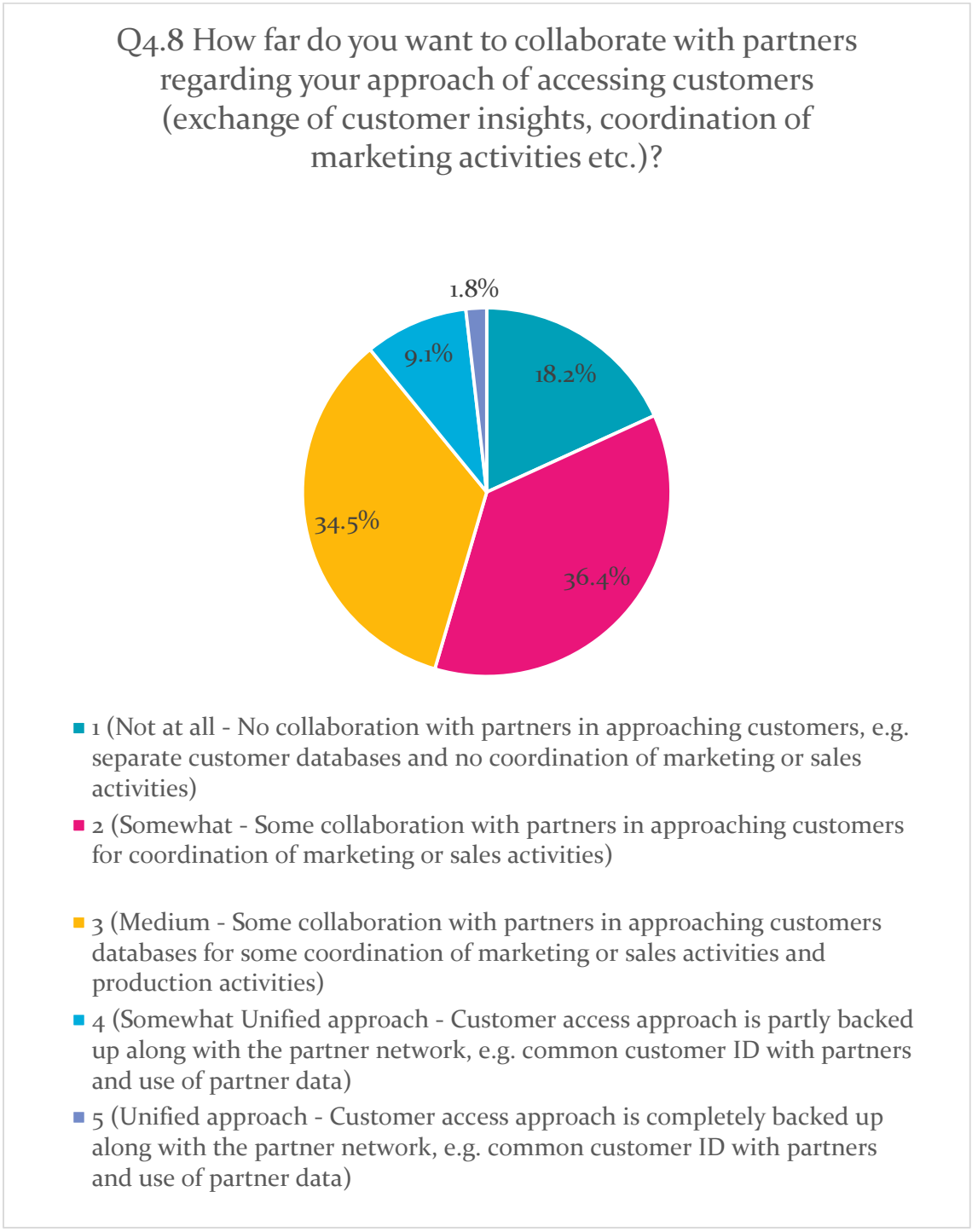


Figure 169 How far do you want to collaborate with partners regarding your approach of accessing customers (exchange of customer insights, coordination of marketing activities etc.)?

Student Assessment Questionnaire

SEX

☐ Male ☐ Female

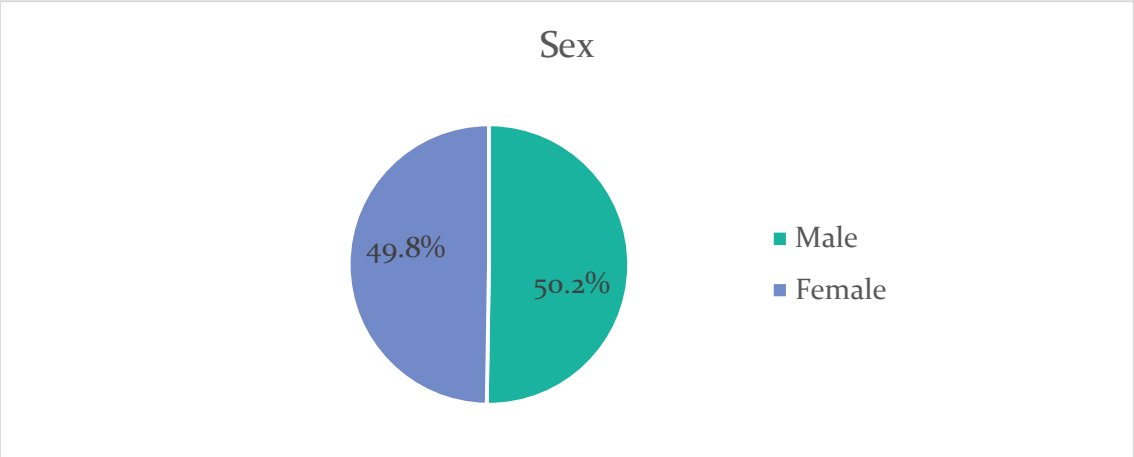


Figure 170 Sex of Student

LEVEL OF STUDY

☐ Master

☐ 1st Year ☐ 2nd Year or more

☐ Ph.D

☐ 1st Year ☐ 2nd Year ☐ 3rd Year or more

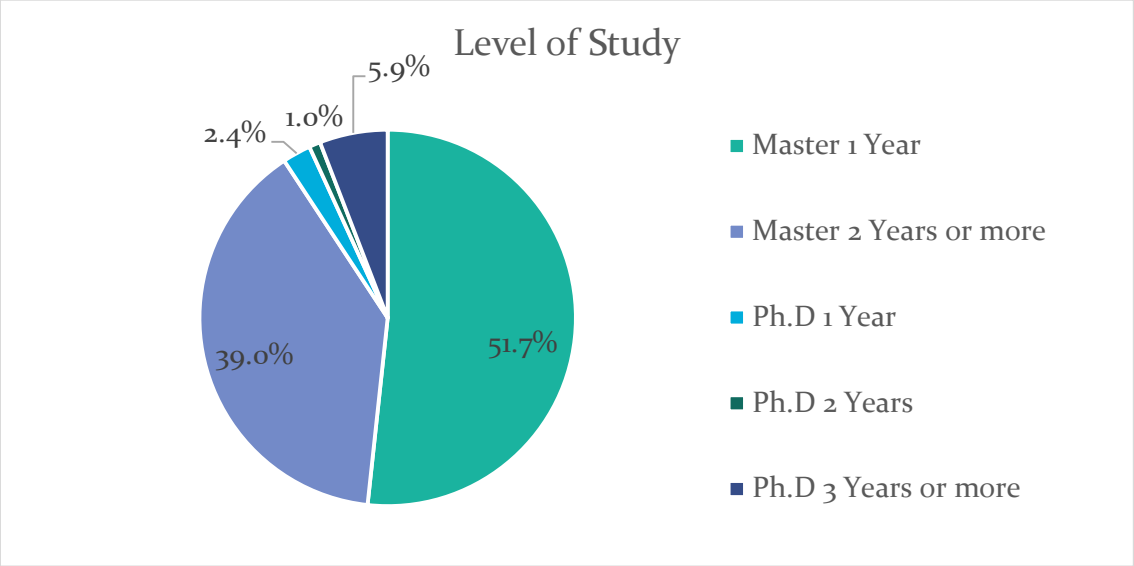


Figure 171 Level of Study

PROGRAM OF STUDY

☐ Industrial Engineering ☐ Adv. Manufacturing ☐ Production Logistics
☐ Industrial Management ☐ others please specify_____

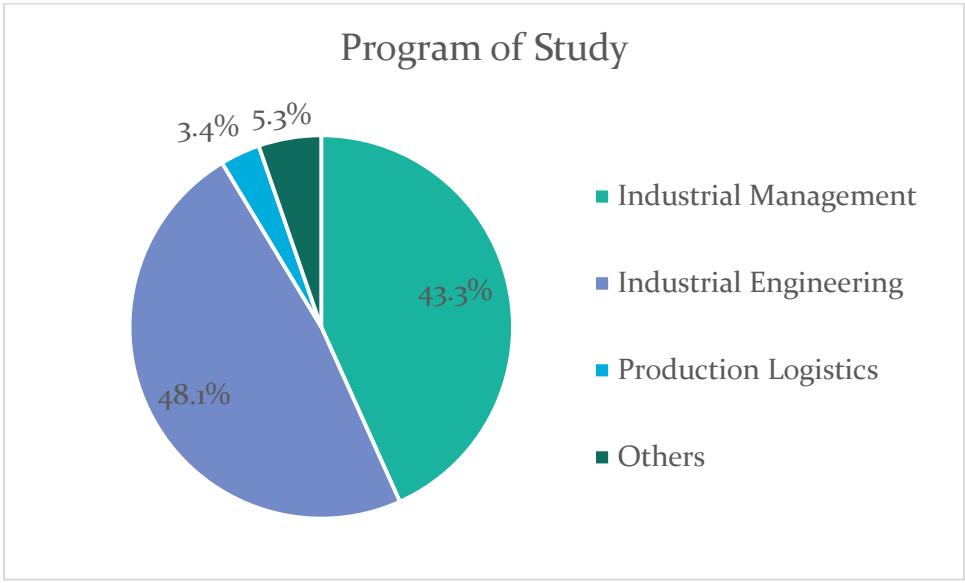


Figure 172 Program of Study

PLEASE INDICATE PREVIOUS EXPERIENCE FROM SENIOR PROJECT

☐ Industrial Engineering application

☐ Lean Manufacturing ☐ Production Logistics ☐ Quality Control/Management

☐ Operation Management ☐ Operation Research ☐ Database/Decision Making

☐ Automation ☐ Ergonomic ☐ Maintenance

☐ CAD/CAM Design ☐ Machine Design ☐ Discrete System Simulation

☐ Engineering Management ☐ Material Science ☐ Production Technology

☐ New Product Development ☐ Organization Development/Improvement

☐ Others, please specify_____

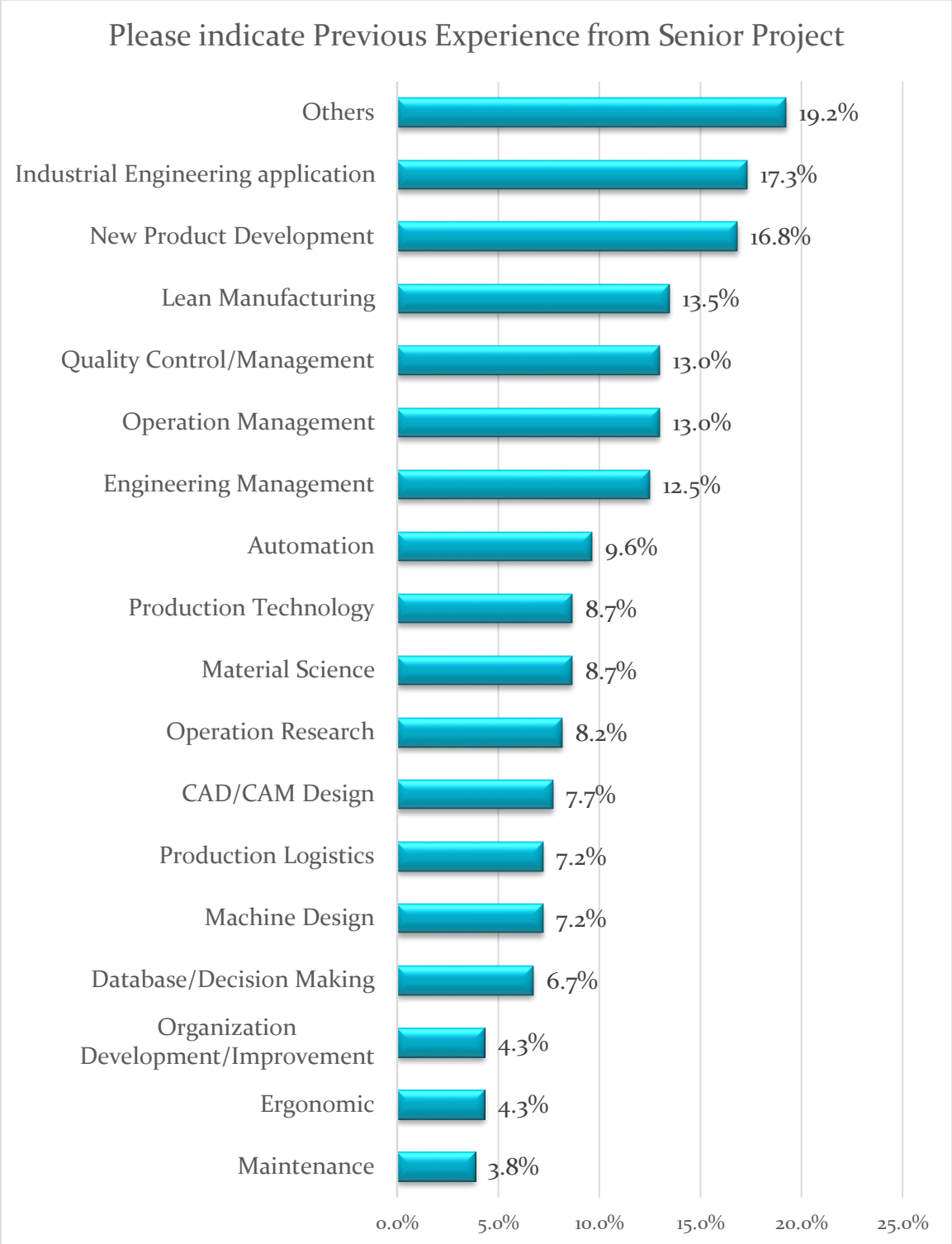


Figure 173 Previous Experience from Senior Project

PREVIOUS EXPERIENCES FROM INDUSTRY

☐ Yes ☐ No

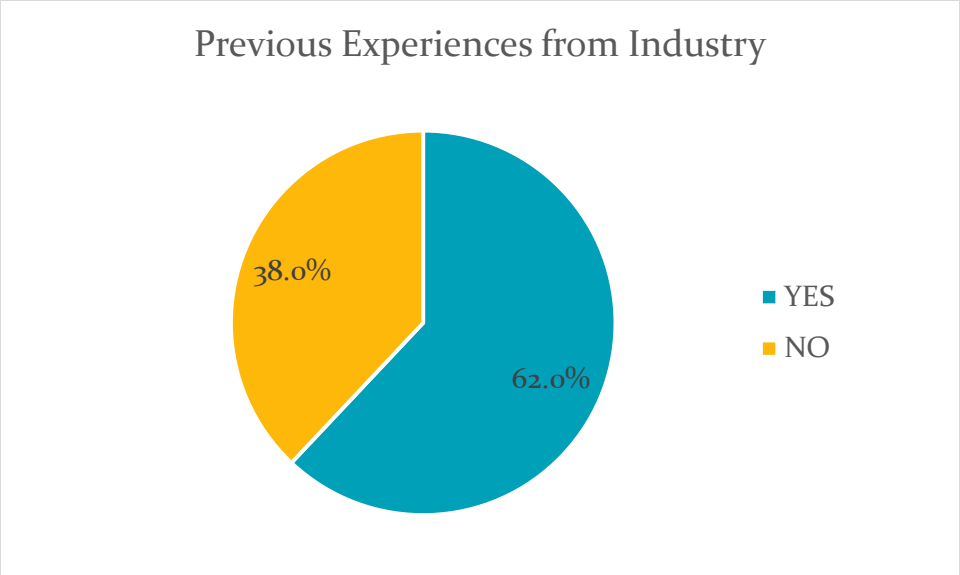


Figure 174 Previous Experiences from Industry

IF YES, PLEASE INDICATE INDUSTRY TYPE FROM YOUR PREVIOUS EXPERIENCES

☐ Electronic	☐ Agro Processing	☐ Textile Industry
☐ Manufacturing	☐ Aerospace	☐ Automotives
☐ Automation	☐ IT	☐ PetroChemical
☐ Seafood Processing	☐ Wood/furniture	☐ Construction
☐ Logistic and Transport	☐ Commerce&Tourism	☐ Packaging

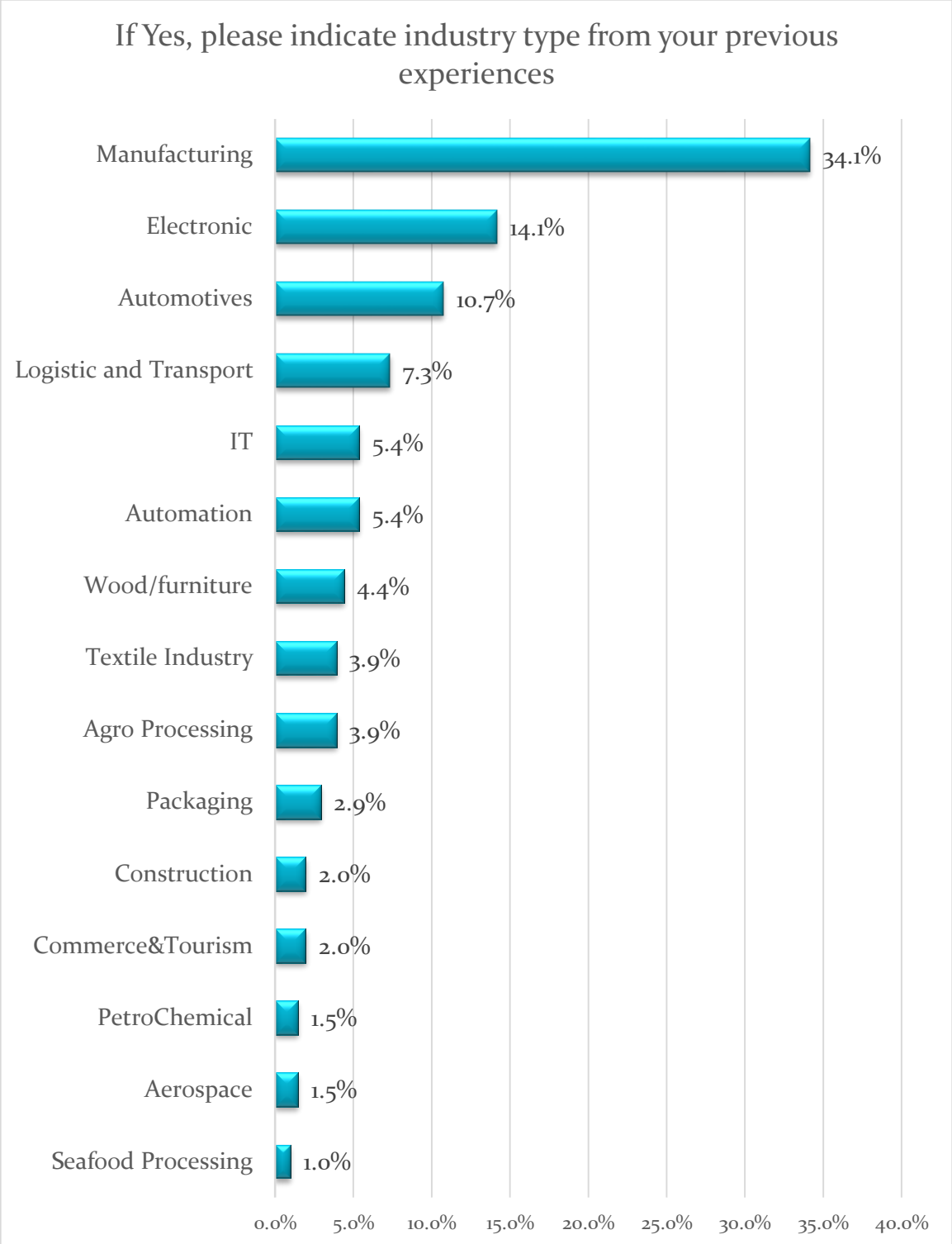


Figure 175 If Yes, please indicate industry type from your previous experiences

PART 1: INDUSTRY 4.0 ADOPTION LITERACY (CAN SELECT >1 ANSWER)

Q1. How would you describe your ability to define/implement Industry 4.0 strategy?

- ☐ (a) I have ability to apply my knowledge to formulate Industry 4.0 strategy
- ☐ (b) I have ability to design a system, component, or process to meet Industry 4.0 strategy
- ☐ (d) I have ability to setup, function and communicate on Multi-Disciplinary Teams
- ☐ I don't have knowledge, competences to define/implement Industry 4.0 strategy
  - ☐ 1 (But I don't think I need to learn it in next 3 years)
  - ☐ 2 (**somewhat** need to learn it in next 2 years)
  - ☐ 3 (need to learn it in next 1 years)
  - ☐ 4 (**very** need to learn since past 1 years)
  - ☐ 5 (**strongly** need to acquire this since past 2 years)

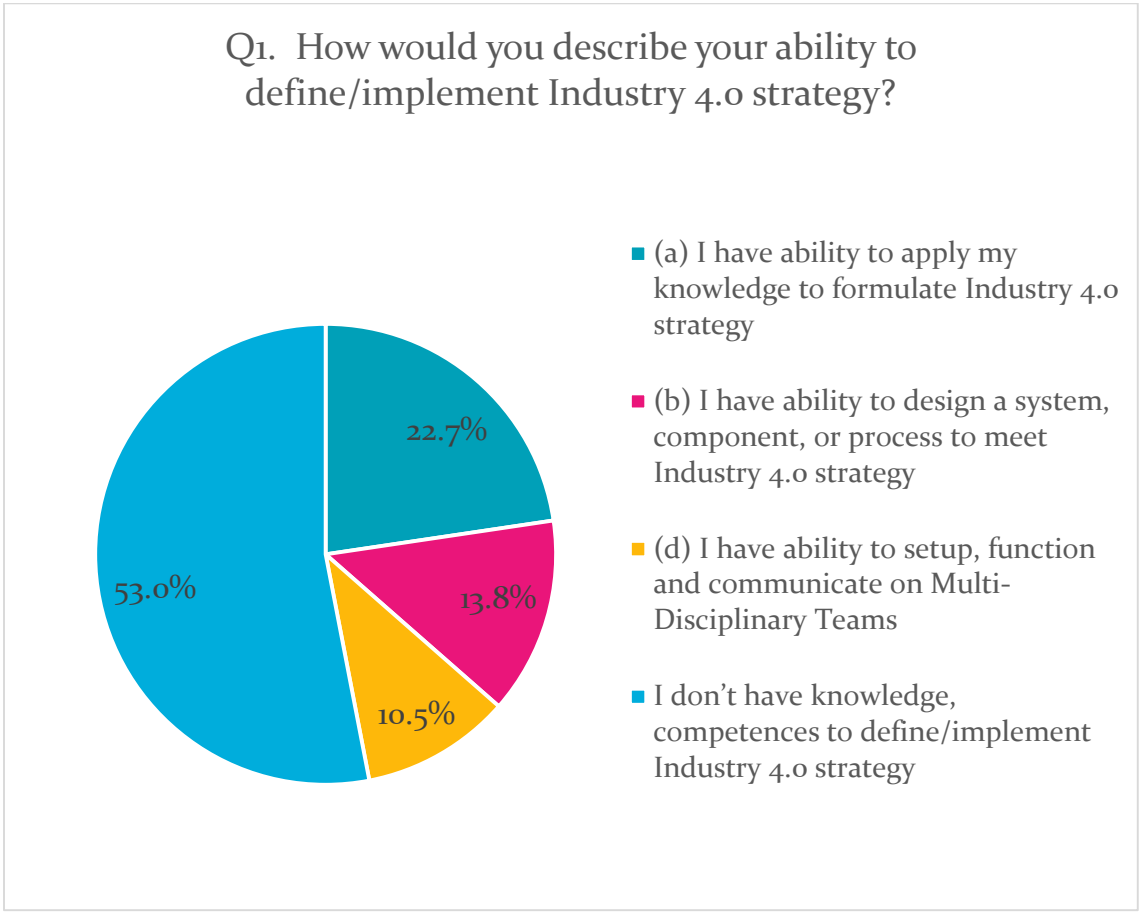


Figure 176 Q1. How would you describe your ability to define/implement Industry 4.0 strategy?

I don't have knowledge

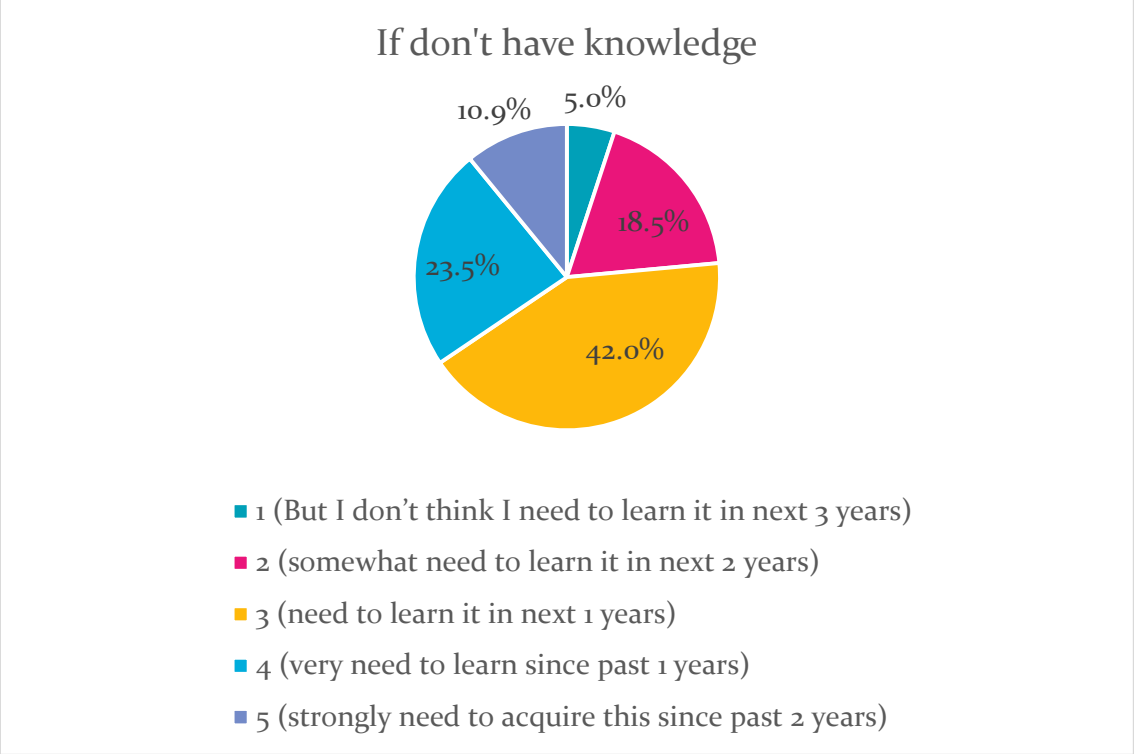


Figure 177 I don't have knowledge

Q2. What is the level of your understanding of IT Knowledge and technology with respect to Industry4.0 that you need in order to increase the your competences, competitiveness after graduation?

- 2.1 Sensor technology
  - ☐ (a) I have ability to apply my knowledge to formulate Sensor technology
  - ☐ (c) I have ability to design a system, component, or process the Sensor technology
  - ☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding Sensor technology
  - ☐ (e) I have ability to identify, formulate, and solve Sensor technology problems
  - ☐ I don't have knowledge, competences to define/implement Sensor technology
    - ☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)
☐ 3 (need to learn it in next 1 years)
☐ 4 (**very** need to learn since past 1 years)
☐ 5 (**strongly** need to acquire this since past 2 years)

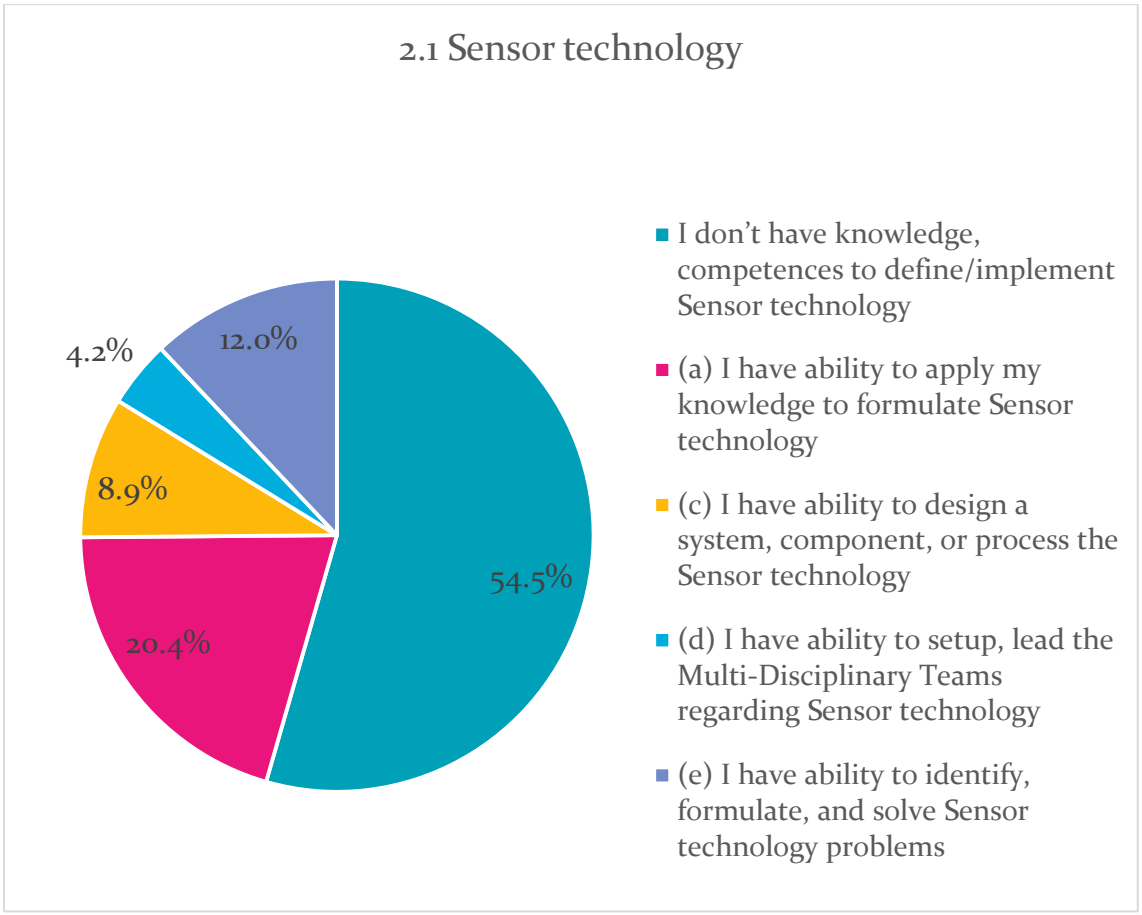


Figure 178 Sensor technology

I don't have knowledge

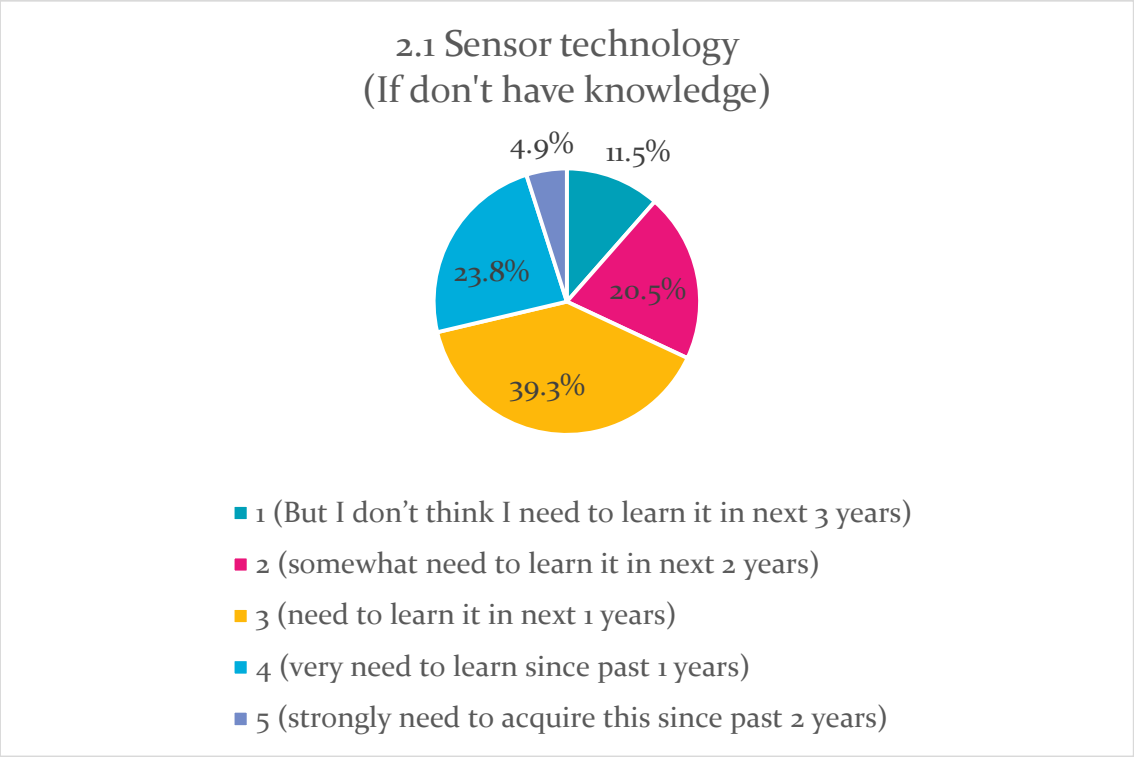


Figure 179 Sensor technology (If don't have knowledge)

☐ 2.2 Mobile devices

☐ (a) I have ability to apply my knowledge to formulate Mobile devices

☐ (c) I have ability to design a system, component, or process the Mobile devices

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding Mobile devices

☐ (e) I have ability to identify, formulate, and solve Mobile devices problems

☐ I don't have knowledge, competences to define/implement Mobile devices

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

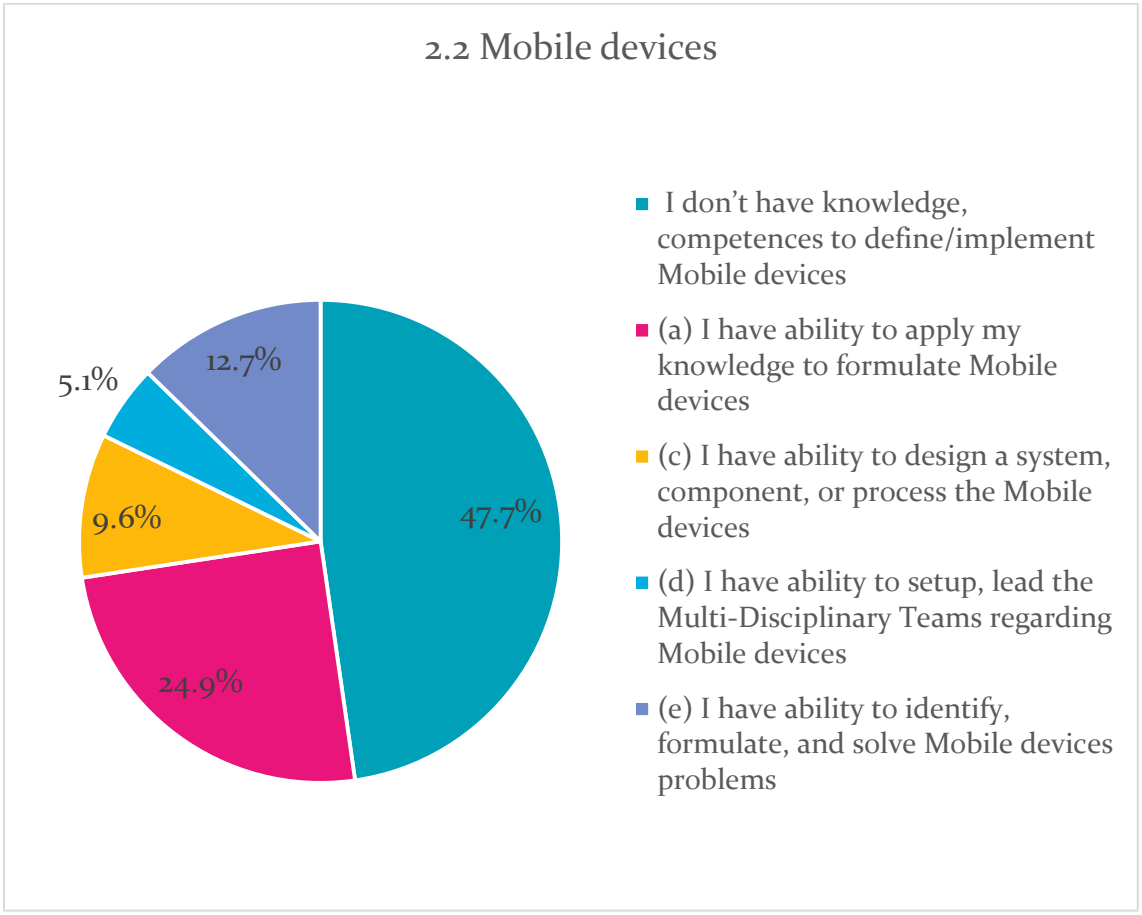


Figure 180 Mobile devices

I don't have knowledge

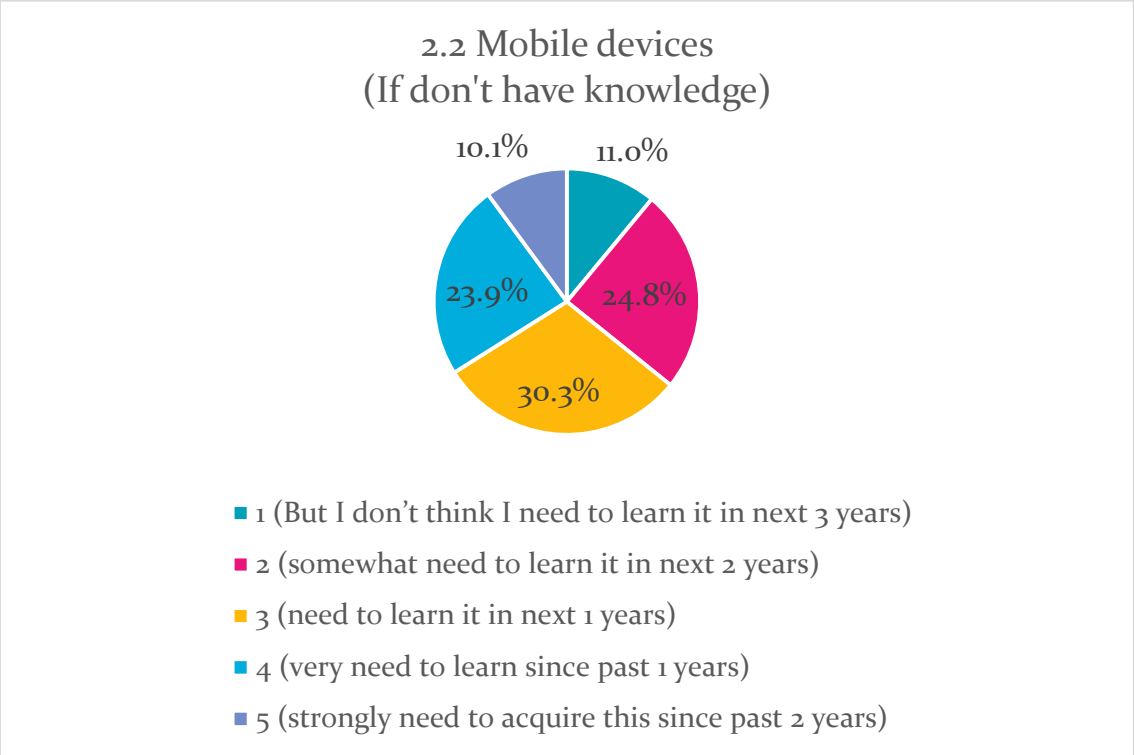


Figure 181 Mobile devices (If don't have knowledge)

- 2.3 RFID
  - ☐ (a) I have ability to apply my knowledge to formulate RFID
  - ☐ (c) I have ability to design a system, component, or process the RFID
  - ☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding RFID
  - ☐ (e) I have ability to identify, formulate, and solve RFID problems
  - ☐ I don't have knowledge, competences to define/implement RFID
    - ☐ 1 (But I don't think I need to learn it in next 3 years)
    - ☐ 2 (**somewhat** need to learn it in next 2 years)
    - ☐ 3 (need to learn it in next 1 years)
    - ☐ 4 (**very** need to learn since past 1 years)
    - ☐ 5 (**strongly** need to acquire this since past 2 years)

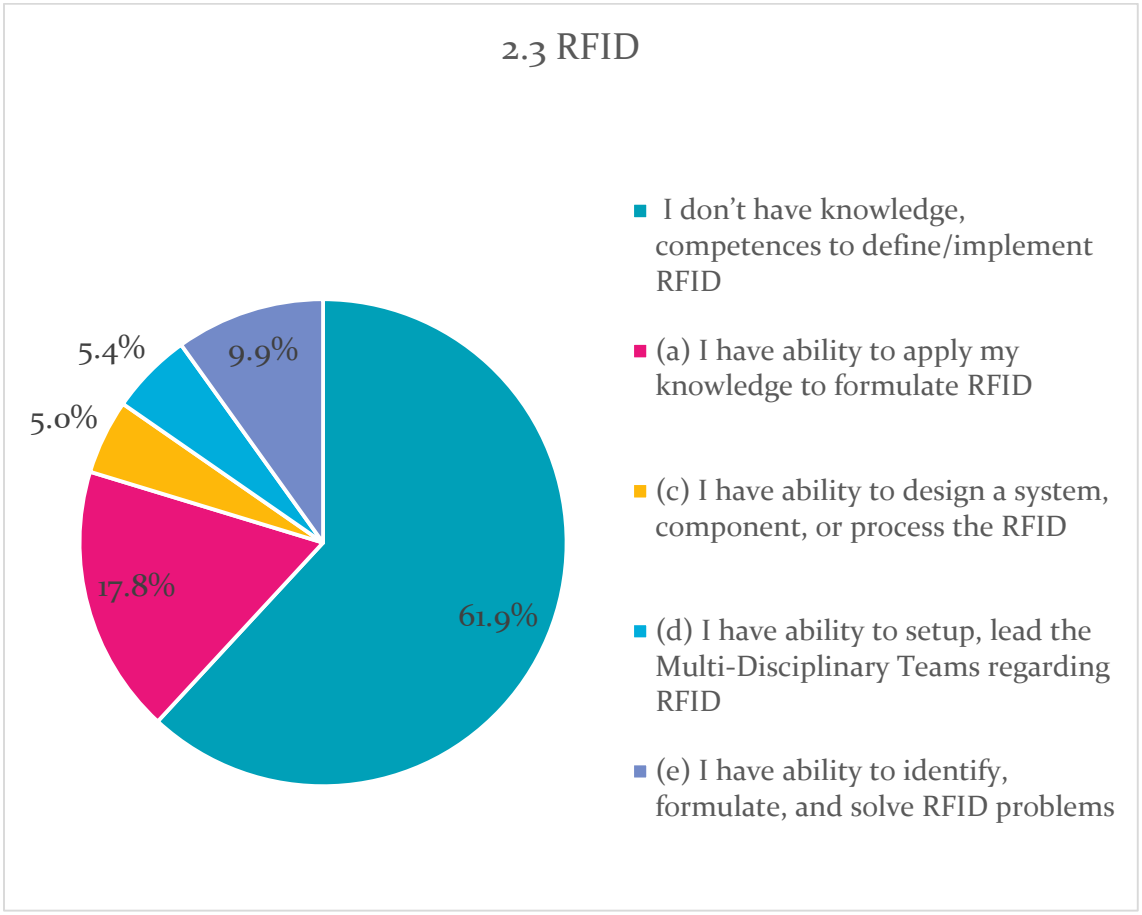


Figure 182 RFID

I don't have knowledge

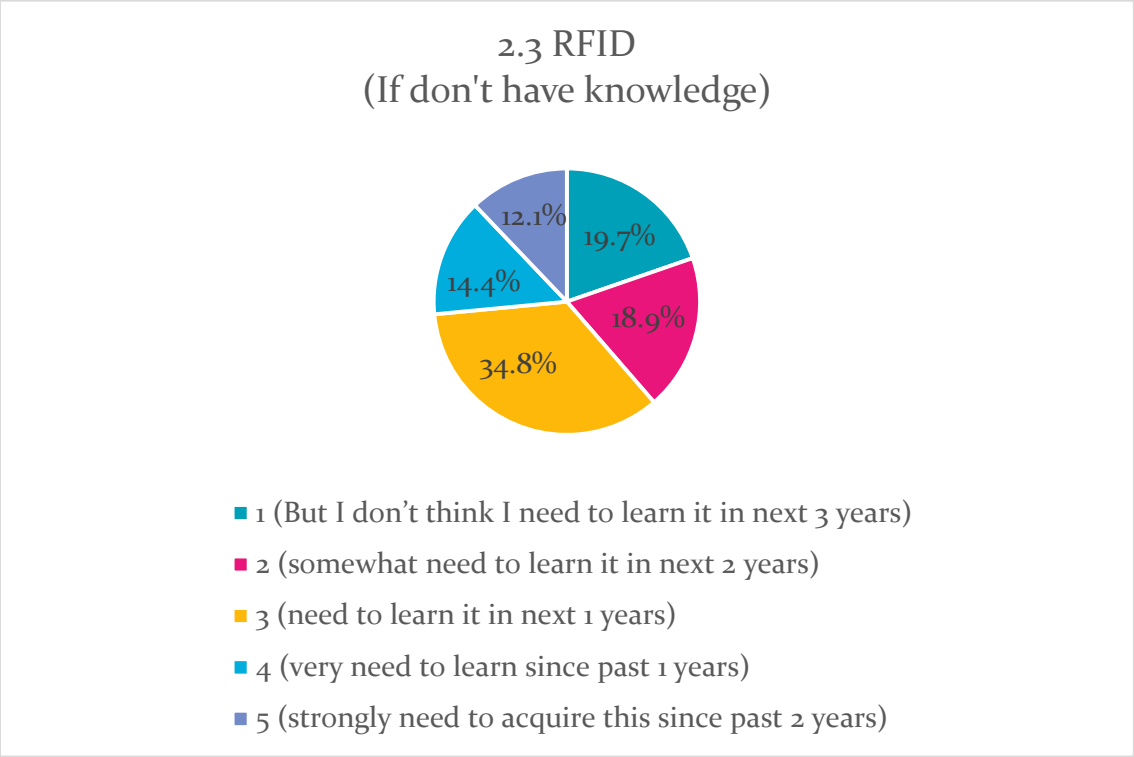


Figure 183 RFID (If don't have knowledge)

- 2.4 Realtime Location System

☐ (a) I have ability to apply my knowledge to formulate Realtime Location Systems

☐ (c) I have ability to design a system, component, or process the Realtime Location Systems

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding Realtime Location Systems

☐ (e) I have ability to identify, formulate, and solve Realtime Location Systems problems

☐ I don't have knowledge, competences to define/implement Realtime Location Systems

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

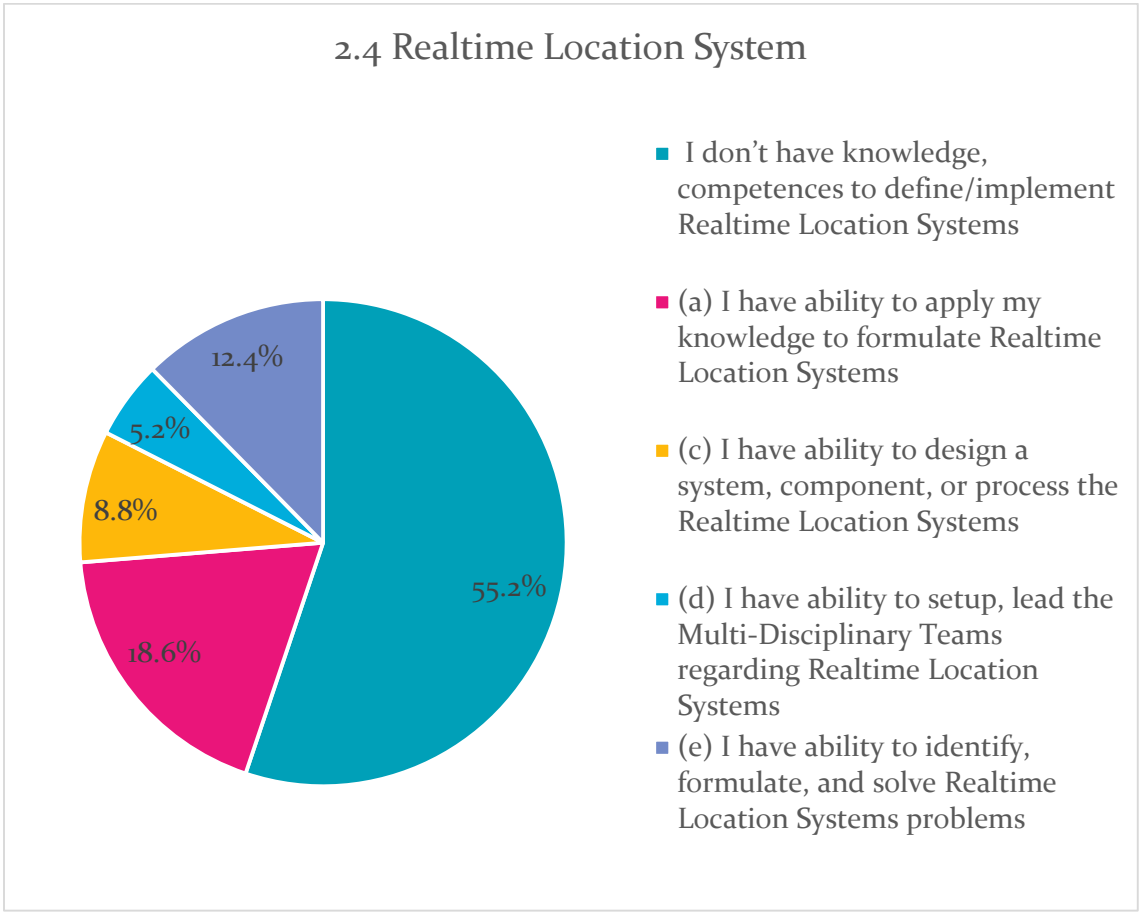


Figure 184 Realtime Location System

I don't have knowledge

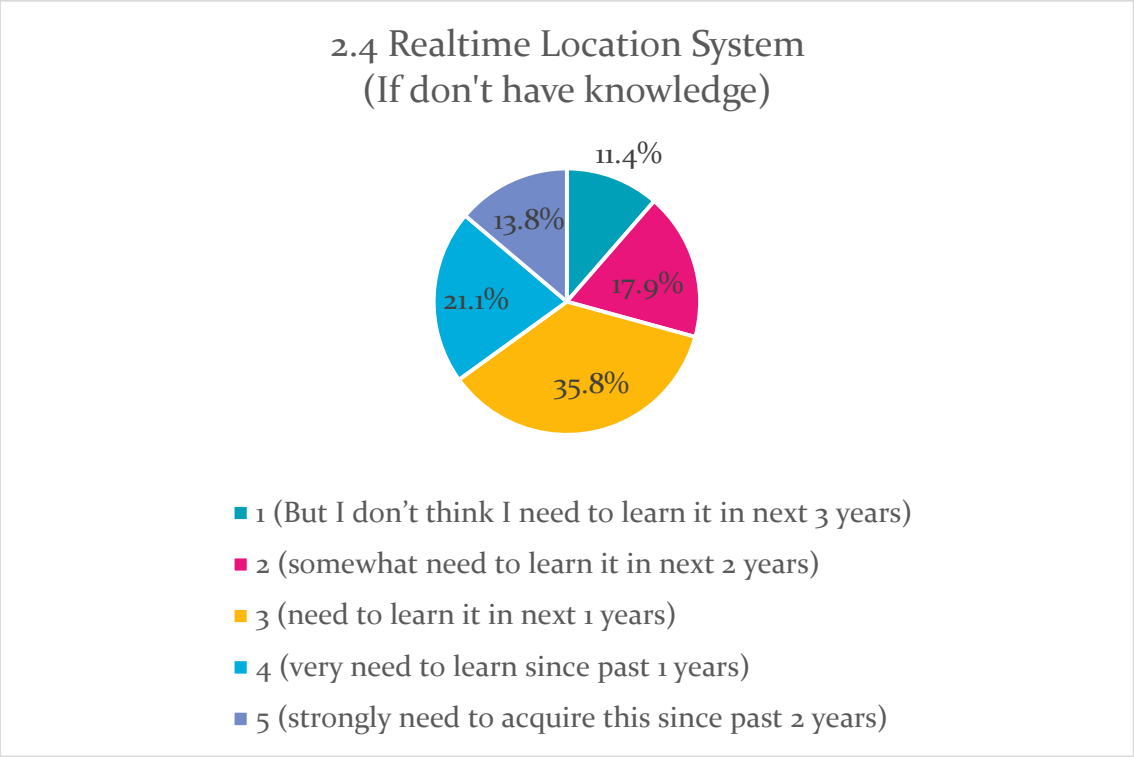


Figure 185 Realtime Location System (If don't have knowledge)

- 2.5 Big data technology

☐ (a) I have ability to apply my knowledge to formulate Big data technology

☐ (c) I have ability to design a system, component, or process the Big data technology

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding Big data technology

☐ (e) I have ability to identify, formulate, and solve Big data technology problems

☐ I don't have knowledge, competences to define/implement Big data technology

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

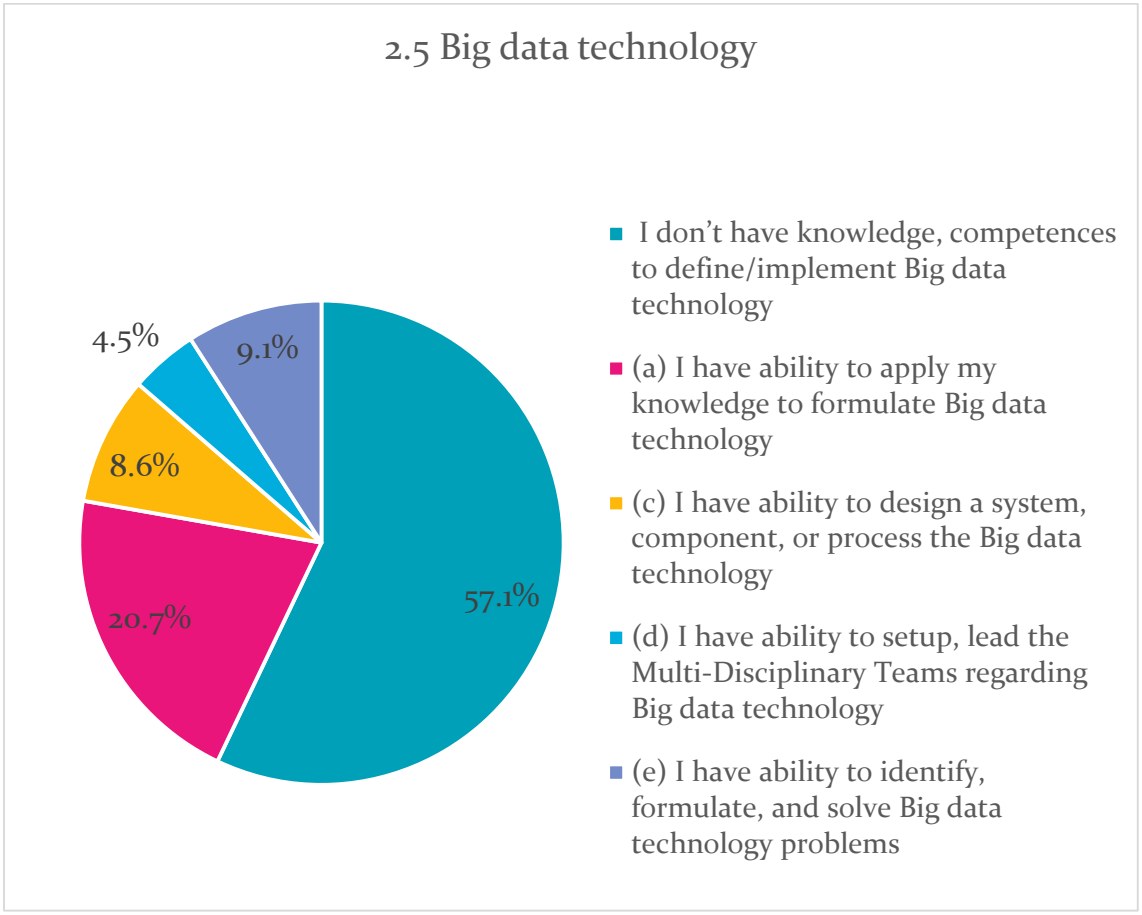


Figure 186 Big data technology

I don't have knowledge

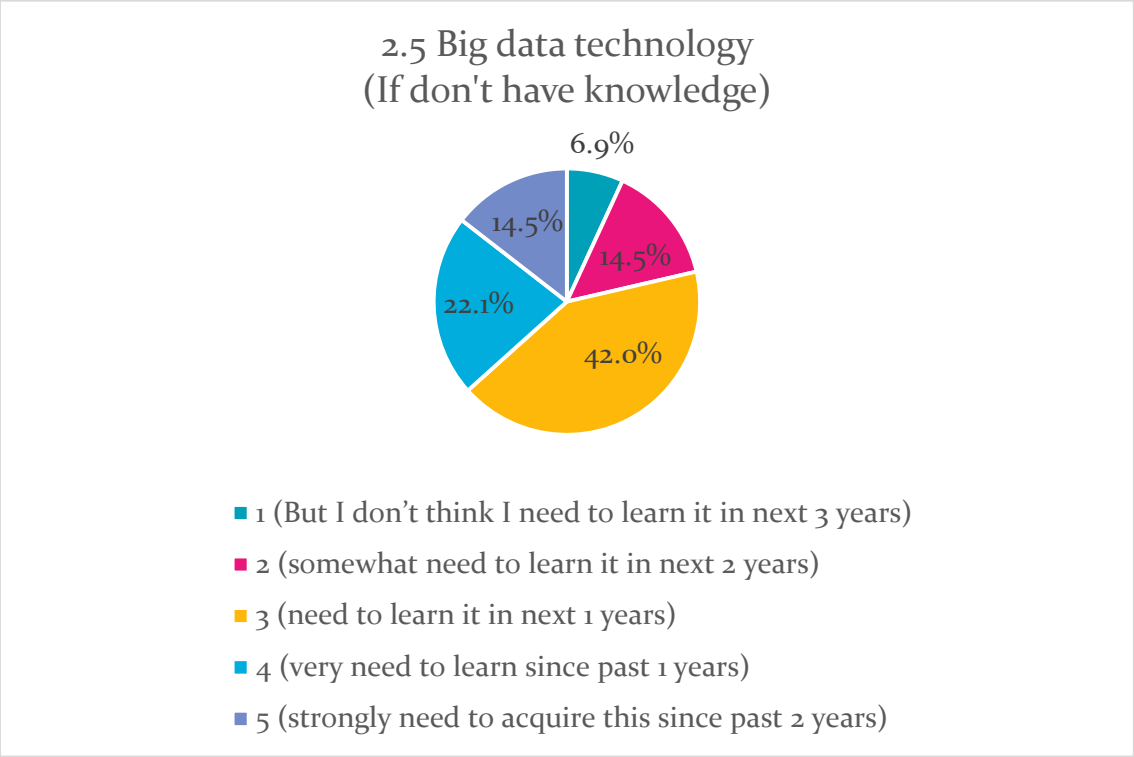


Figure 187 Big data technology (If don't have knowledge)

- 2.6 Cloud technologies as scalable IT infrastructure
  - ☐ (a) I have ability to apply my knowledge to formulate Cloud technologies
  - ☐ (c) I have ability to design a system, component, or process the Cloud technologies
  - ☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding Cloud technologies
  - ☐ (e) I have ability to identify, formulate, and solve Cloud technologies problems
  - ☐ I don't have knowledge, competences to define/implement Cloud technologies
    - ☐ 1 (But I don't think I need to learn it in next 3 years)
    - ☐ 2 (**somewhat** need to learn it in next 2 years)
    - ☐ 3 (need to learn it in next 1 years)
    - ☐ 4 (**very** need to learn since past 1 years)
    - ☐ 5 (**strongly** need to acquire this since past 2 years)

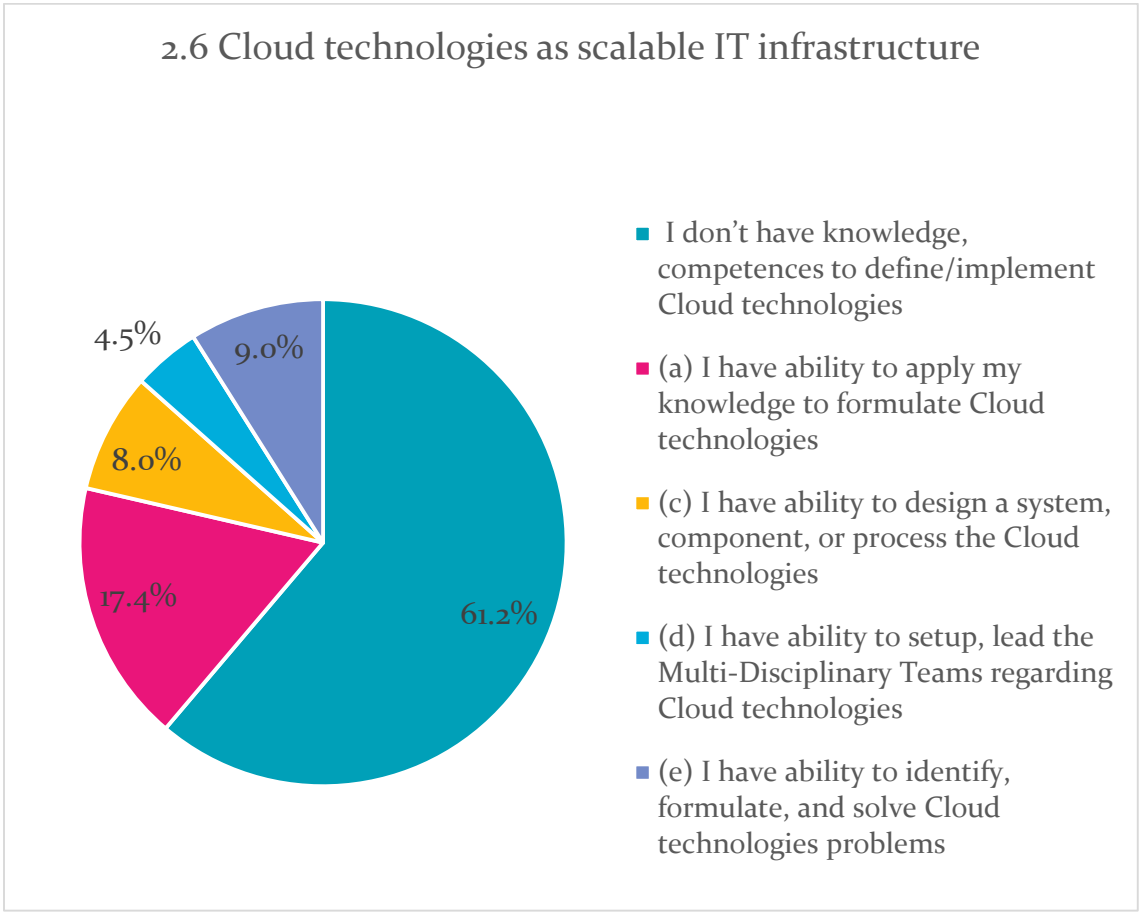


Figure 188 Cloud technologies as scalable IT infrastructure

I don't have knowledge

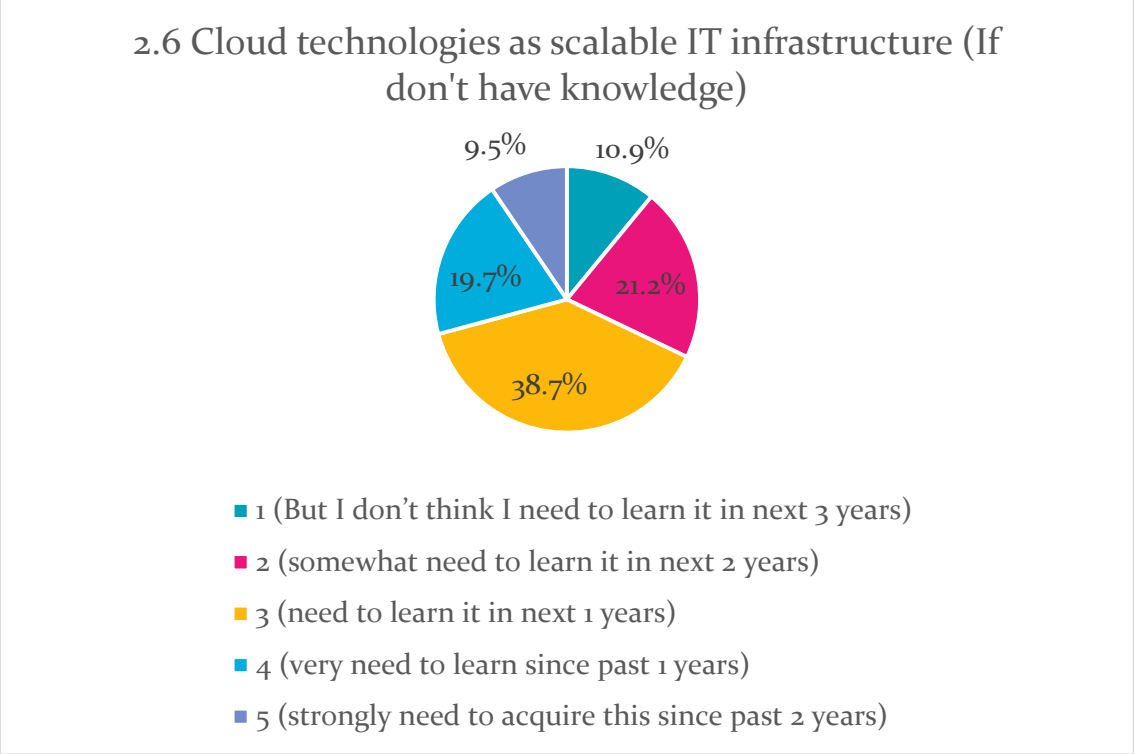


Figure 189 Cloud technologies as scalable IT infrastructure (If don't have knowledge)

☐ 2.7 Embedded IT systems

☐ (a) I have ability to apply my knowledge to formulate Embedded IT systems

☐ (c) I have ability to design a system, component, or process the Embedded IT systems

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding Embedded IT systems

☐ (e) I have ability to identify, formulate, and solve Embedded IT systems problems

☐ I don't have knowledge, competences to define/implement Embedded IT systems

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

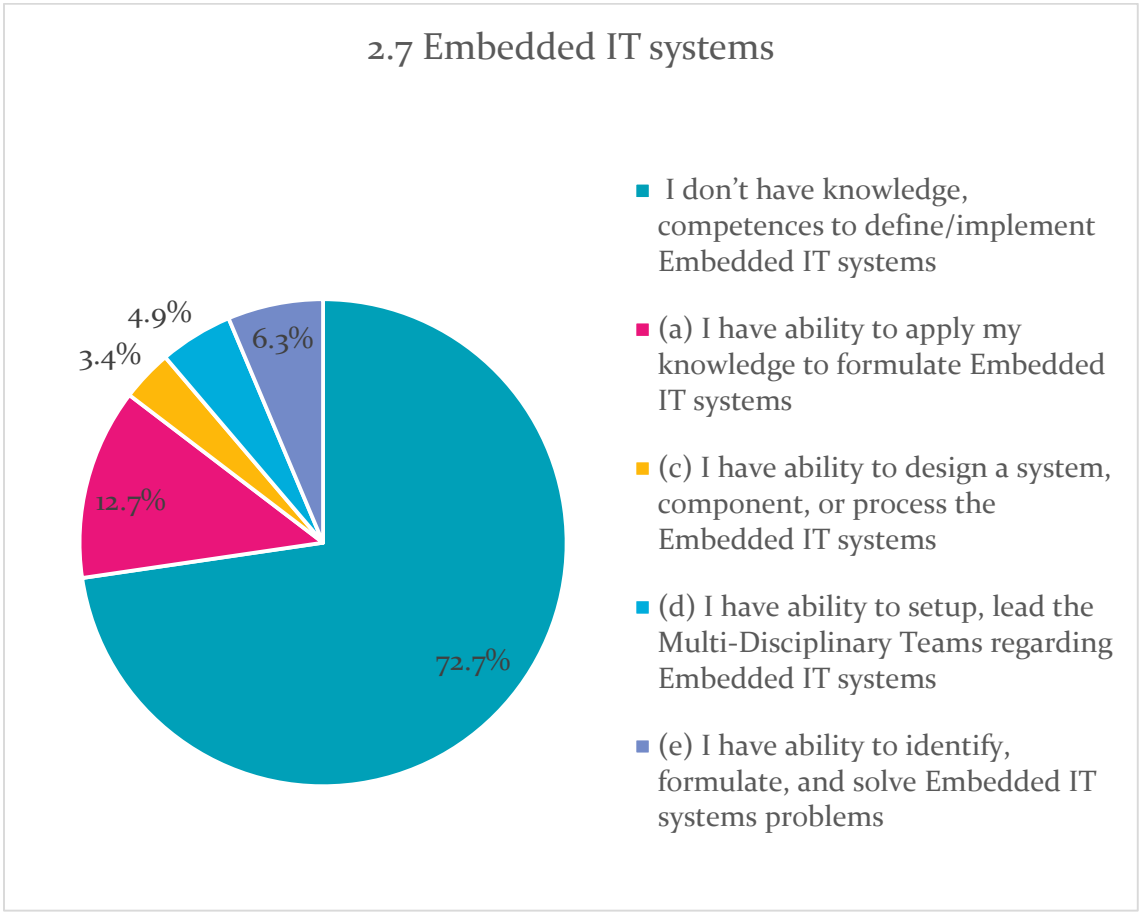


Figure 190 Embedded IT systems

I don't have knowledge

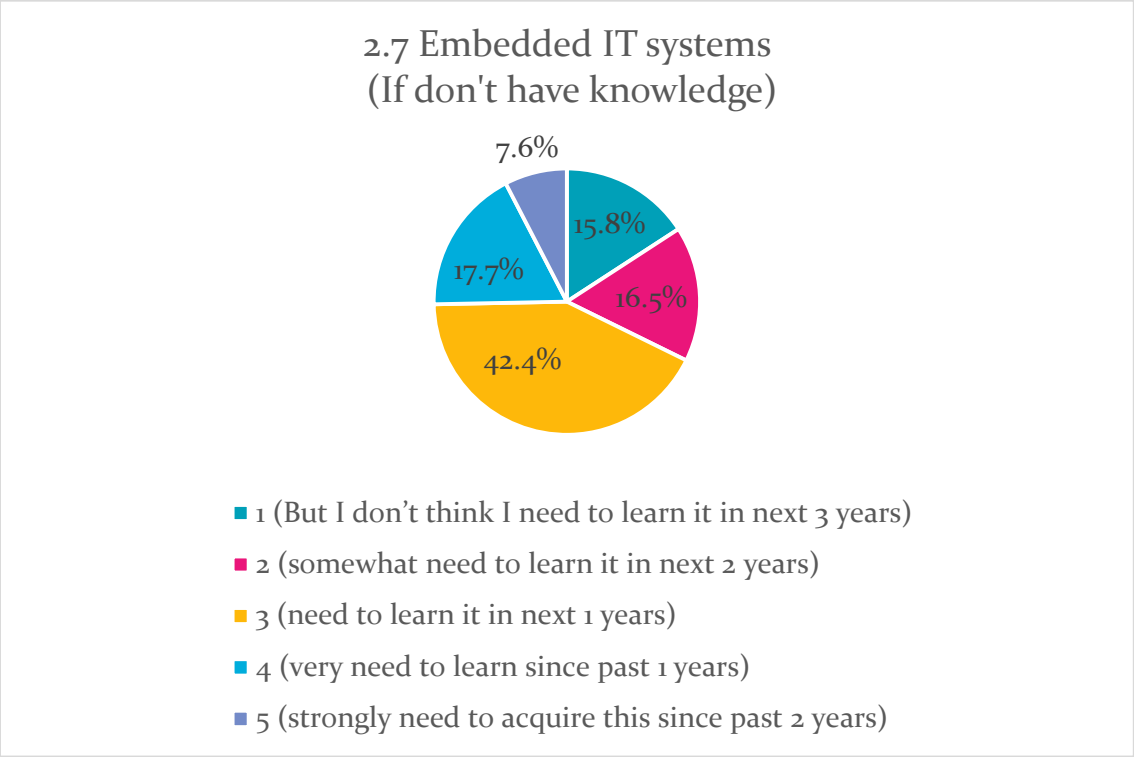


Figure 191 Embedded IT systems (I don't have knowledge)

- 2.8 M2M communications

☐ (a) I have ability to apply my knowledge to formulate M2M communications

☐ (c) I have ability to design a system, component, or process the M2M communications

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding M2M communications

☐ (e) I have ability to identify, formulate, and solve M2M communications problems

☐ I don't have knowledge, competences to define/implement M2M communications

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

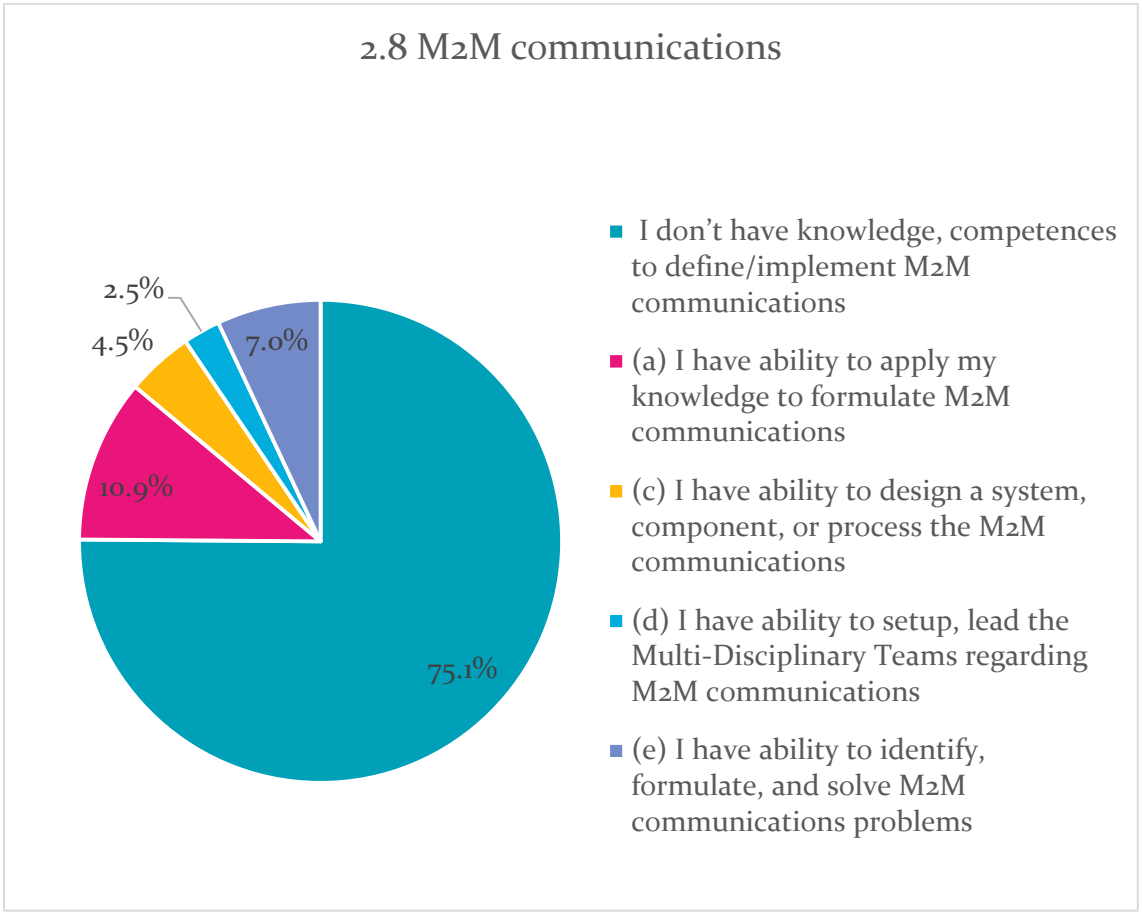


Figure 192 M2M communications

I don't have knowledge

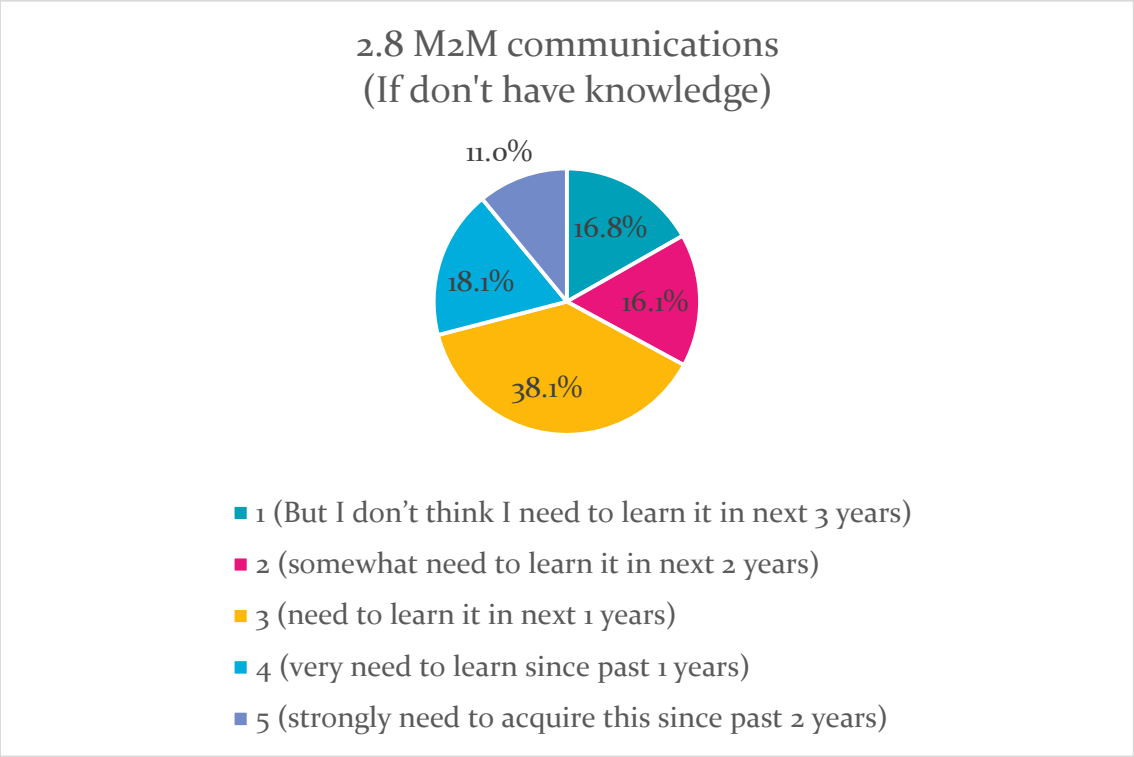


Figure 193 M2M communications (I don't have knowledge)

2.9 Automation Technology

☐ (a) I have ability to apply my knowledge to formulate Automation Technology

☐ (c) I have ability to design a system, component, or process the Automation Technology

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding Automation Technology

☐ (e) I have ability to identify, formulate, and solve Automation Technology problems

☐ I don't have knowledge, competences to define/implement Automation Technology

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

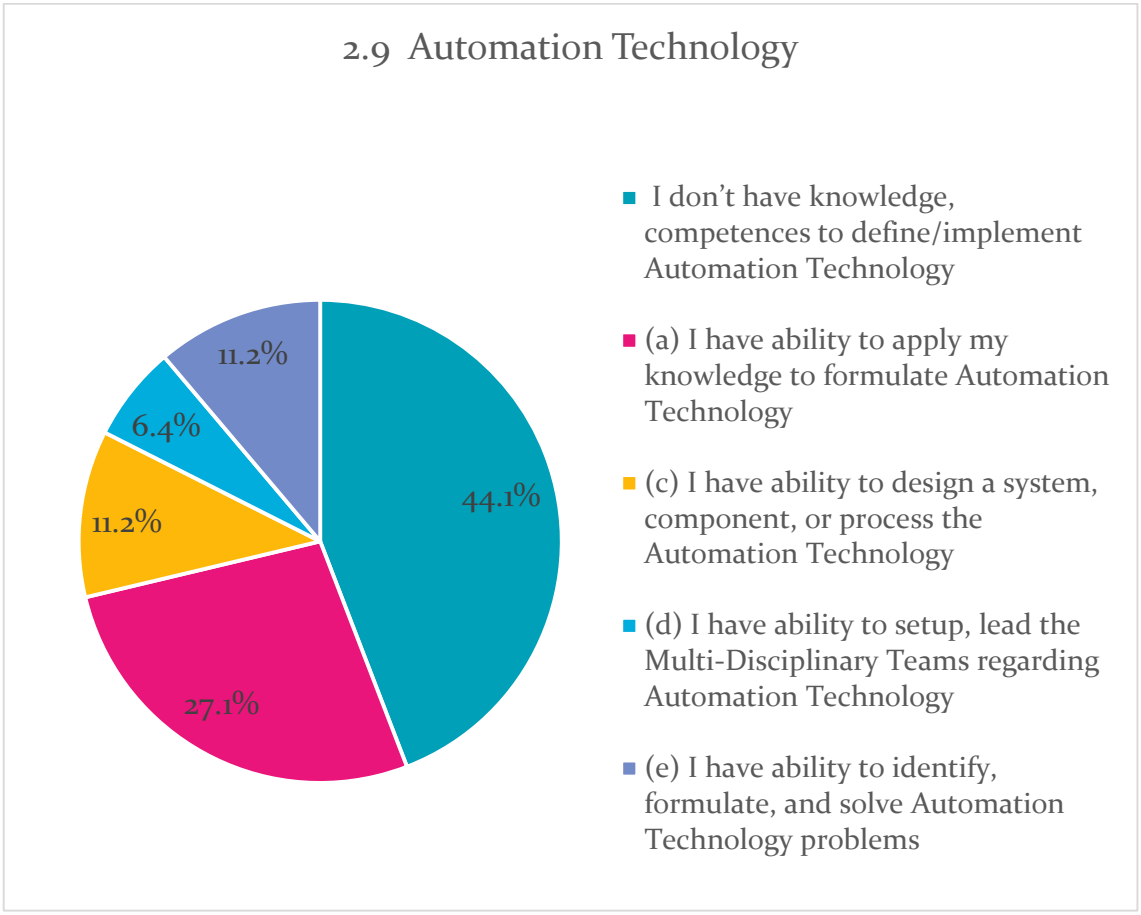


Figure 194 Automation Technology

I don't have knowledge

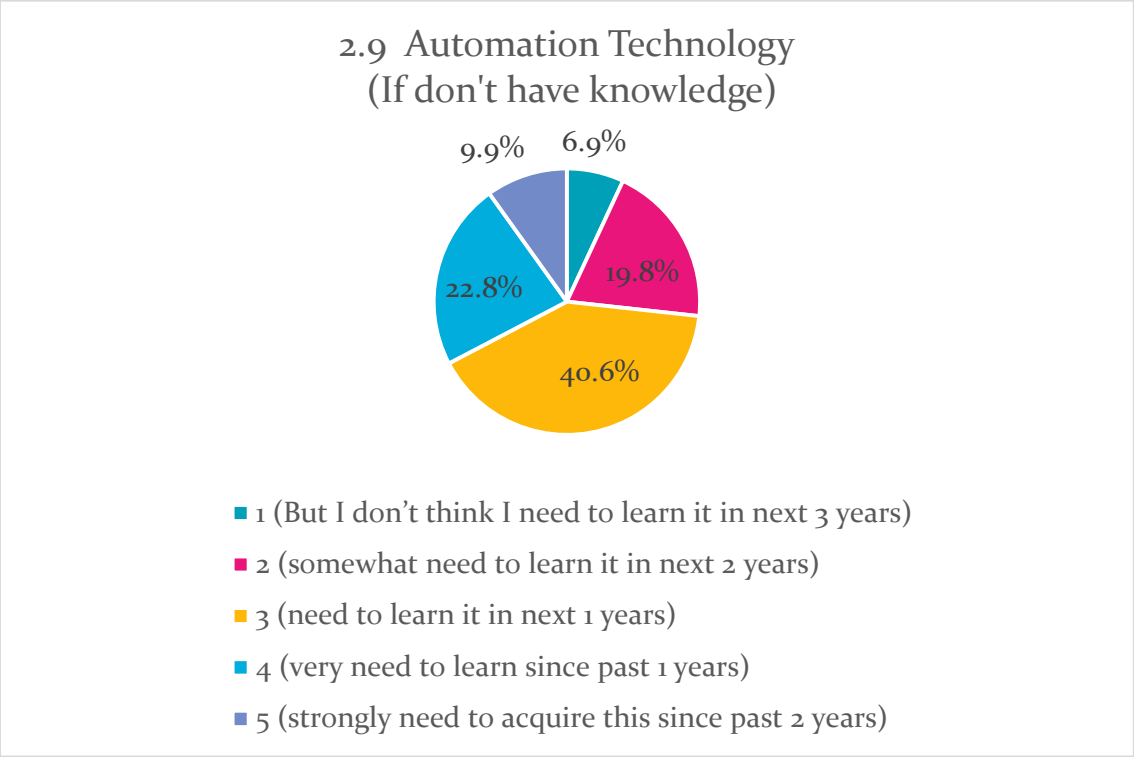


Figure 195 Automation Technology (I don't have knowledge)

2.10 CAD/CAM/CAE Technology

☐ (a) I have ability to apply my knowledge to formulate CAD/CAM/CAE Technology

☐ (c) I have ability to design a system, component, or process the CAD/CAM/CAE Technology

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams regarding CAD/CAM/CAE Technology

☐ (e) I have ability to identify, formulate, and solve CAD/CAM/CAE Technology problems

☐ I don't have knowledge, competences to define/implement CAD/CAM/CAE Technology

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

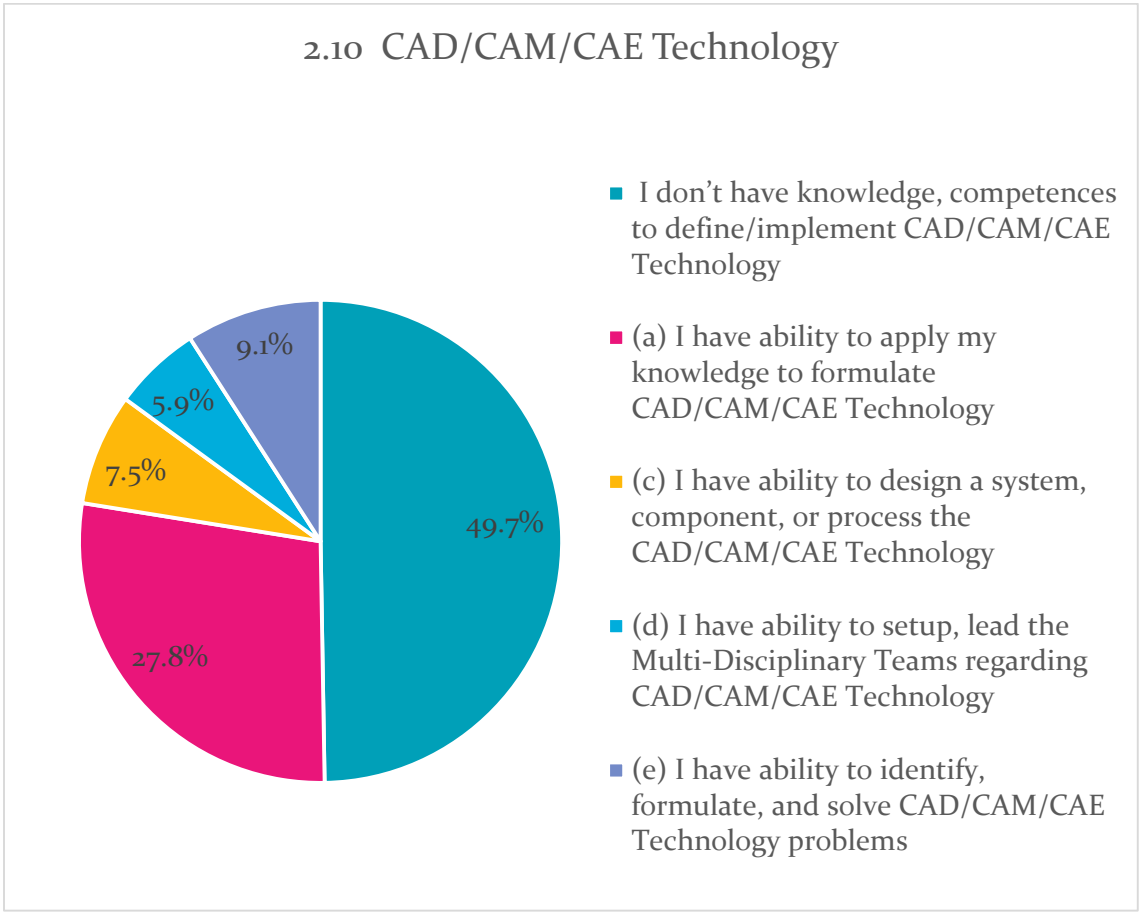


Figure 196 CAD/CAM/CAE Technology

I don't have knowledge

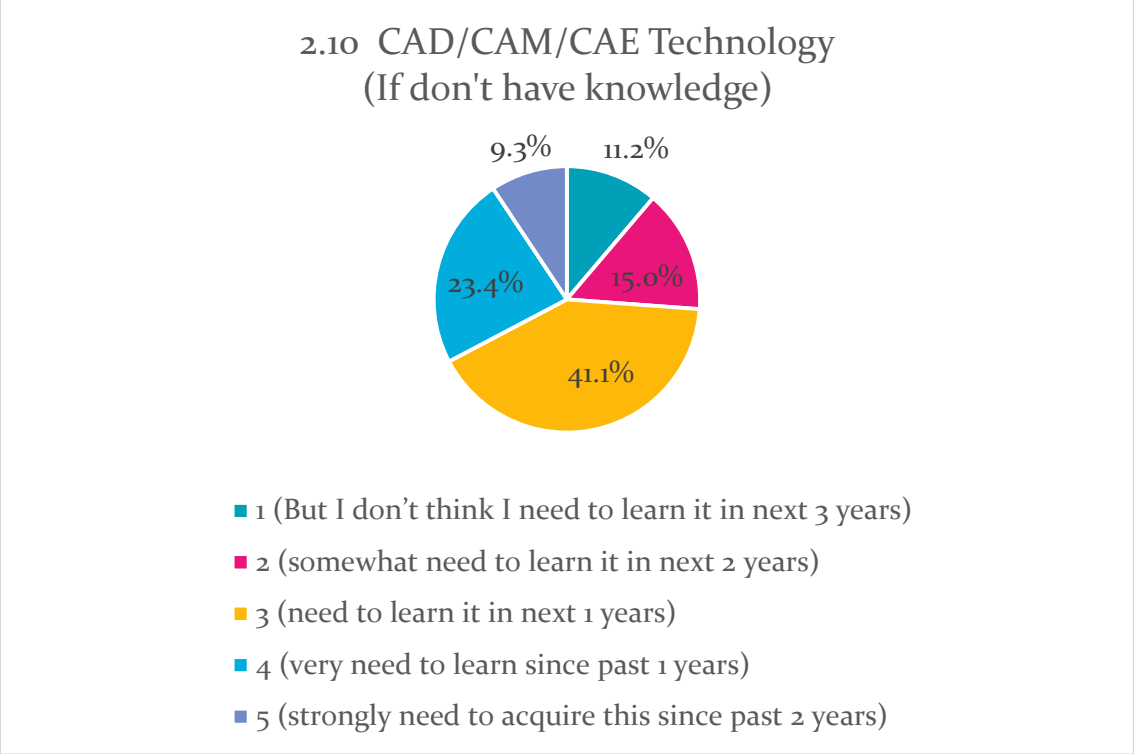


Figure 197 CAD/CAM/CAE Technology (I don't have knowledge)

PART 2: INDUSTRY 4.0 READINESS SKILL & COMPETENCE (CAN SELECT >1 ANSWER)

Q3. What is the level of your understanding of Computer programming/coding abilities with respect to Industry4.0 that you need in order to increase the your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Computer programming/coding abilities for Indudstry4.0

☐ (c) I have ability to design a system, component, or process the Computer programming/coding abilities for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Computer programming/coding abilities for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using Computer programming/coding abilities

☐ I don't have knowledge, competences to define/implement Computer programming/coding abilities

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

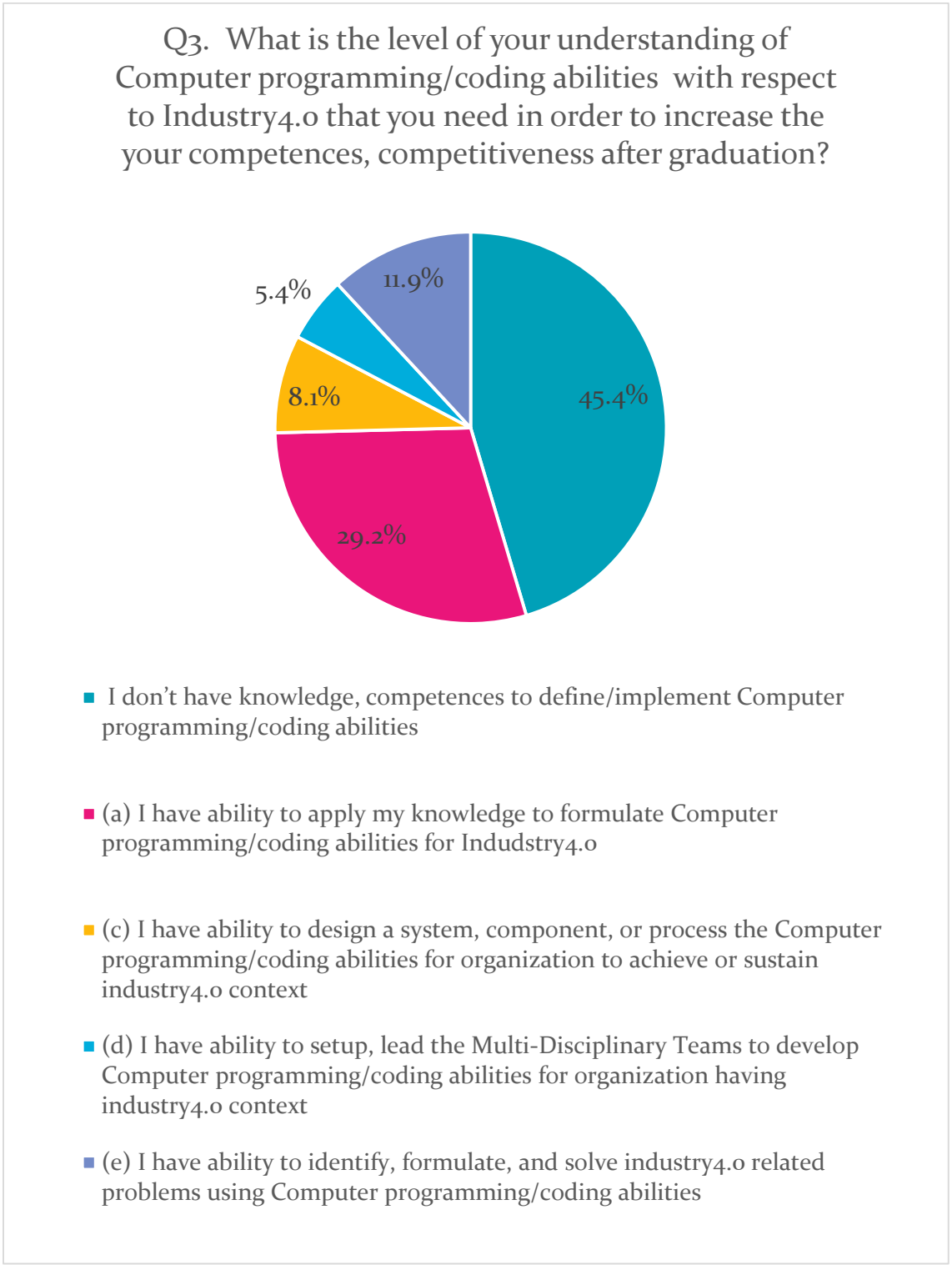


Figure 198 Q3.What is the level of your understanding of Computer programming/coding abilities with respect to Industry4.0 that you need in order to increase the your competences, competitiveness after graduation?

I don't have knowledge

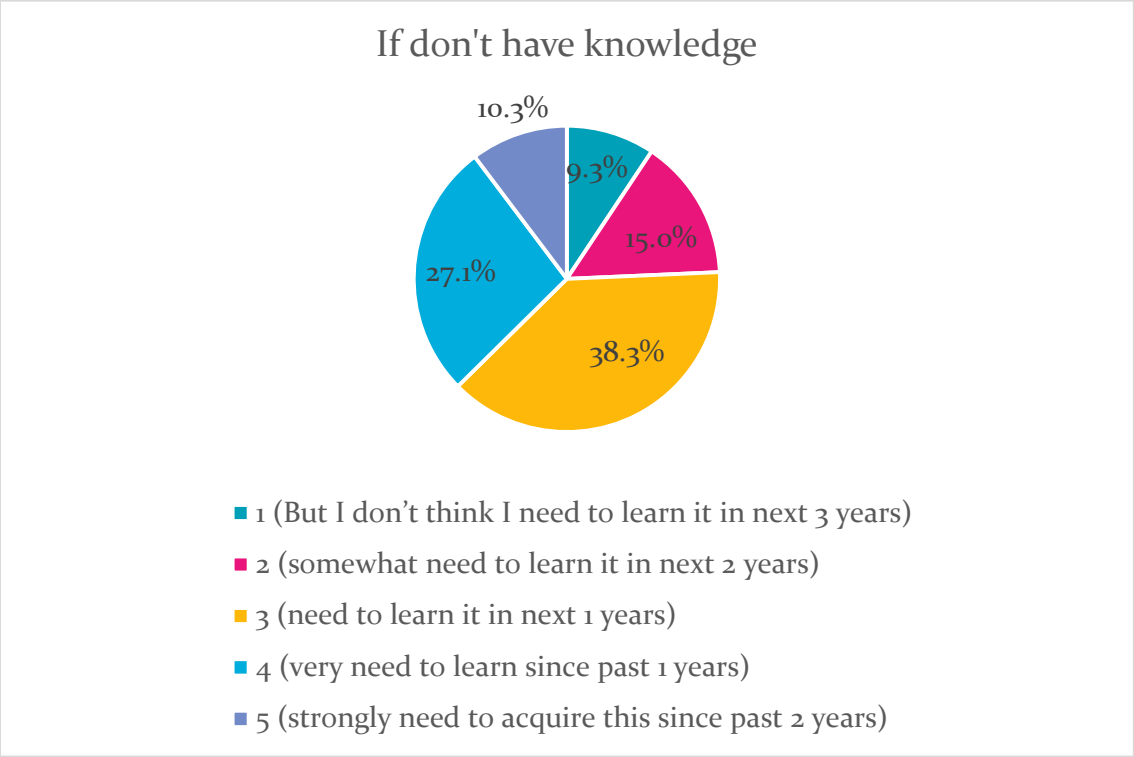


Figure 199 I don't have knowledge

Q4. What is the level of your understanding of Data and information processing and analytics with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Data and information processing and analytics for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Data and information processing and analytics for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Data and information processing and analytics for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using Data and information processing and analytics

☐ I don't have knowledge, competences to define/implement Data and information processing and analytics

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

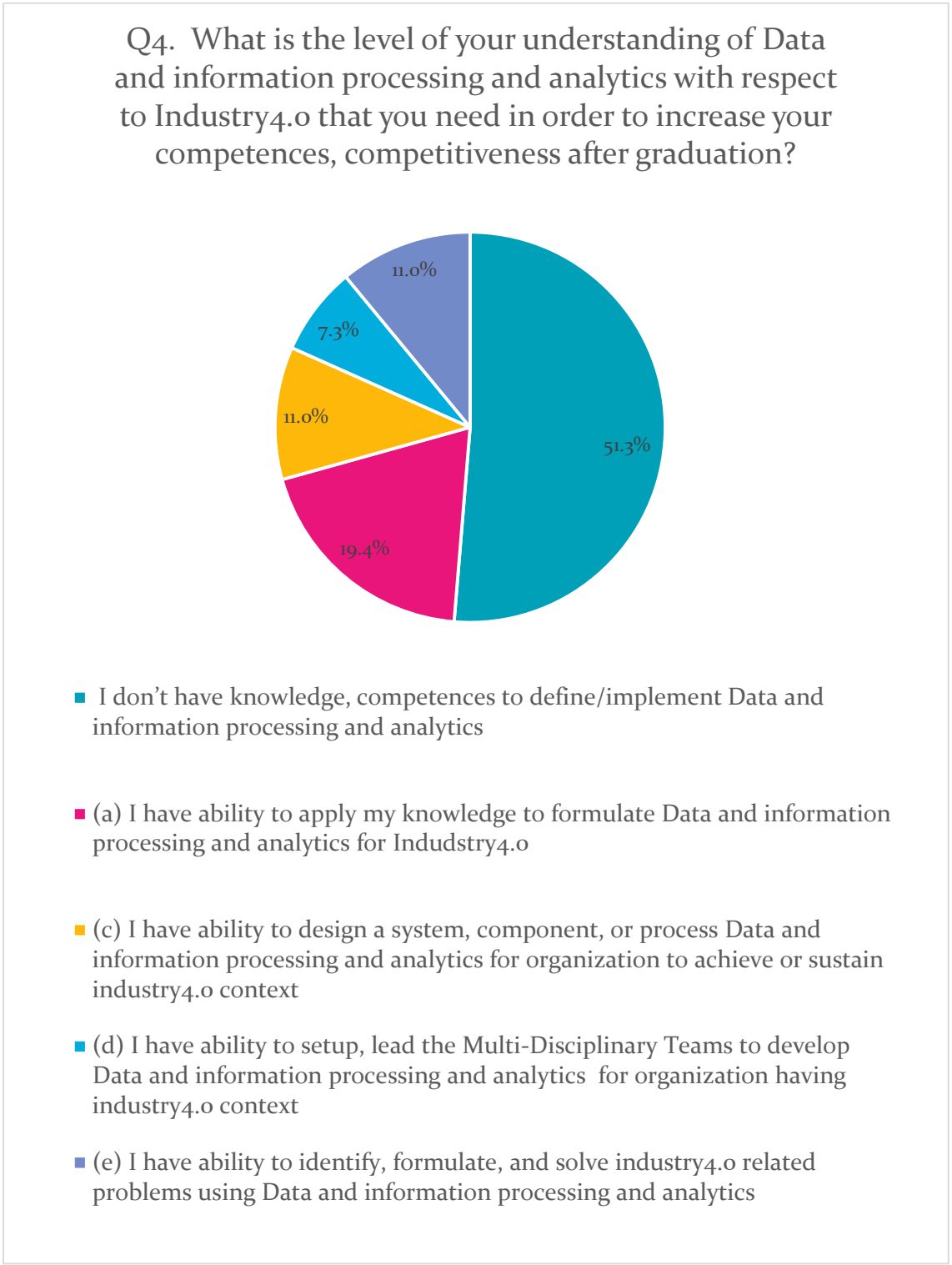


Figure 200 Q4. What is the level of your understanding of Data and information processing and analytics with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

I don't have knowledge

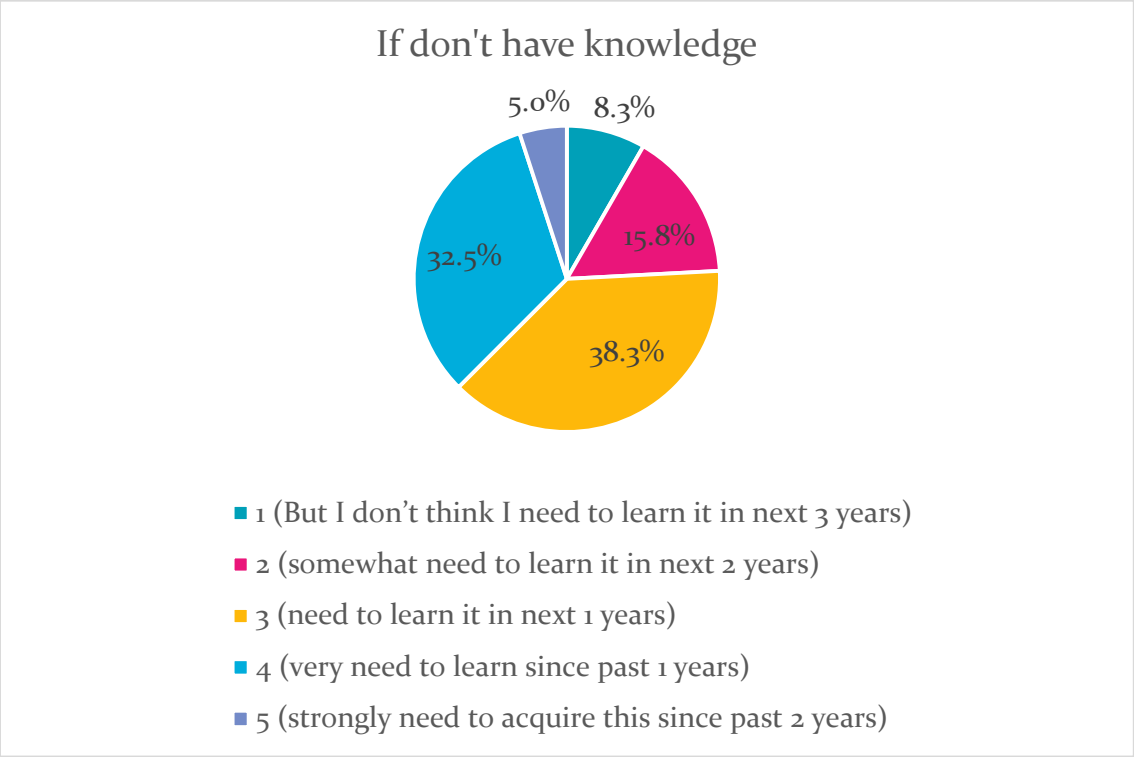


Figure 201 I don't have knowledge

Q5. What is the level of your understanding of Data Analytic/Statistical knowledge with respect to Industry4.0 that you <u>need</u> in order to increase the your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Data Analytic/Statistical knowledge for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Data Analytic/Statistical knowledge for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Data Analytic/Statistical knowledge for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using Data Analytic/Statistical knowledge

☐ I don't have knowledge, competences to define/implement Data Analytic/Statistical knowledge

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

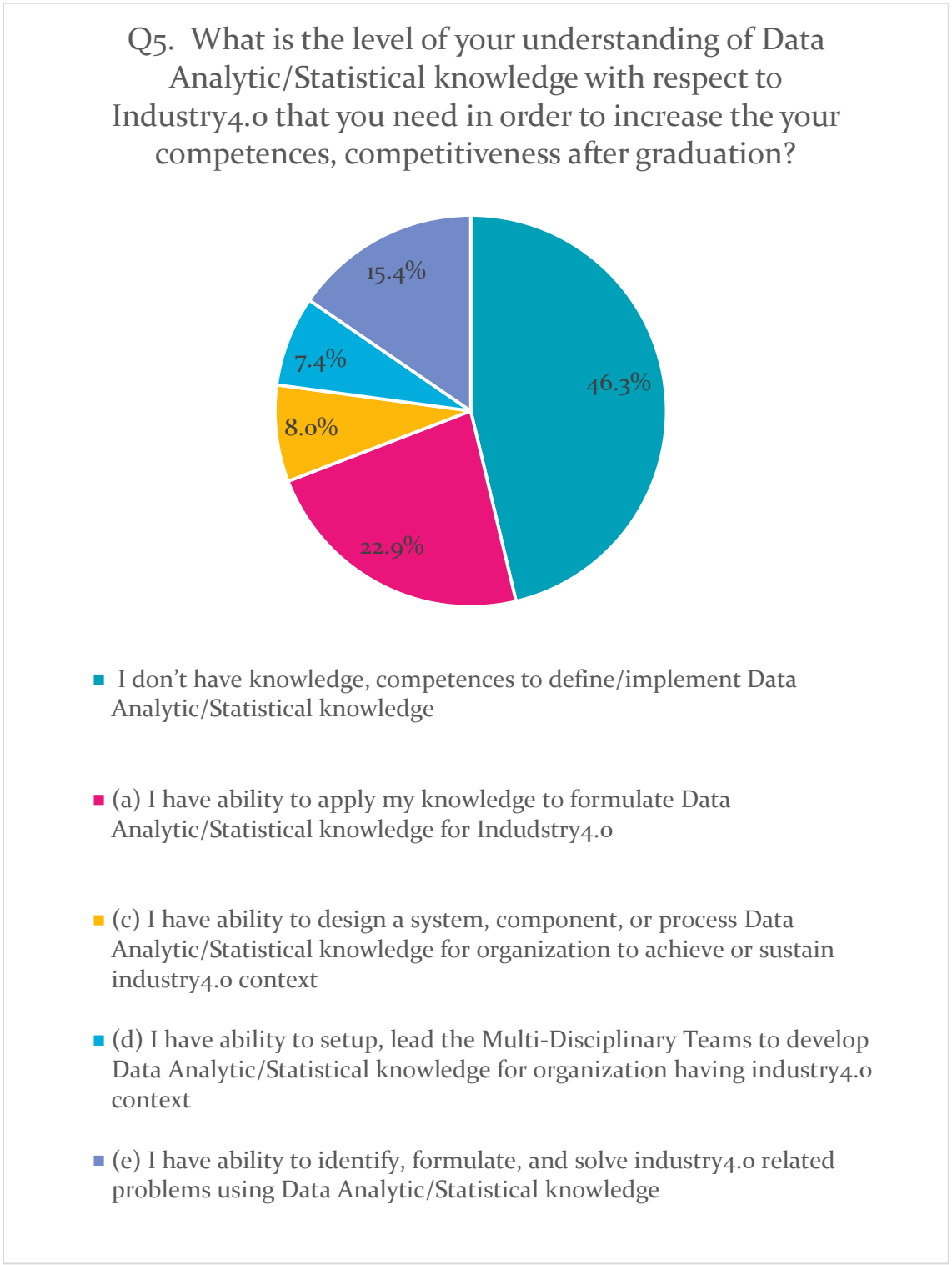


Figure 202 Q5. What is the level of your understanding of Data Analytic/Statistical knowledge with respect to Industry4.0 that you need in order to increase the your competences, competitiveness after graduation?

I don't have knowledge

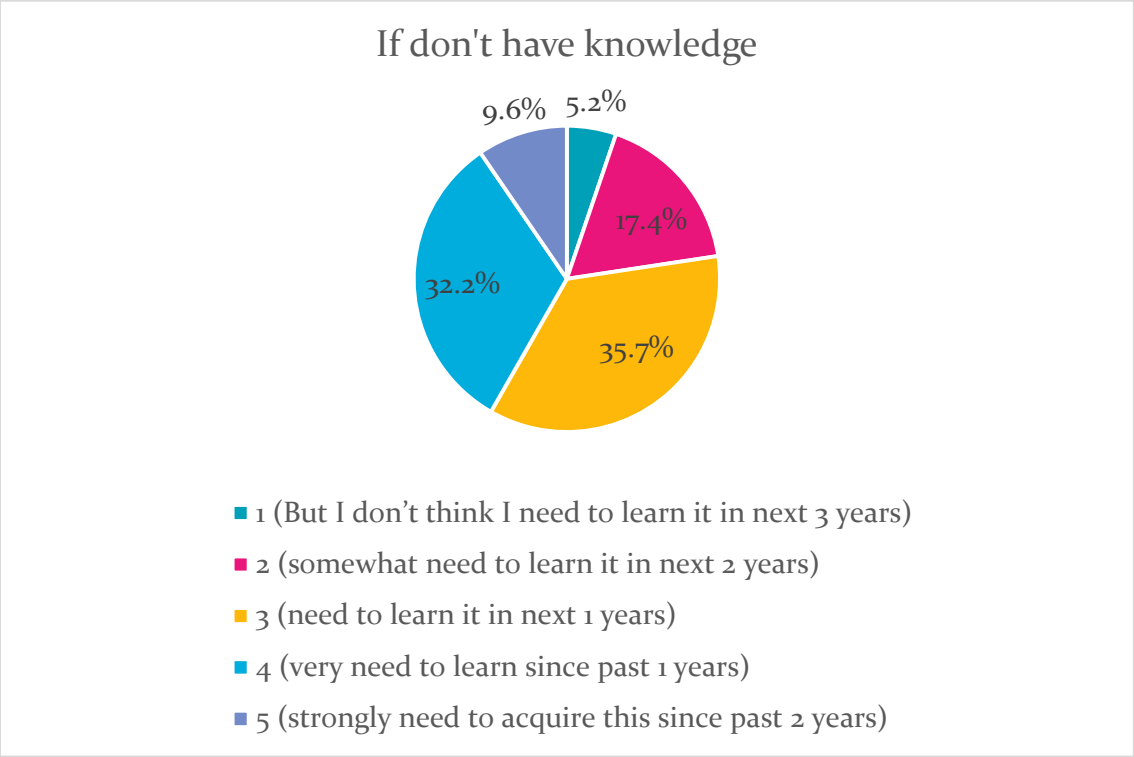


Figure 203 I don't have knowledge

Q6. What is the level of your understanding of IT security and data protection with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate IT security and data protection for Indudstry4.0

☐ (c) I have ability to design a system, component, or process IT security and data protection for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop IT security and data protection for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using IT security and data protection

☐ I don't have knowledge, competences to define/implement IT security and data protection

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

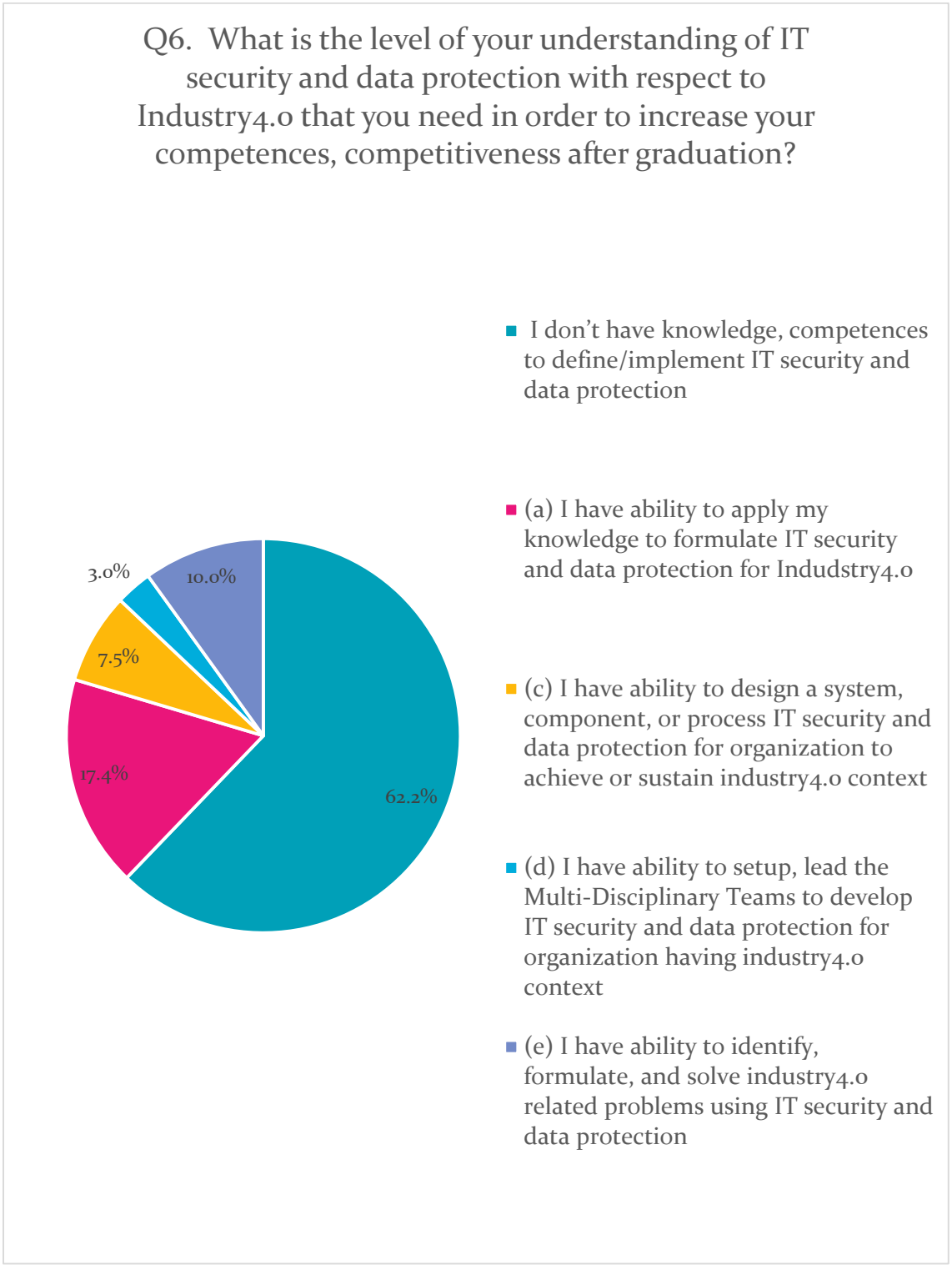


Figure 204 Q6. What is the level of your understanding of IT security and data protection with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

I don't have knowledge

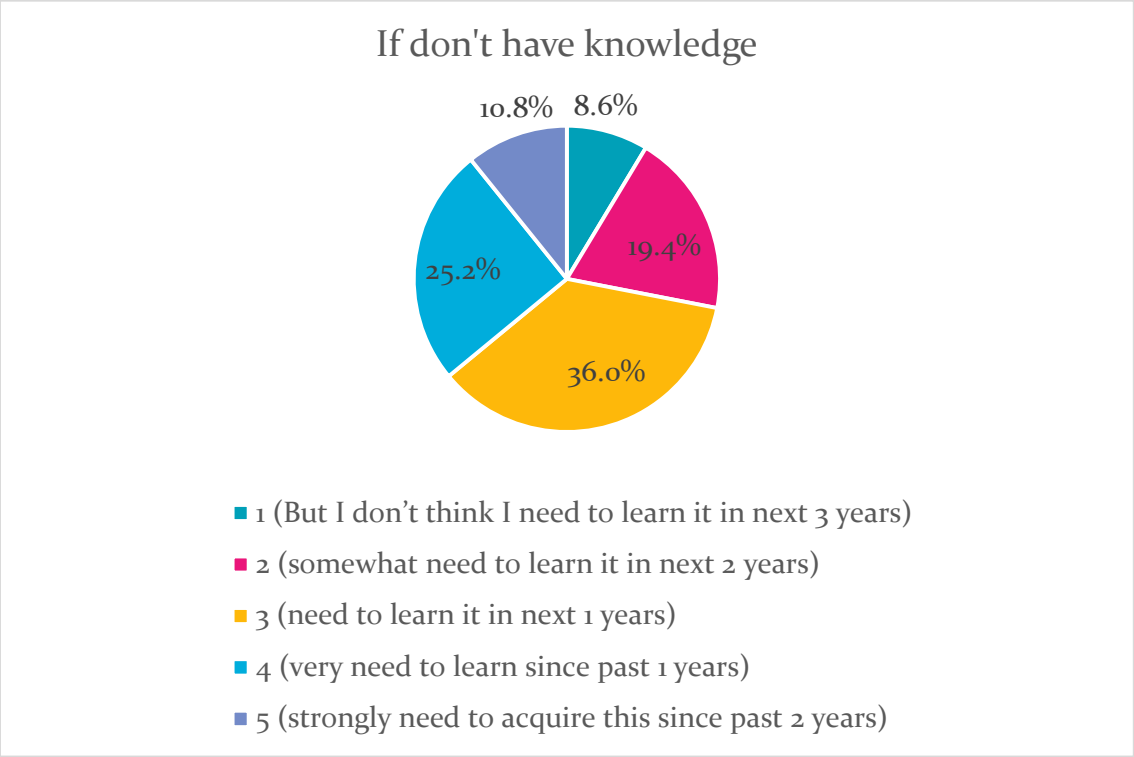


Figure 205 I don't have knowledge

Q7. What is the level of your understanding of ability to interact with modern interfaces (human-machine/human-robot) with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate interaction with modern interfaces (human-machine/human-robot) for Indudstry4.0

☐ (c) I have ability to design a system, component, or process interaction with modern interfaces (human-machine/human-robot) for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop interaction with modern interfaces (human-machine/human-robot) for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems of interaction with modern interfaces (human-machine/human-robot)

☐ I don't have knowledge, competences to define/implement interaction with modern interfaces (human-machine/human-robot)

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

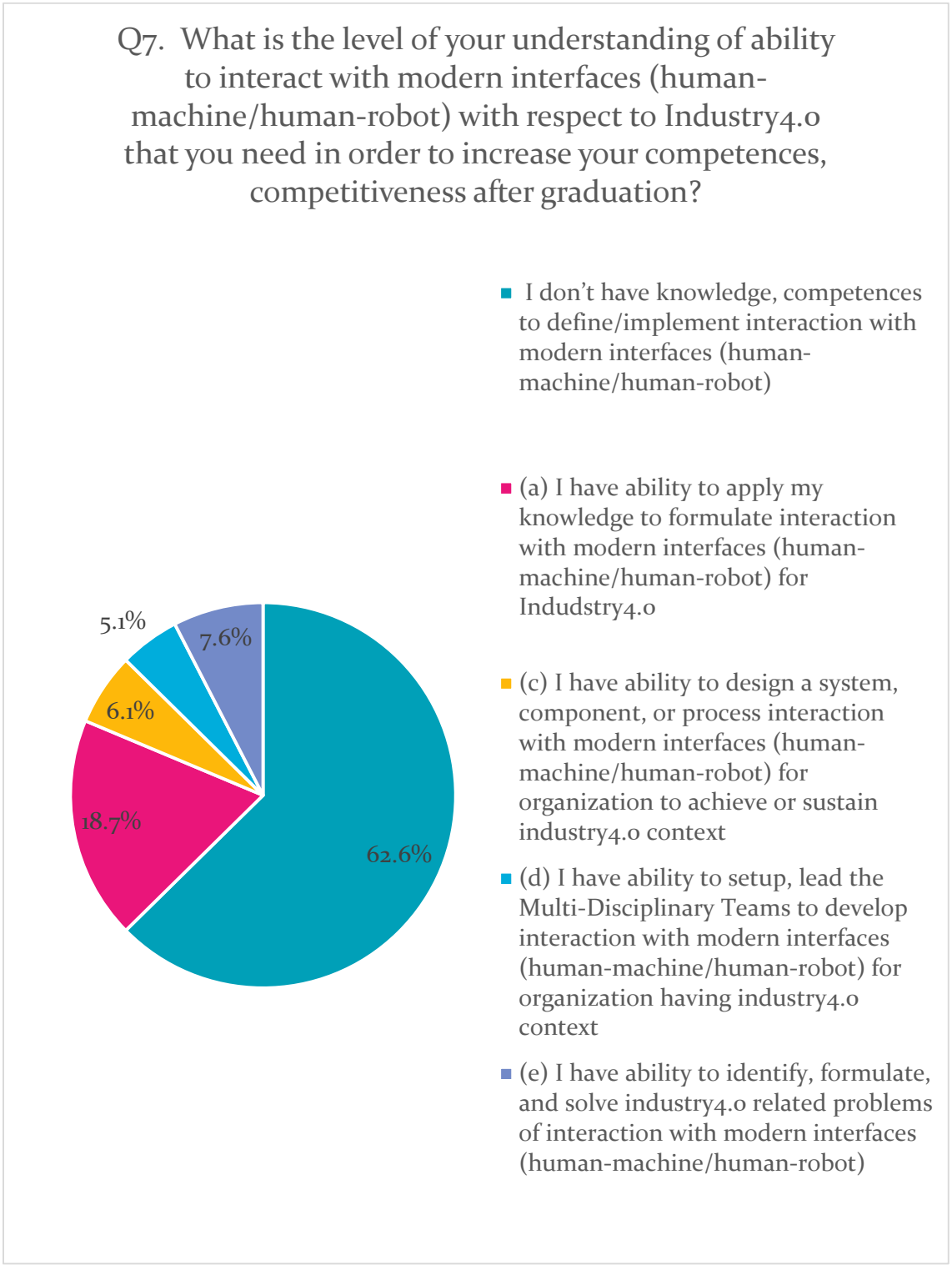


Figure 206 Q7. What is the level of your understanding of ability to interact with modern interfaces (human-machine/human-robot) with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

I don't have knowledge

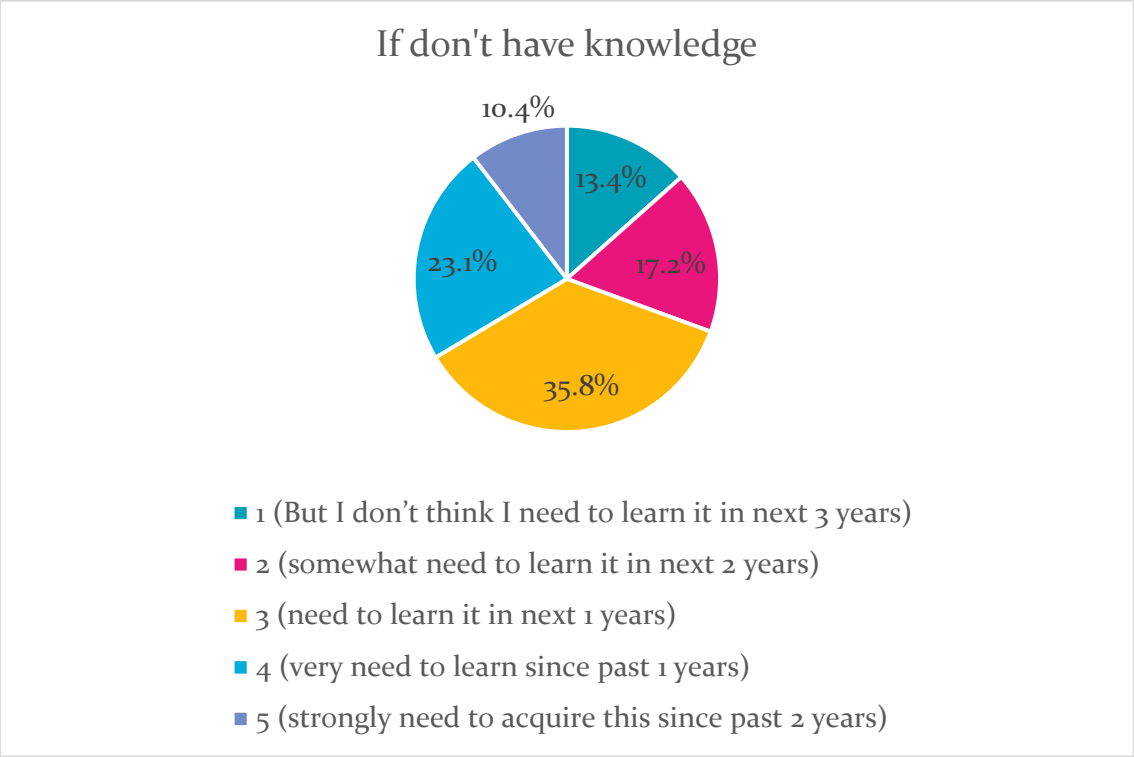


Figure 207 I don't have knowledge

Q8. What is the level of your understanding of Smart Work&Ergonomics with respect to Industry4.0 that you <u>need</u> in order to increase the competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Smart Work&Ergonomics for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Smart Work&Ergonomics for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Smart Work&Ergonomics for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems of Smart Work&Ergonomics

☐ I don't have knowledge, competences to define/implement Smart Work&Ergonomics

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

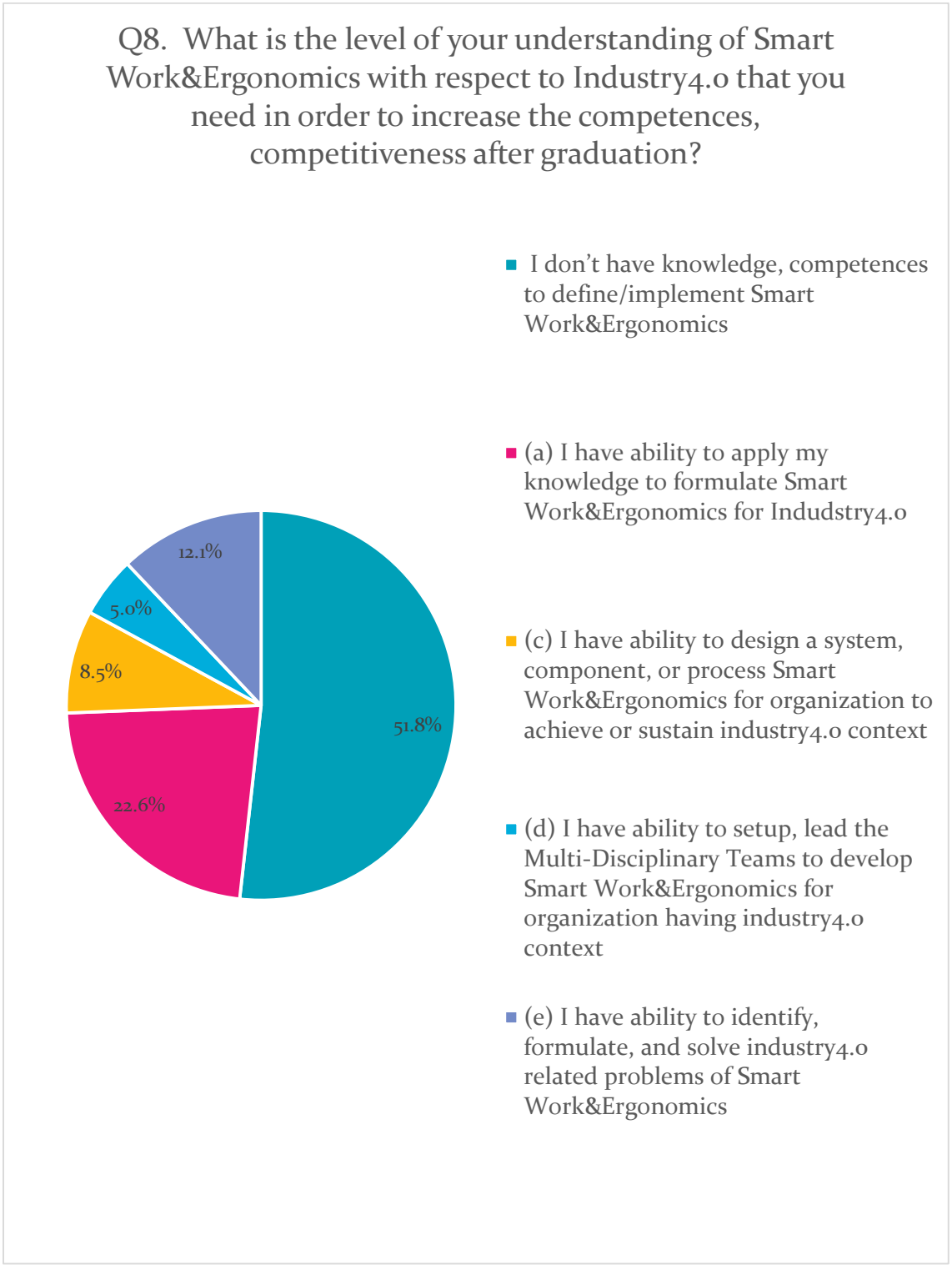


Figure 208 Q8. What is the level of your understanding of Smart Work&Ergonomics with respect to Industry4.0 that you need in order to increase the competences, competitiveness after graduation?

I don't have knowledge

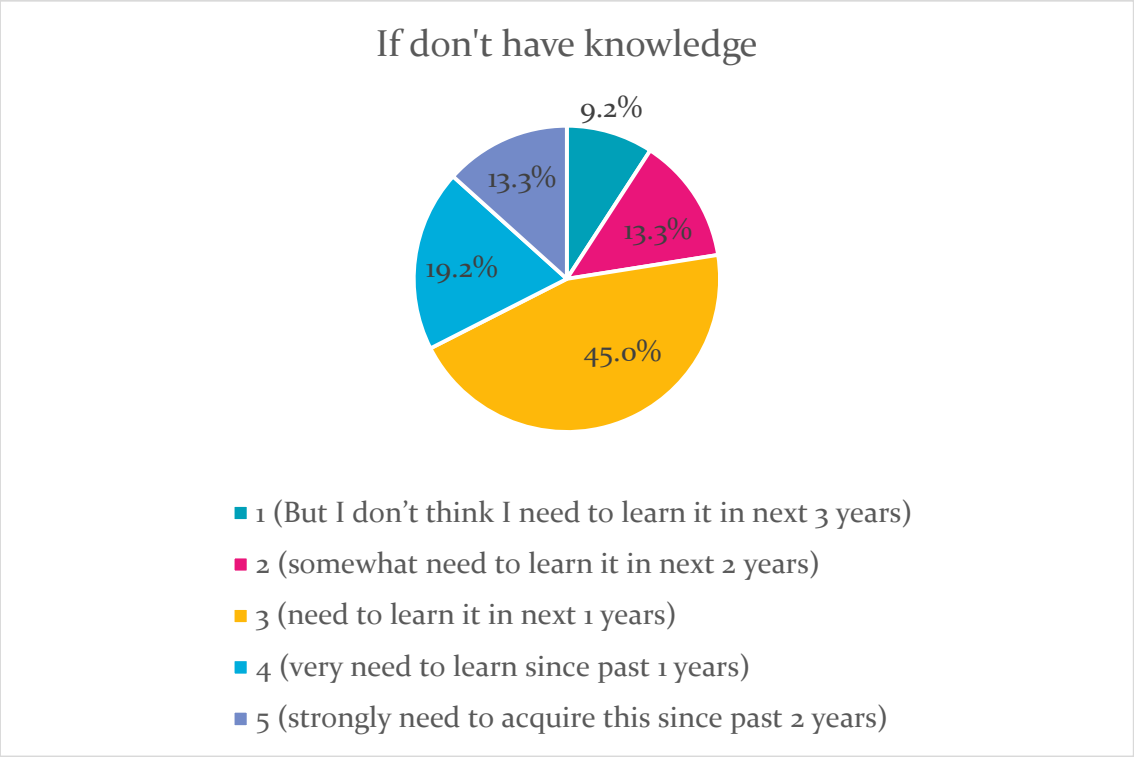


Figure 209 I don't have knowledge

Q9. What is the level of your understanding of Smart Product with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Smart Product for Indudstry4.0

☐ (c) I have ability to design a system, component, or process the Smart Product for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop organization having industry4.0 context by using Smart Product

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using Smart Product ☐ I don't have knowledge, competences to define/implement Smart Product

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

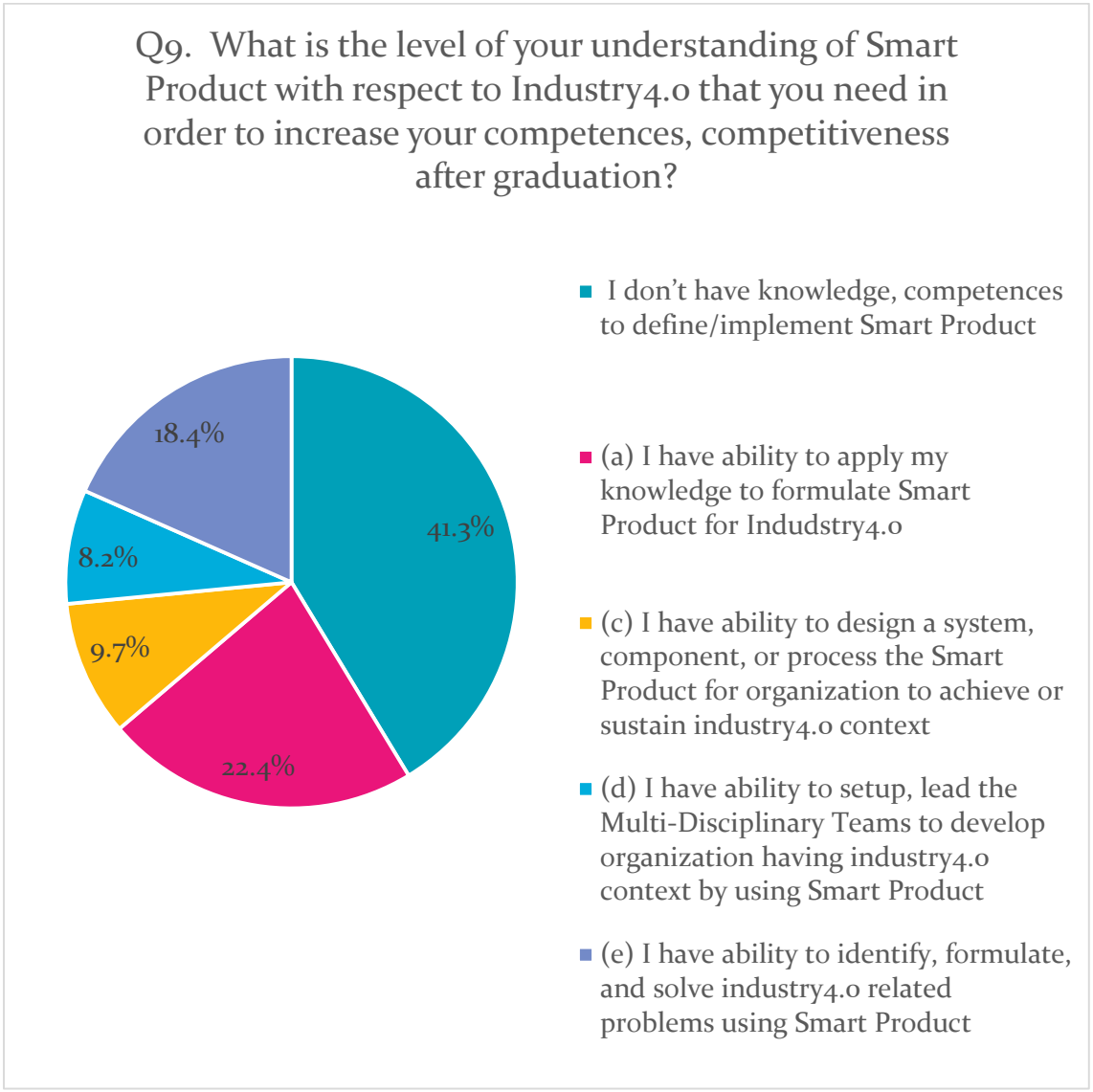


Figure 210 Q9. What is the level of your understanding of Smart Product with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

I don't have knowledge

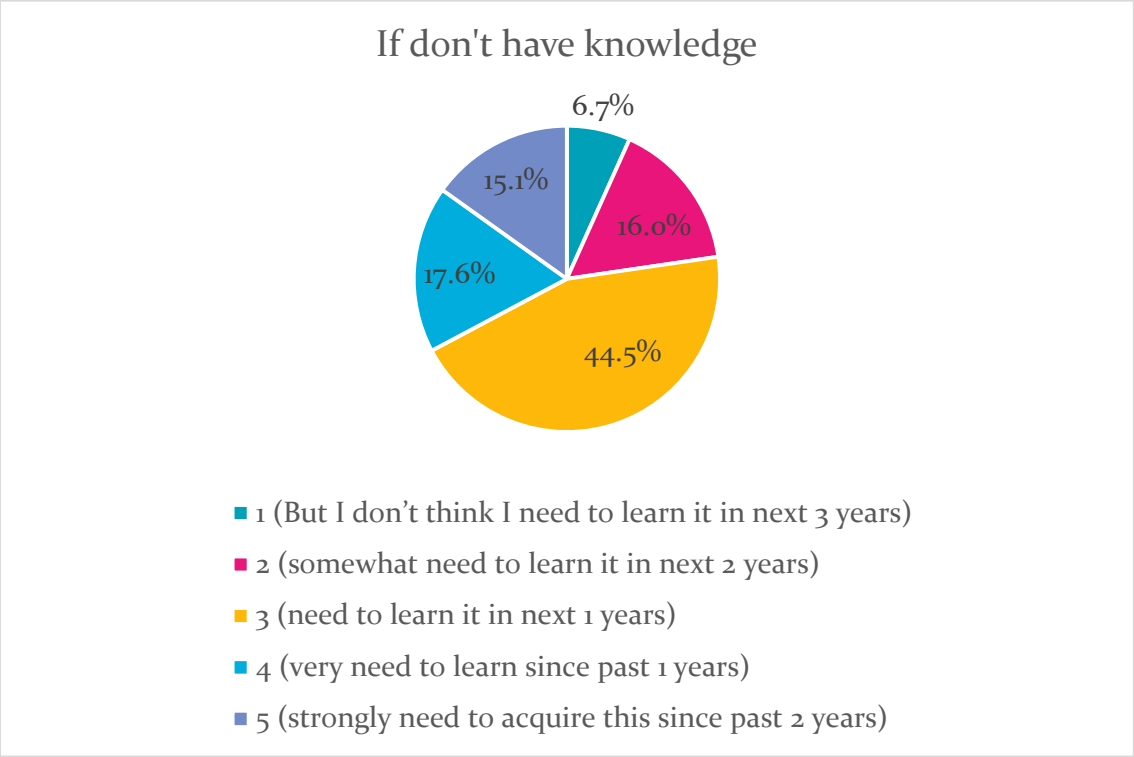


Figure 211 I don't have knowledge

Q10. What is the level of your understanding of Co-created Design with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Co-created Design for Indudstry4.0

☐ (c) I have ability to design a system, component, or process the Co-created Design for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop organization having industry4.0 context by using Co-created Design

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using Co-created Design

☐ I don't have knowledge, competences to define/implement Co-created Design

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

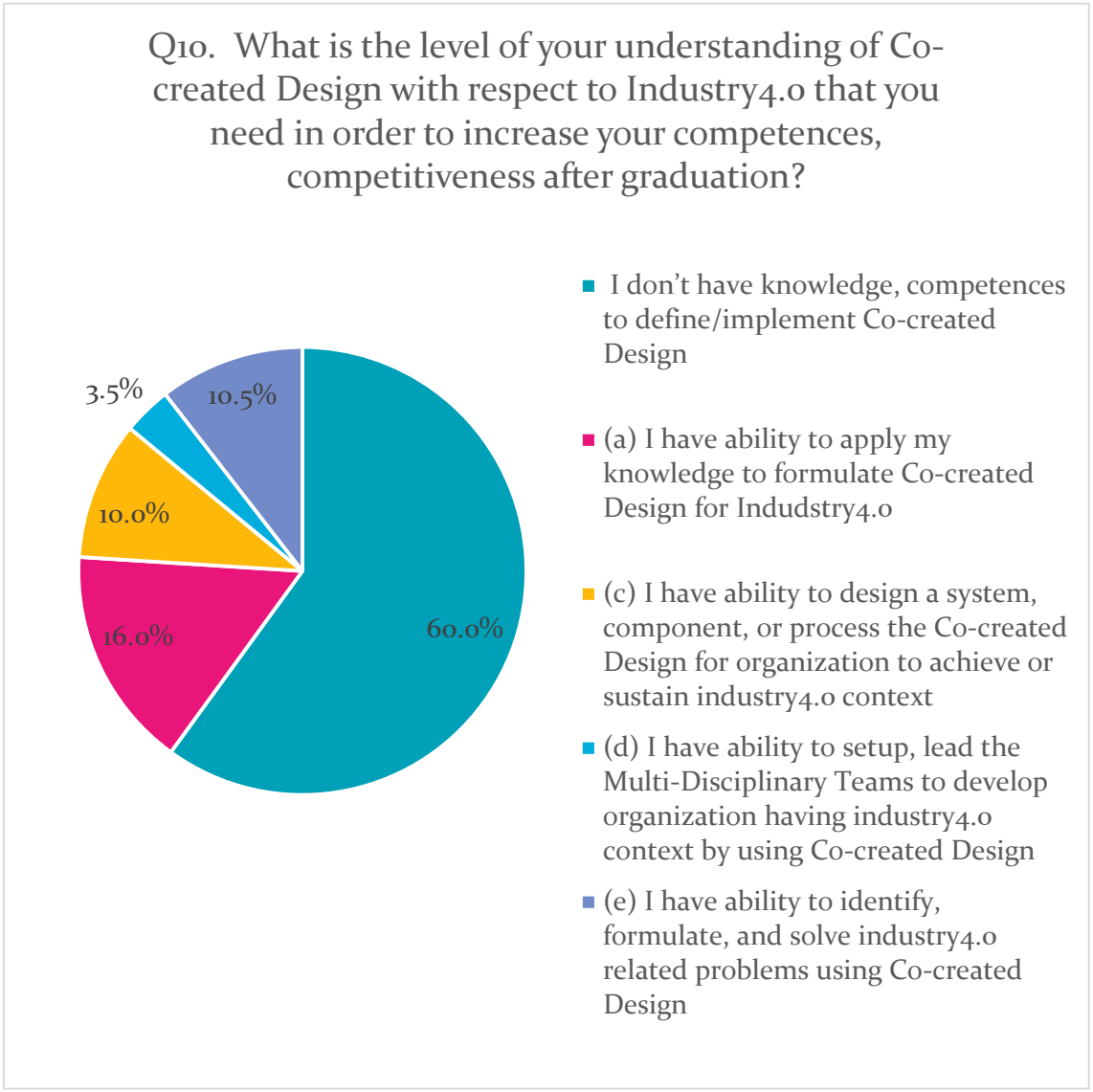


Figure 212 Q10. What is the level of your understanding of Co-created Design with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

I don't have knowledge

Figure 213 I don't have knowledge

Q11. What is the level of your understanding of Smart Digital Factory with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Smart Digital Factory for Indudstry4.0

☐ (c) I have ability to design a system, component, or process the Smart Digital Factory for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop organization having industry4.0 context by using Smart Digital Factory

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using Smart Digital Factory

☐ I don't have knowledge, competences to define/implement Smart Digital Factory

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

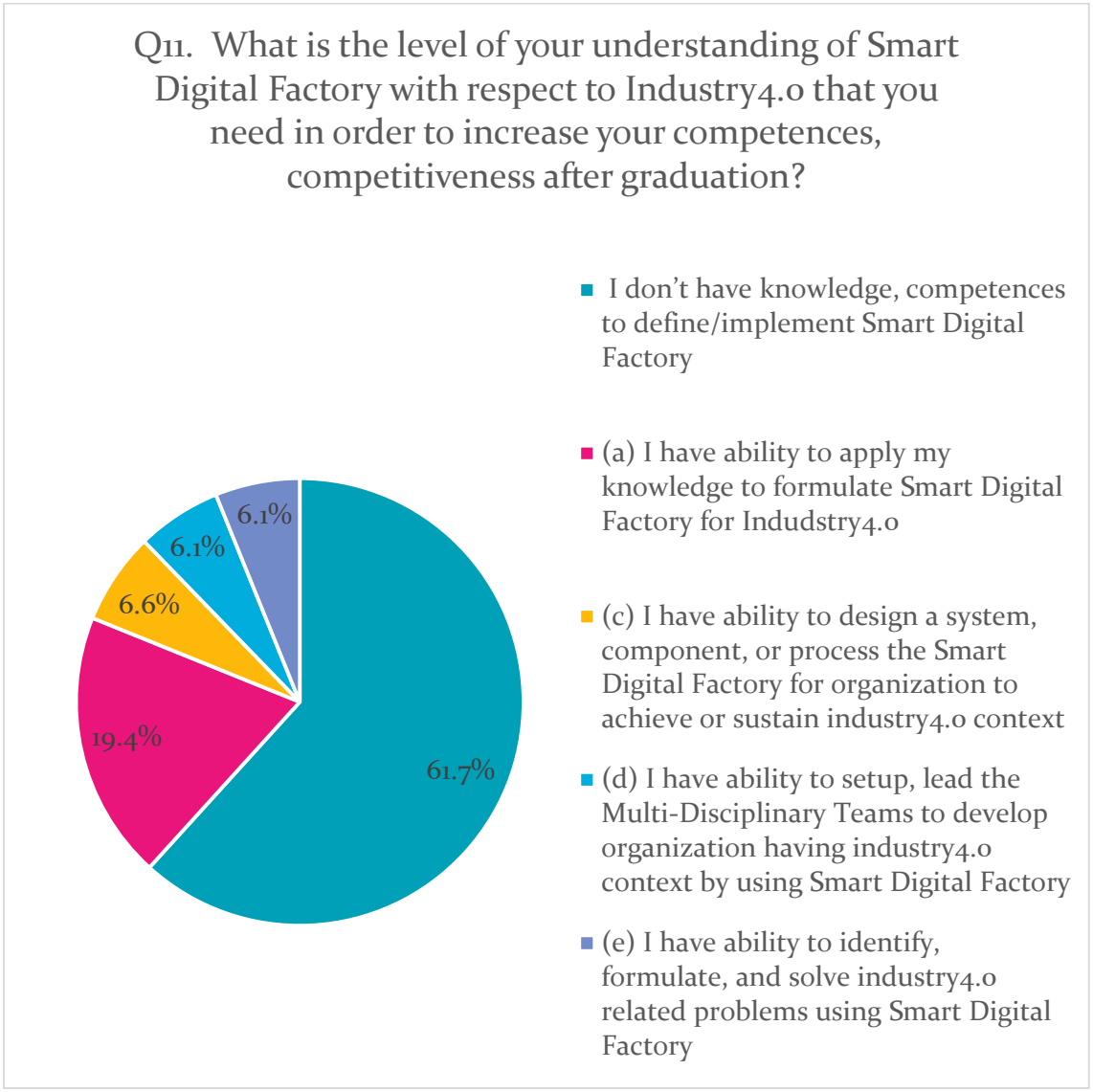


Figure 214 Q11. What is the level of your understanding of Smart Digital Factory with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

I don't have knowledge

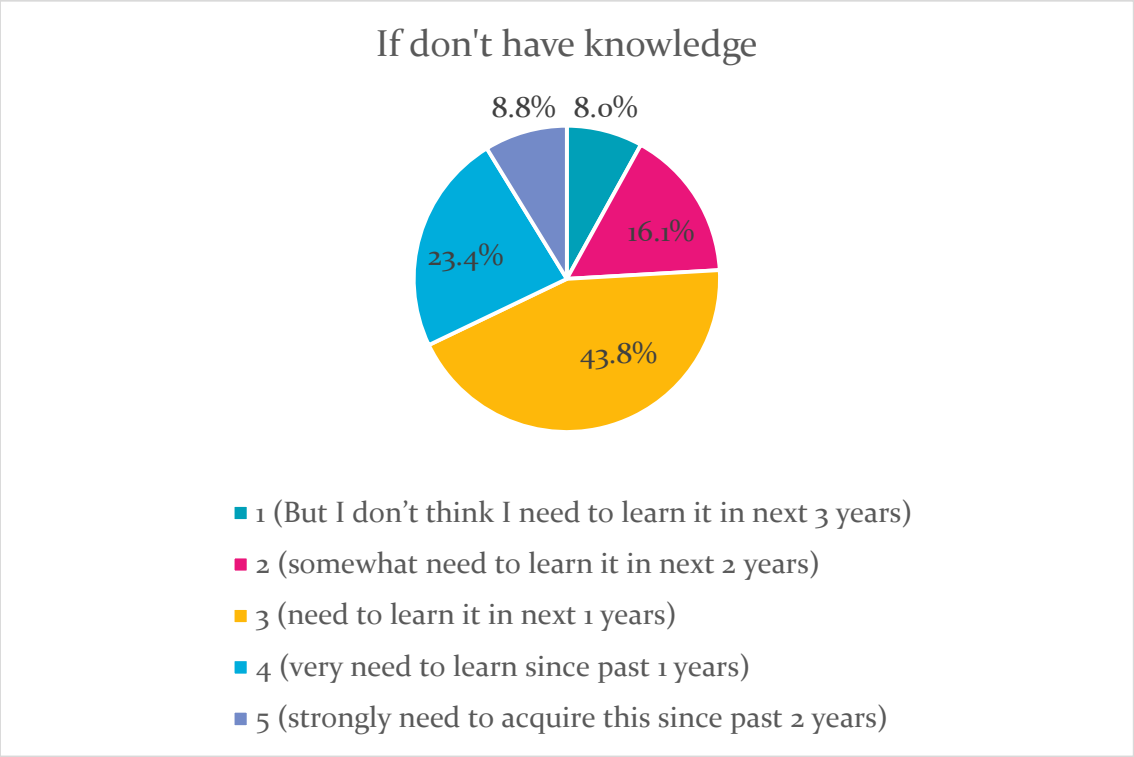


Figure 215 I don't have knowledge

Q12. What is the level of your understanding of Smart operations - Controlling, Adjusting & Monitoring Process Real Time with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Smart operations for Indudstry4.0

☐ (c) I have ability to design a system, component, or process the Smart operations for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop organization having industry4.0 context by using Smart operations

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using Smart operations

☐ I don't have knowledge, competences to define/implement Smart operations

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

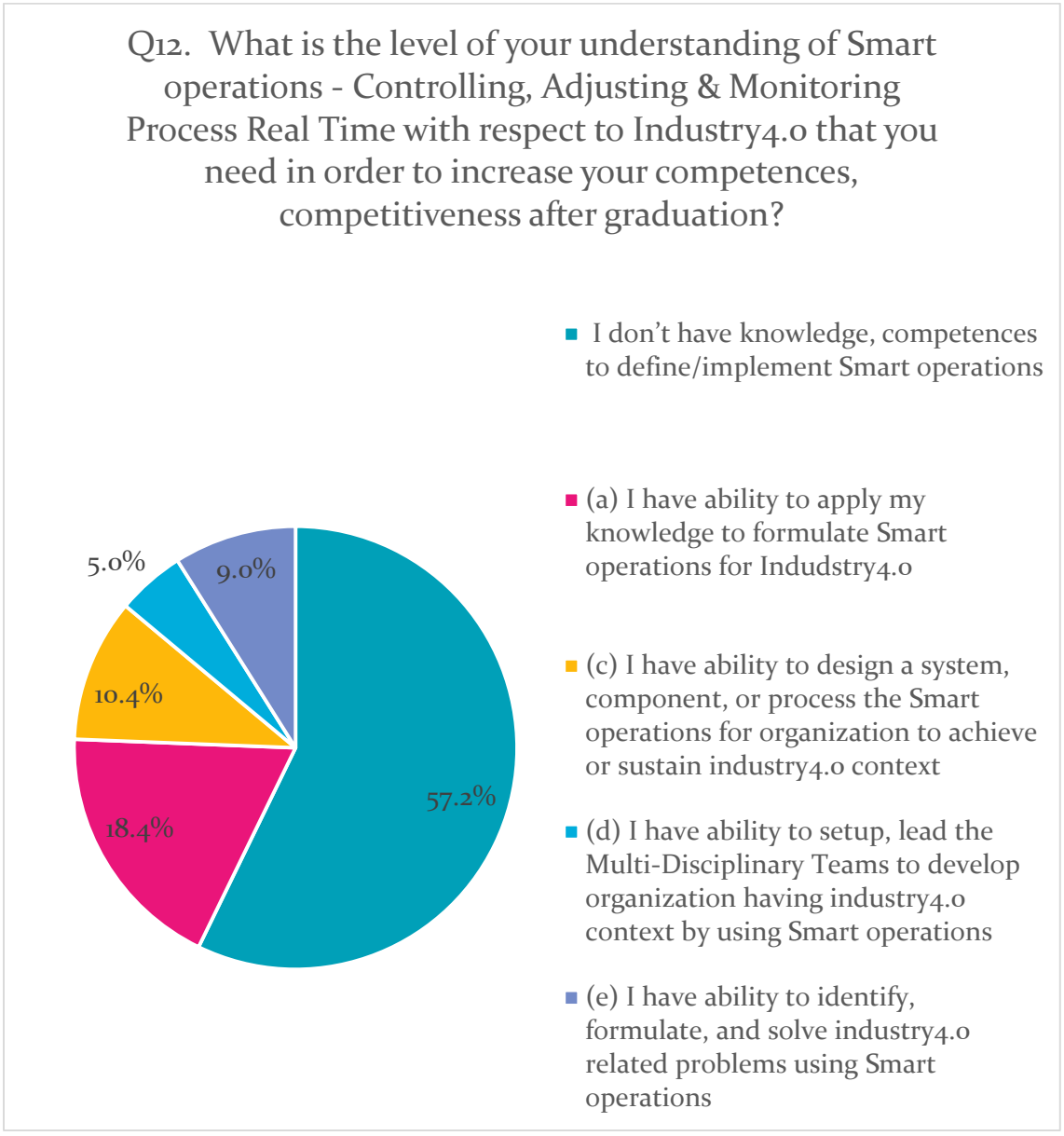


Figure 216 Q12. What is the level of your understanding of Smart operations - Controlling, Adjusting & Monitoring Process Real Time with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

I don't have knowledge

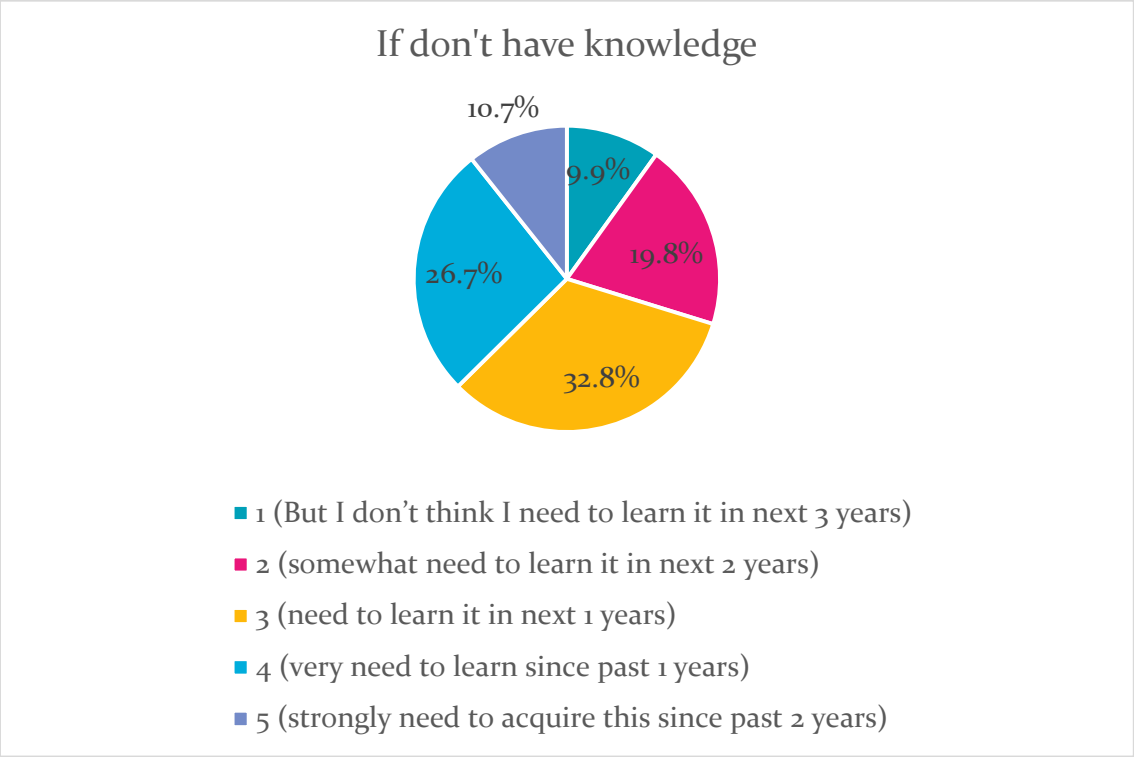


Figure 217 I don't have knowledge

Q13. What is the level of your understanding of Data-driven services-Integrated Business and Operational Data Management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Data-driven services-Integrated Business for Indudstry4.0

☐ (c) I have ability to design a system, component, or process the Data-driven services-Integrated Business for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop organization having industry4.0 context by using Data-driven services-Integrated Business

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems using Data-driven services-Integrated Business

☐ I don't have knowledge, competences to define/implement Data-driven services-Integrated Business

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

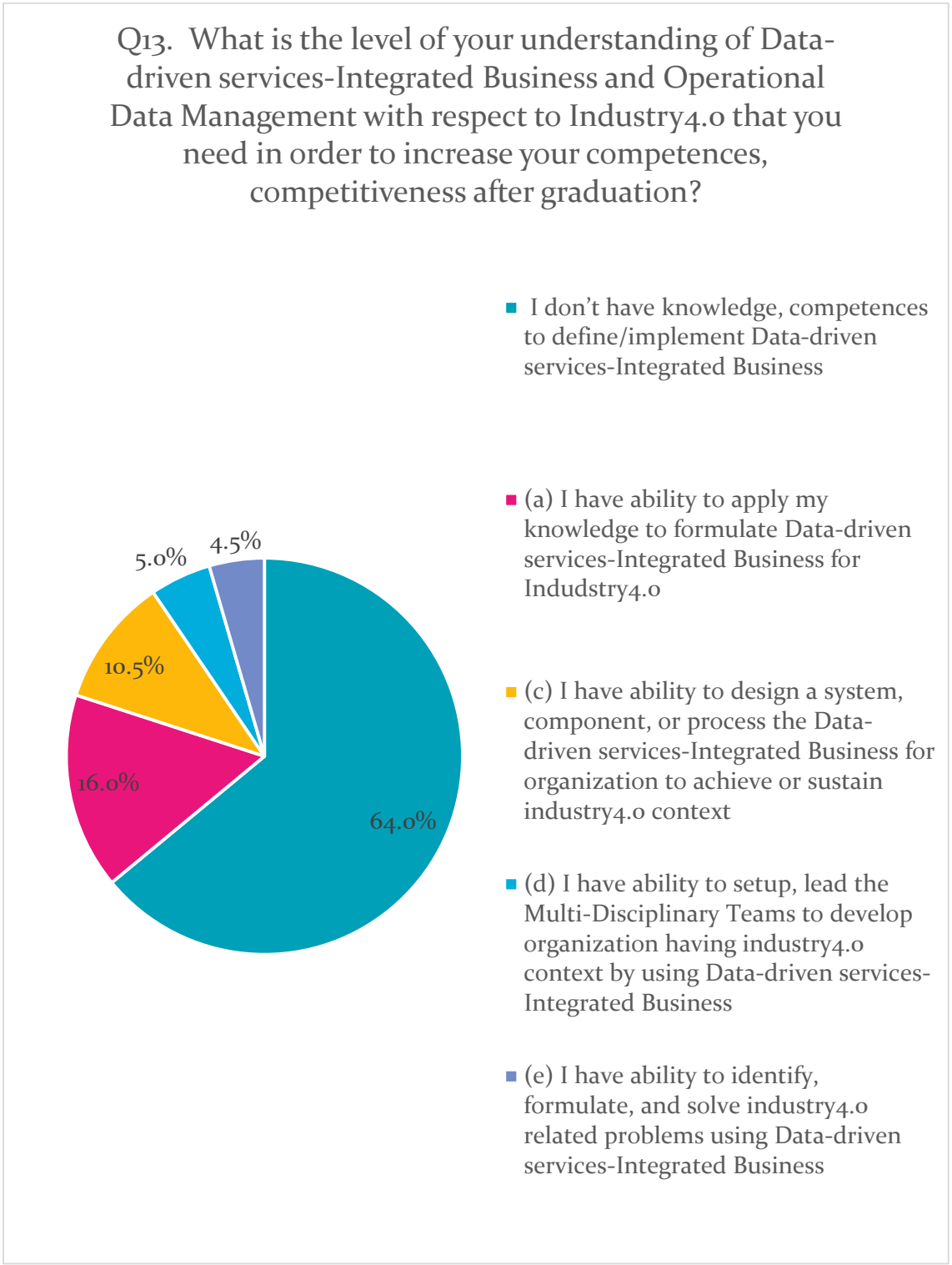


Figure 218 Q13. What is the level of your understanding of Data-driven services-Integrated Business and Operational Data Management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

I don't have knowledge

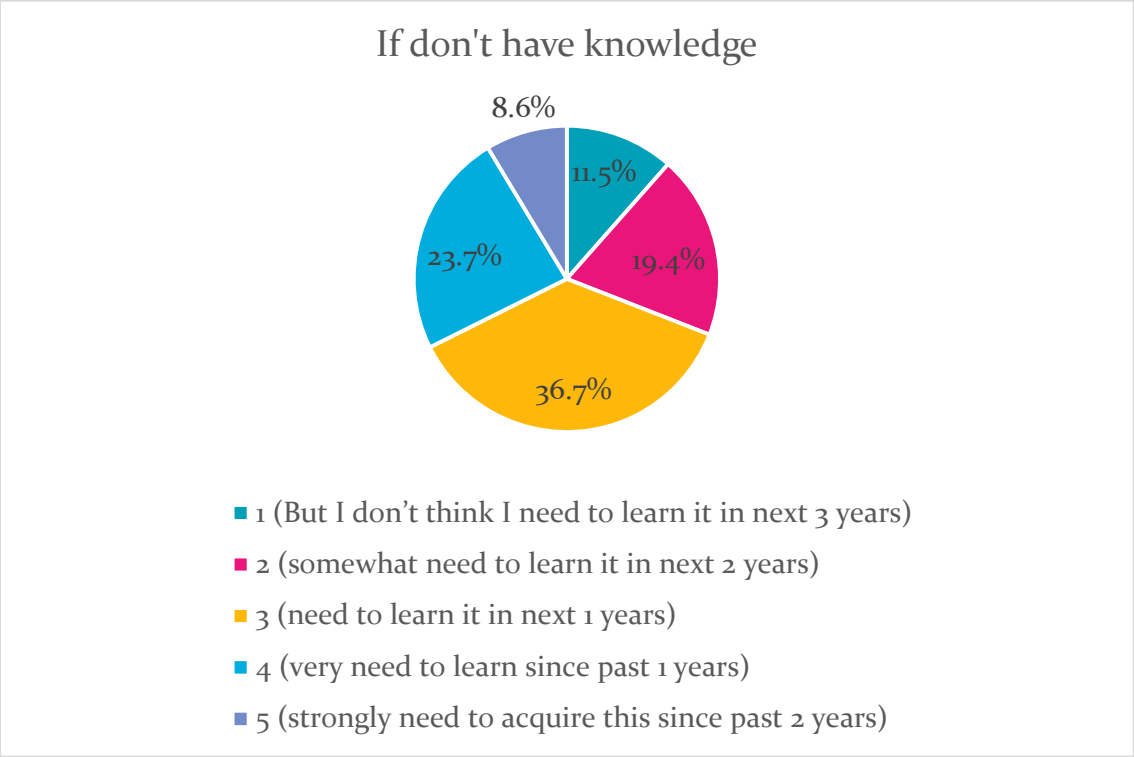


Figure 219 I don't have knowledge

Q14. What is the level of your understanding of Centralized integrative production operation management with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Centralized integrative production operation management for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Centralized integrative production operation management for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Centralized integrative production operation management for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems of Centralized integrative production operation management

☐ I don't have knowledge, competences to define/implement Centralized integrative production operation

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

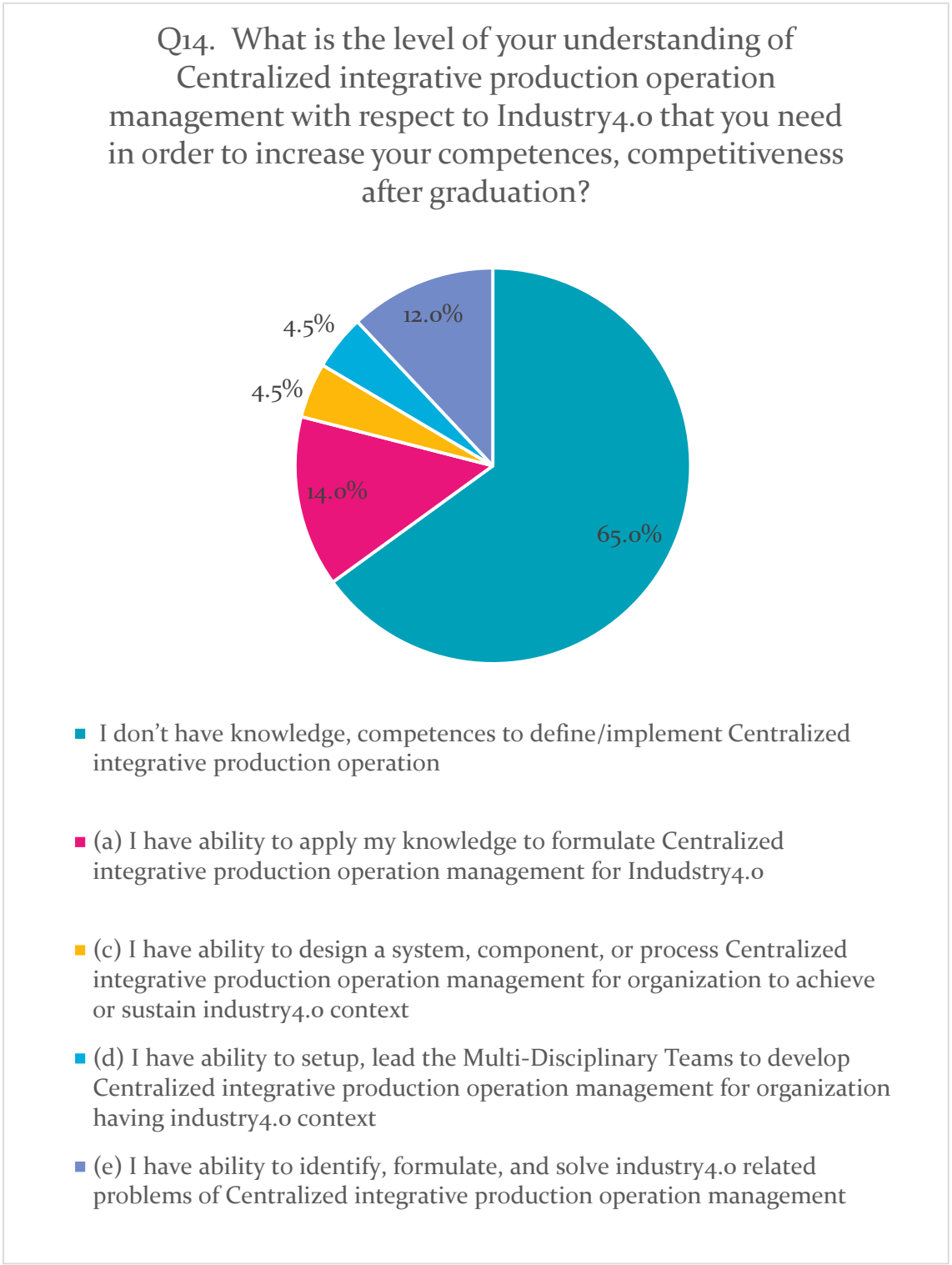


Figure 220 Q14. What is the level of your understanding of Centralized integrative production operation management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

I don't have knowledge

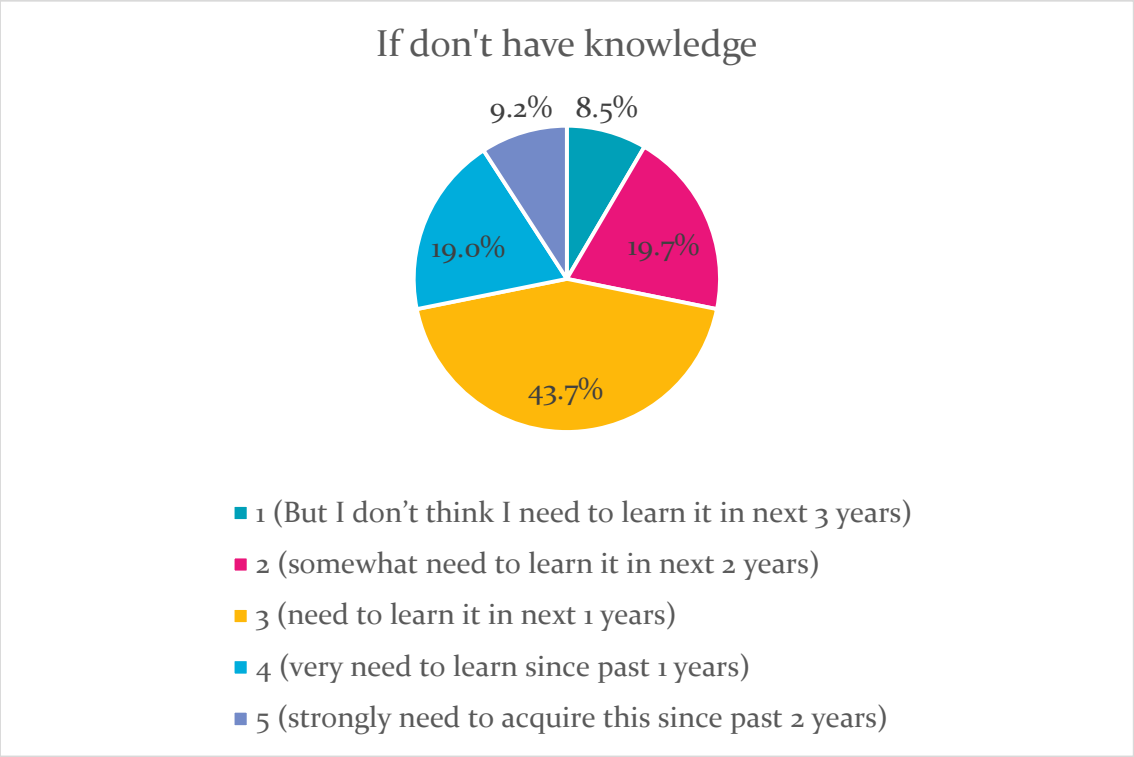


Figure 221 I don't have knowledge

Q15. What is the level of your understanding of Digitization life cycle production management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Digitization life cycle production management for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Digitization life cycle production management for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Digitization life cycle production management for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems of Digitization life cycle production management

☐ I don't have knowledge, competences to define/implement Digitization life cycle production management

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

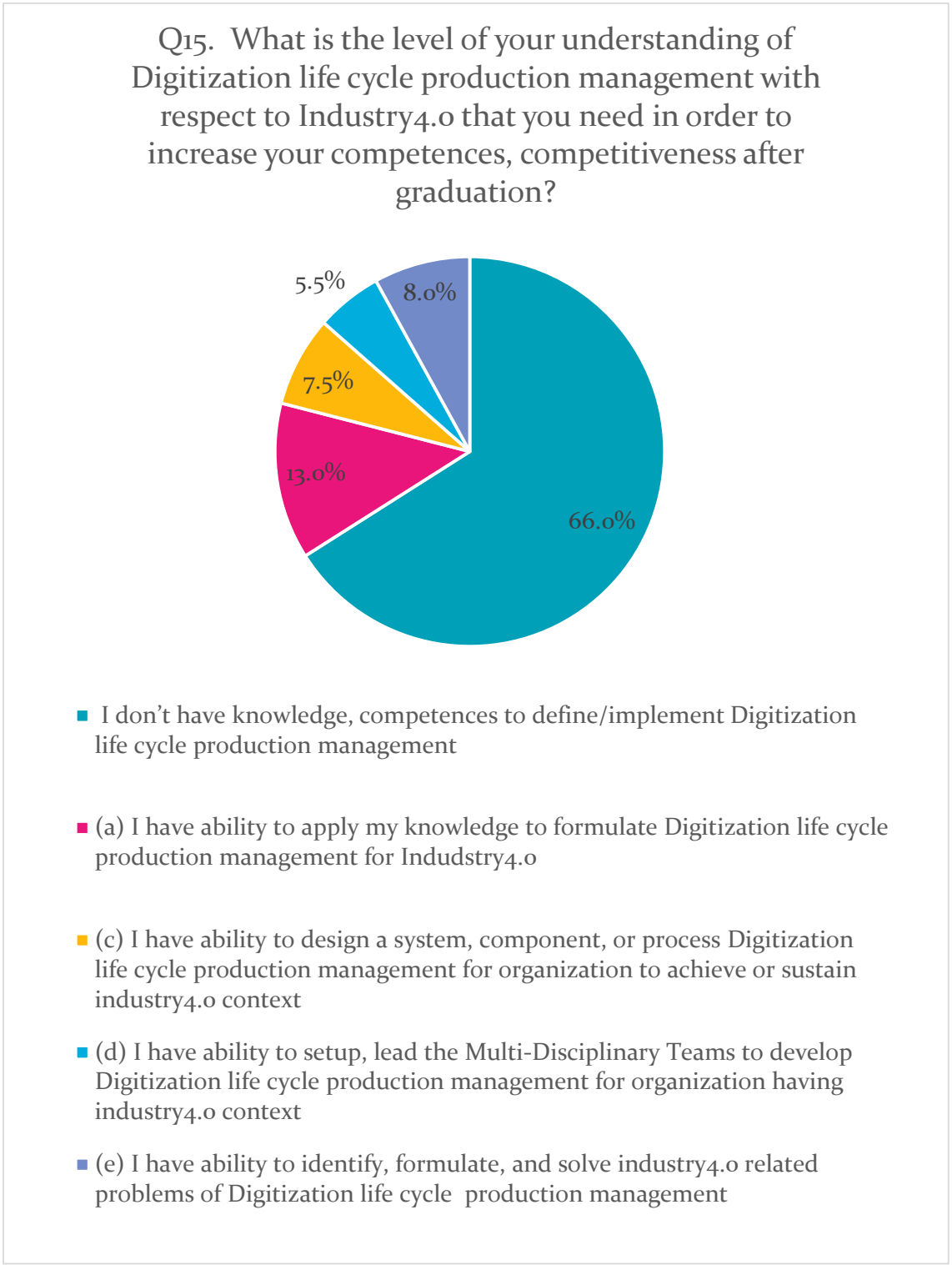


Figure 222 Q15. What is the level of your understanding of Digitization life cycle production management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

I don't have knowledge

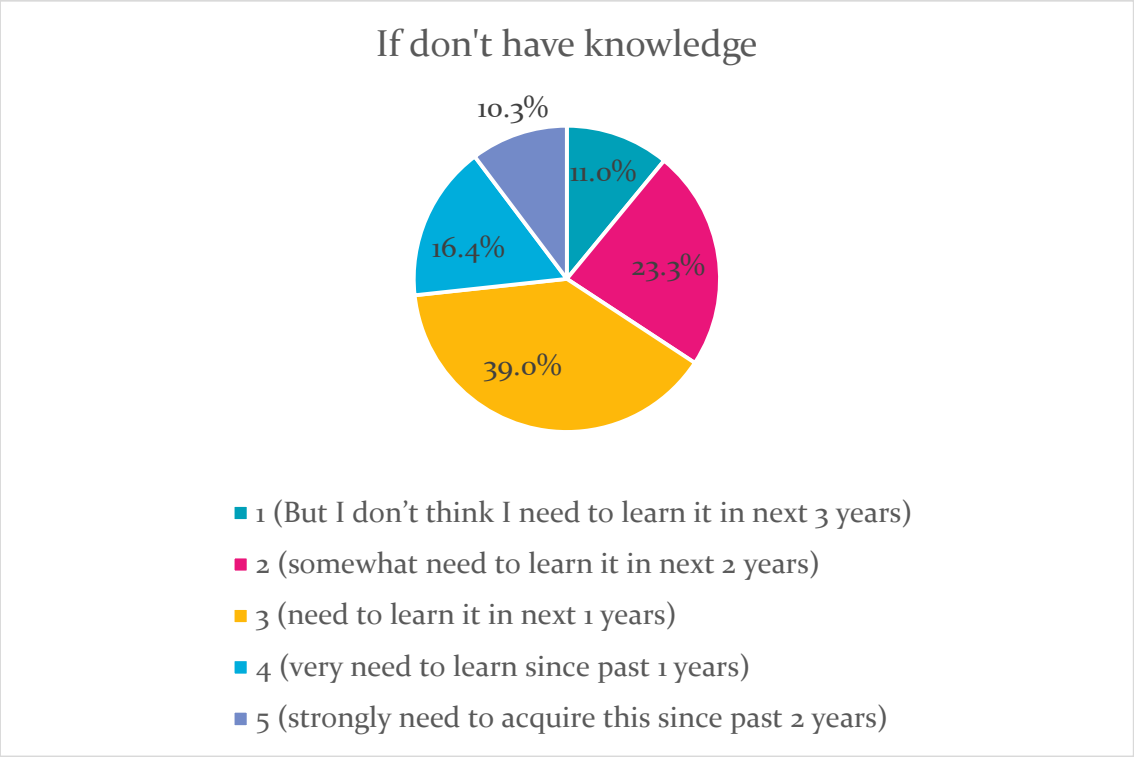


Figure 223 I don't have knowledge

Q16. What is the level of your understanding of Modern Quality Management with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Modern Quality Management for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Modern Quality Management for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Modern Quality Management for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems of Modern Quality Management

☐ I don't have knowledge, competences to define/implement Modern Quality Management

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

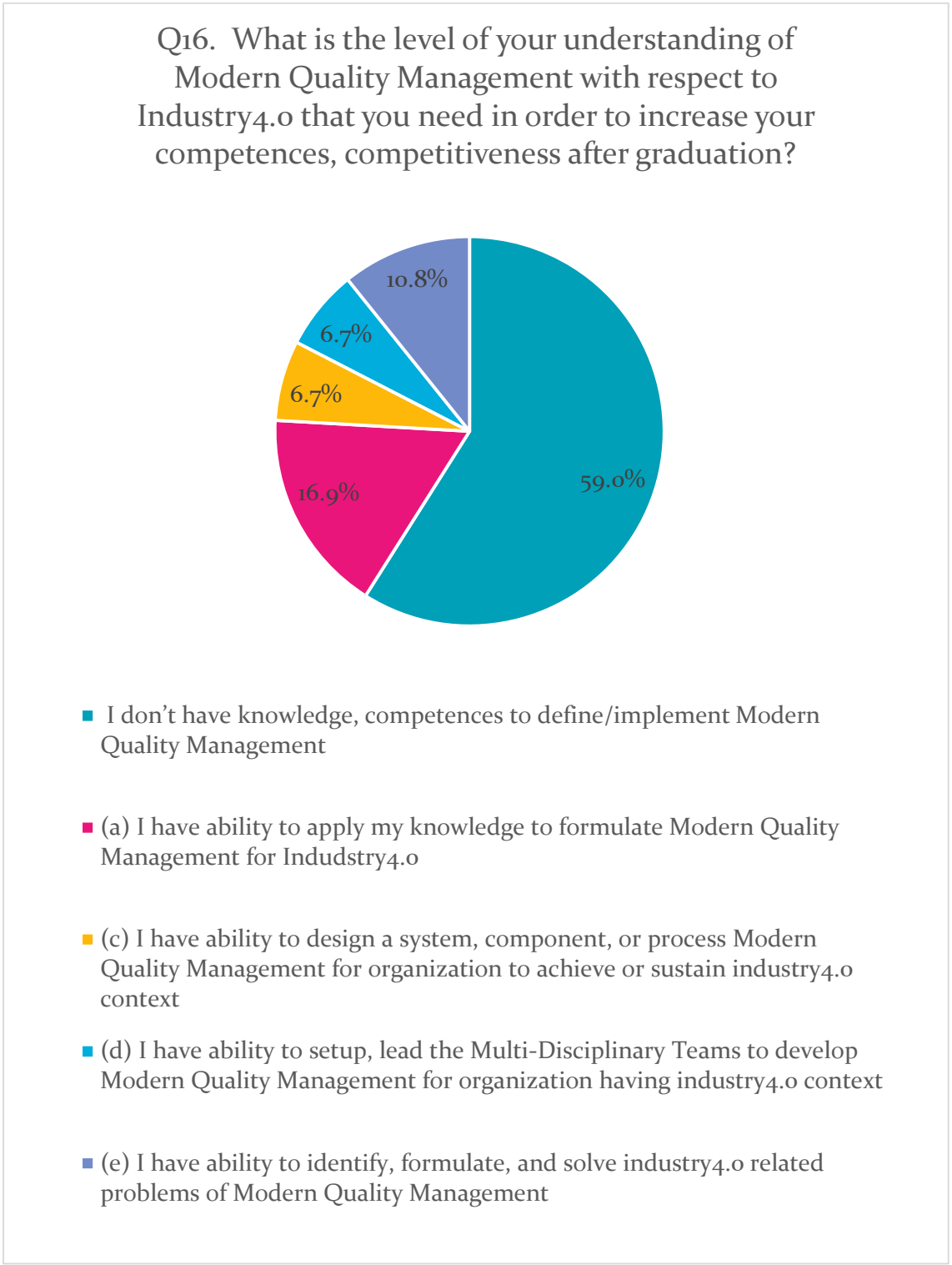


Figure 224 Q16. What is the level of your understanding of Modern Quality Management with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

I don't have knowledge

Figure 225 I don't have knowledge

Q17. What is the level of your understanding of Modern Supply Chain & Logistics Management with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Modern Supply Chain & Logistics Management for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Modern Supply Chain & Logistics Management for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Modern Supply Chain & Logistics Management for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems of Modern Supply Chain&Logistics Management

☐ I don't have knowledge, competences to define/implement Modern Supply Chain & Logistics Management

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

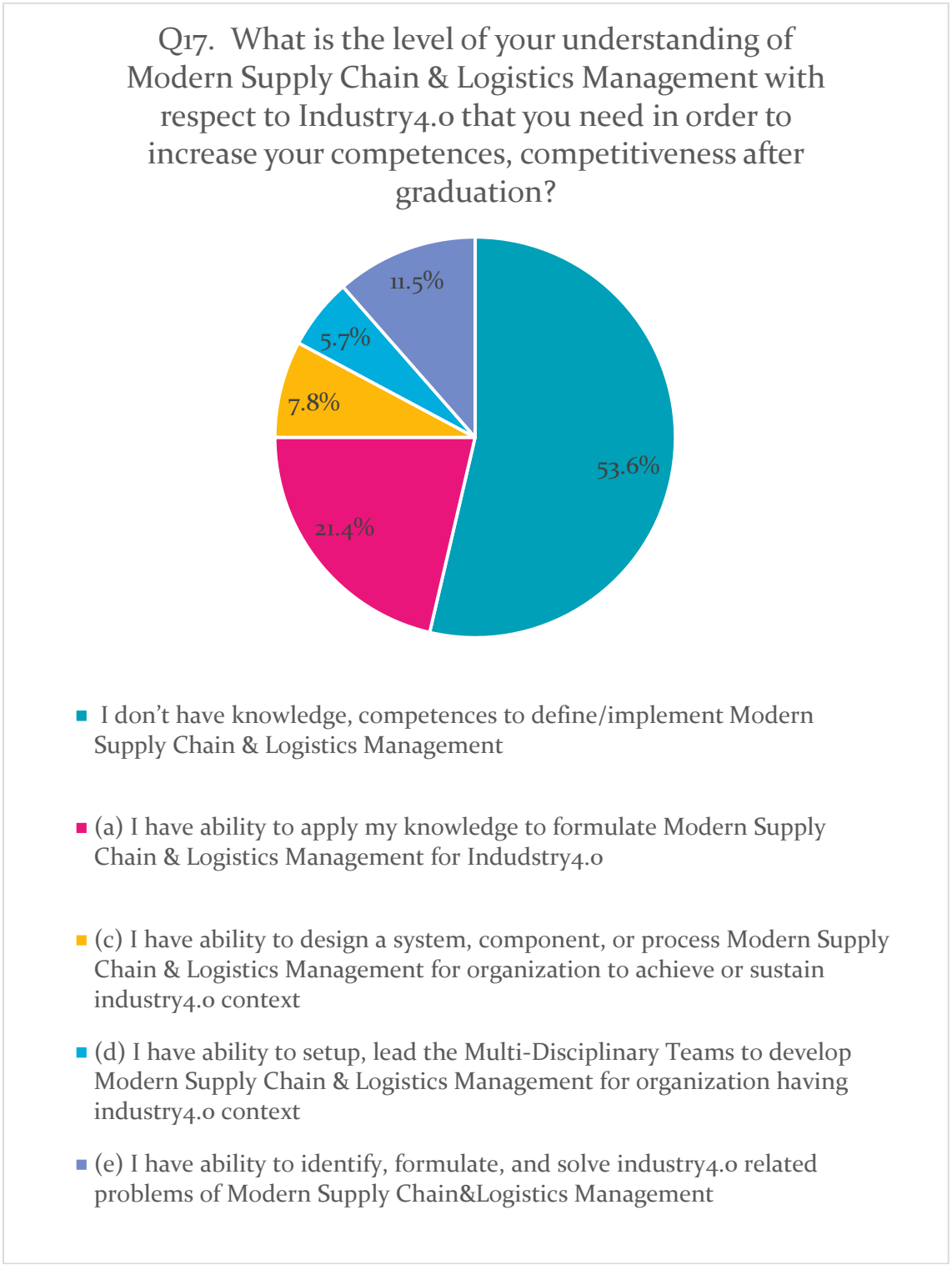


Figure 226 Q17. What is the level of your understanding of Modern Supply Chain & Logistics Management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

I don't have knowledge

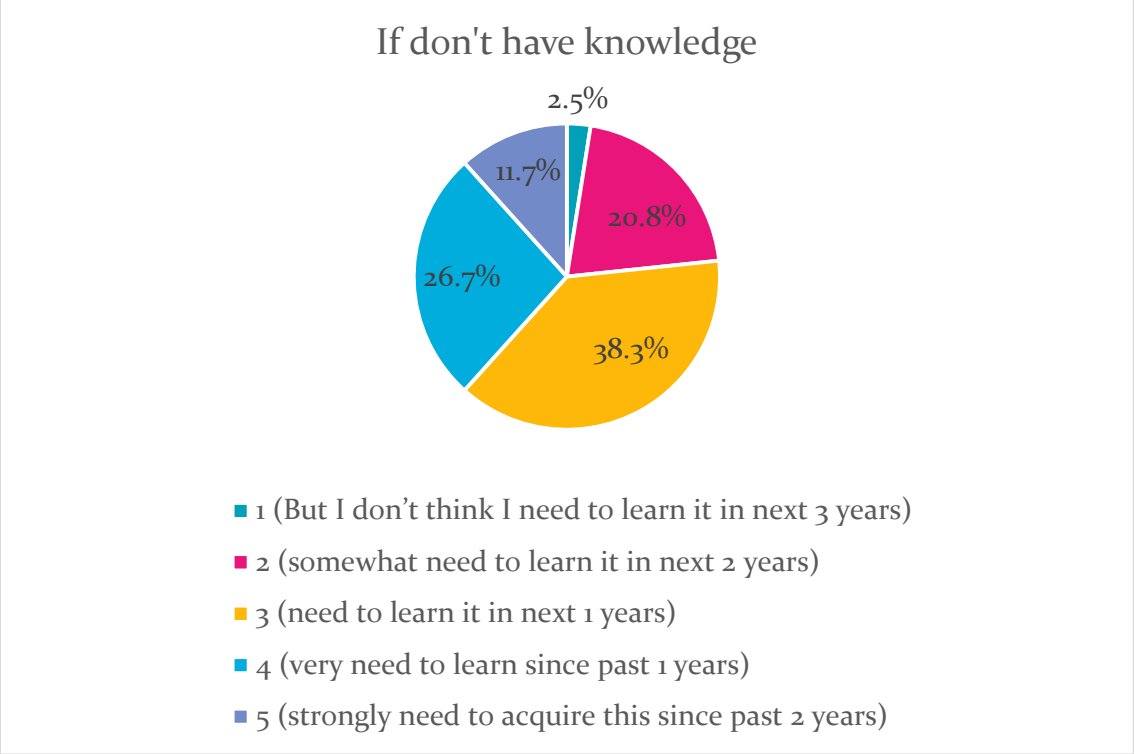


Figure 227 I don't have knowledge

Q18. What is the level of your understanding of Modern Preventive/Predictive Maintenance Management with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Modern Preventive/Predictive Maintenance Management for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Modern Preventive/Predictive Maintenance Management for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Modern Preventive/Predictive Maintenance Management for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems of Modern Preventive/Predictive Maintenance Management

☐ I don't have knowledge, competences to define/implement Modern Preventive/Predictive Maintenance Management

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

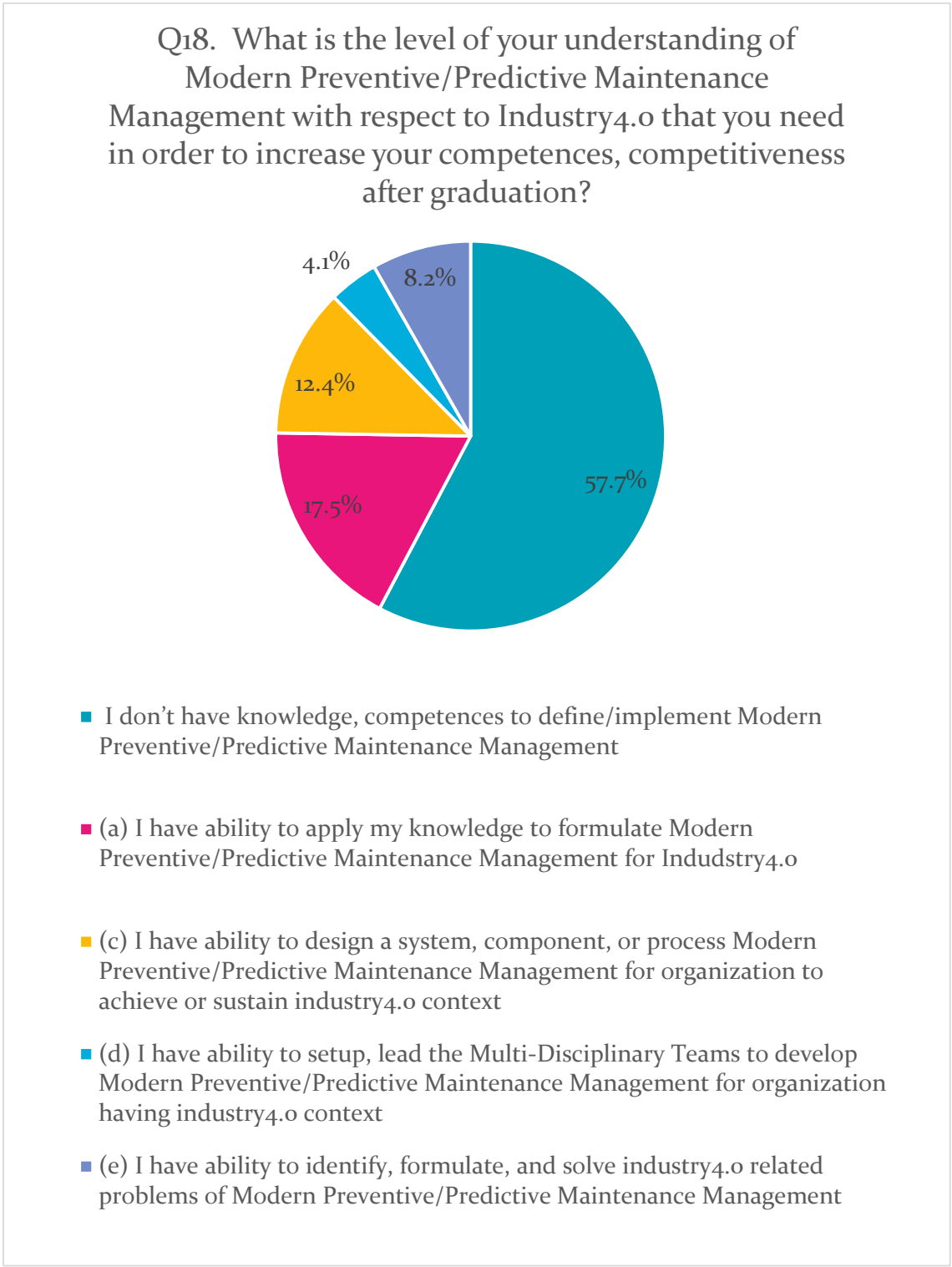


Figure 228 Q18. What is the level of your understanding of Modern Preventive/Predictive Maintenance Management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

I don't have knowledge

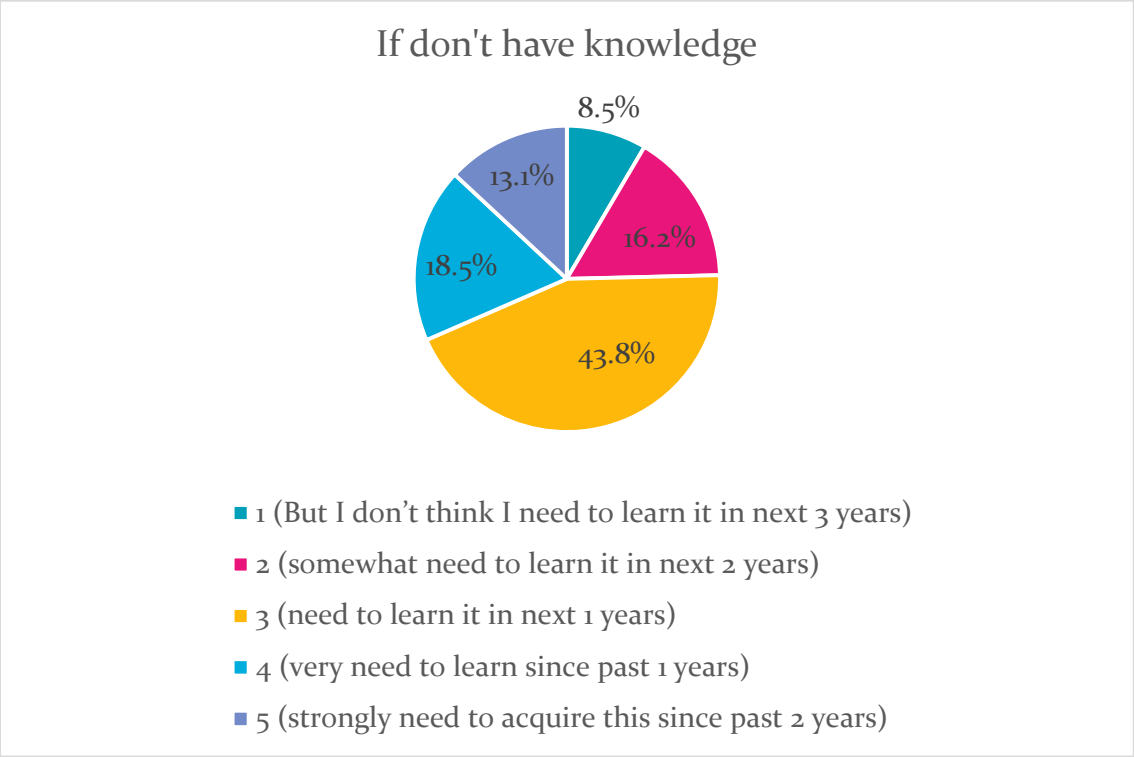


Figure 229 I don't have knowledge

Q19. What is the level of your understanding of Modern Business & Organizational Management for sustainabity with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ (a) I have ability to apply my knowledge to formulate Modern Business & Organizational Management for sustainabity for Indudstry4.0

☐ (c) I have ability to design a system, component, or process Modern Business & Organizational Management for sustainabity for organization to achieve or sustain industry4.0 context

☐ (d) I have ability to setup, lead the Multi-Disciplinary Teams to develop Modern Business & Organizational Management for sustainabity for organization having industry4.0 context

☐ (e) I have ability to identify, formulate, and solve industry4.0 related problems of Modern Business & Organizational Management for sustainabity

☐ I don't have knowledge, competences to define/implement Modern Business & Organizational Management for sustainabity

☐ 1 (But I don't think I need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

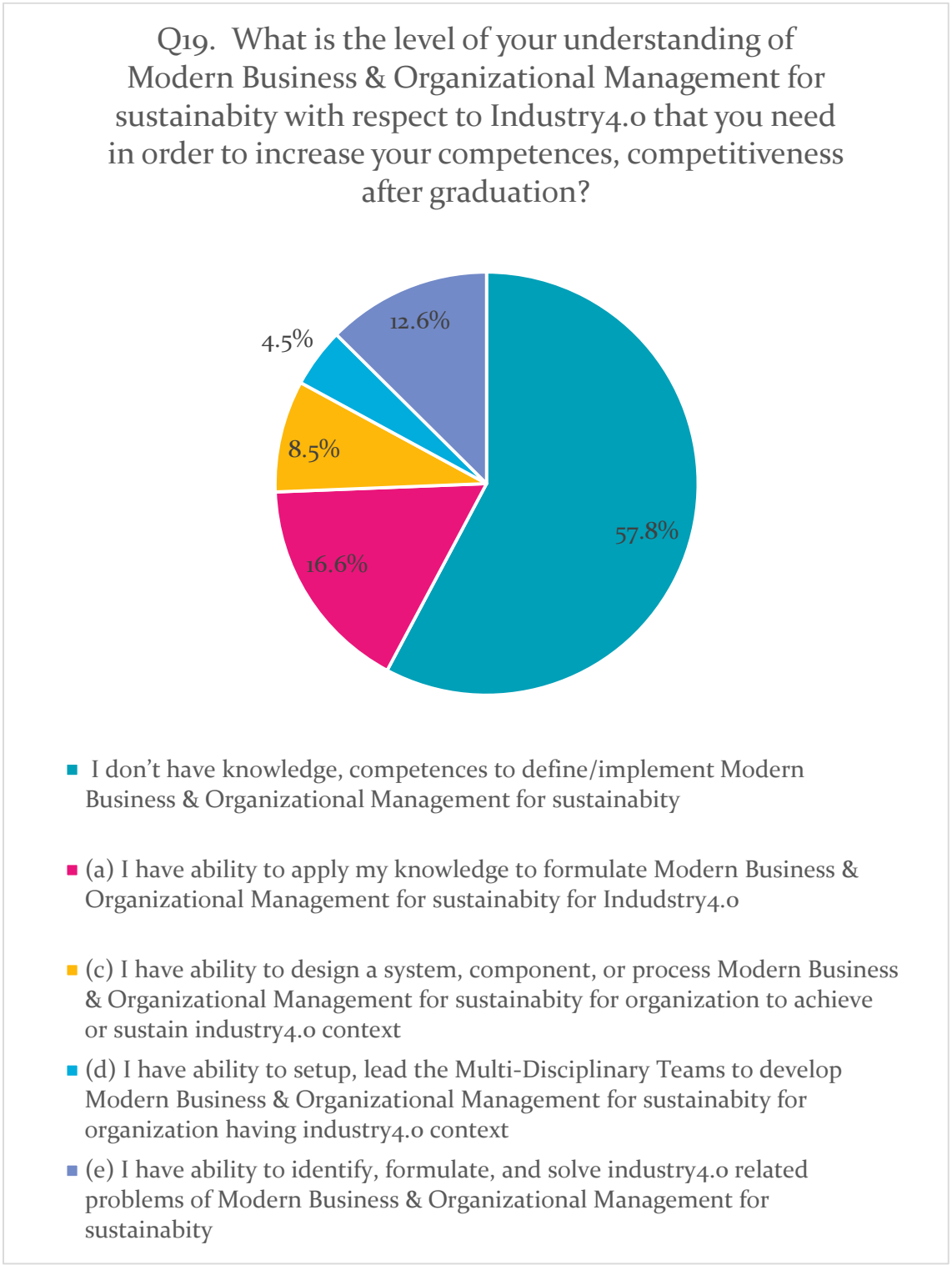


Figure 230 Q19. What is the level of your understanding of Modern Business & Organizational Management for sustainabity with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

I don't have knowledge

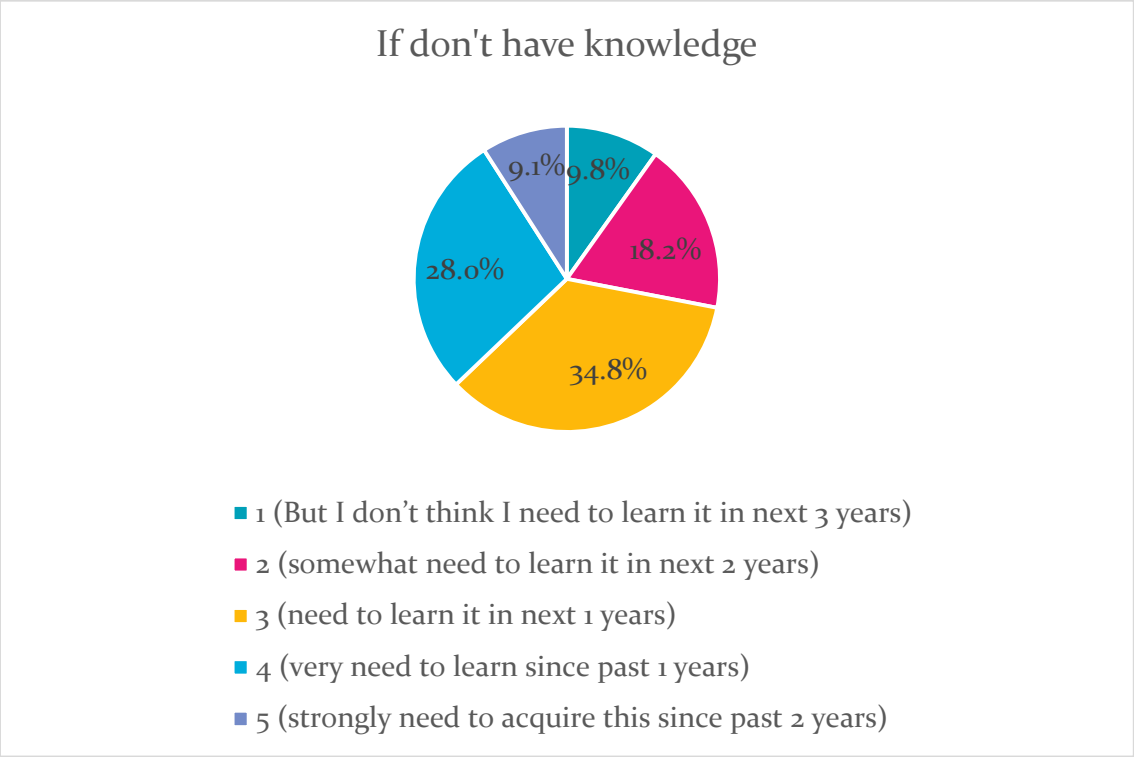


Figure 231 I don't have knowledge

PART 3: CHARACTER QUALITY (SELECT ONLY 1 ANSWER)

Q20. What is the level of your needs to understand Legal affairs and sustainability with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

- ☐ 1 (we are not need to learn it in next 3 years)
- ☐ 2 (**somewhat** need to learn it in next 2 years)
- ☐ 3 (need to learn it in next 1 years)
- ☐ 4 (**very** need to learn since past 1 years)
- ☐ 5 (**strongly** need to acquire this since past 2 years)

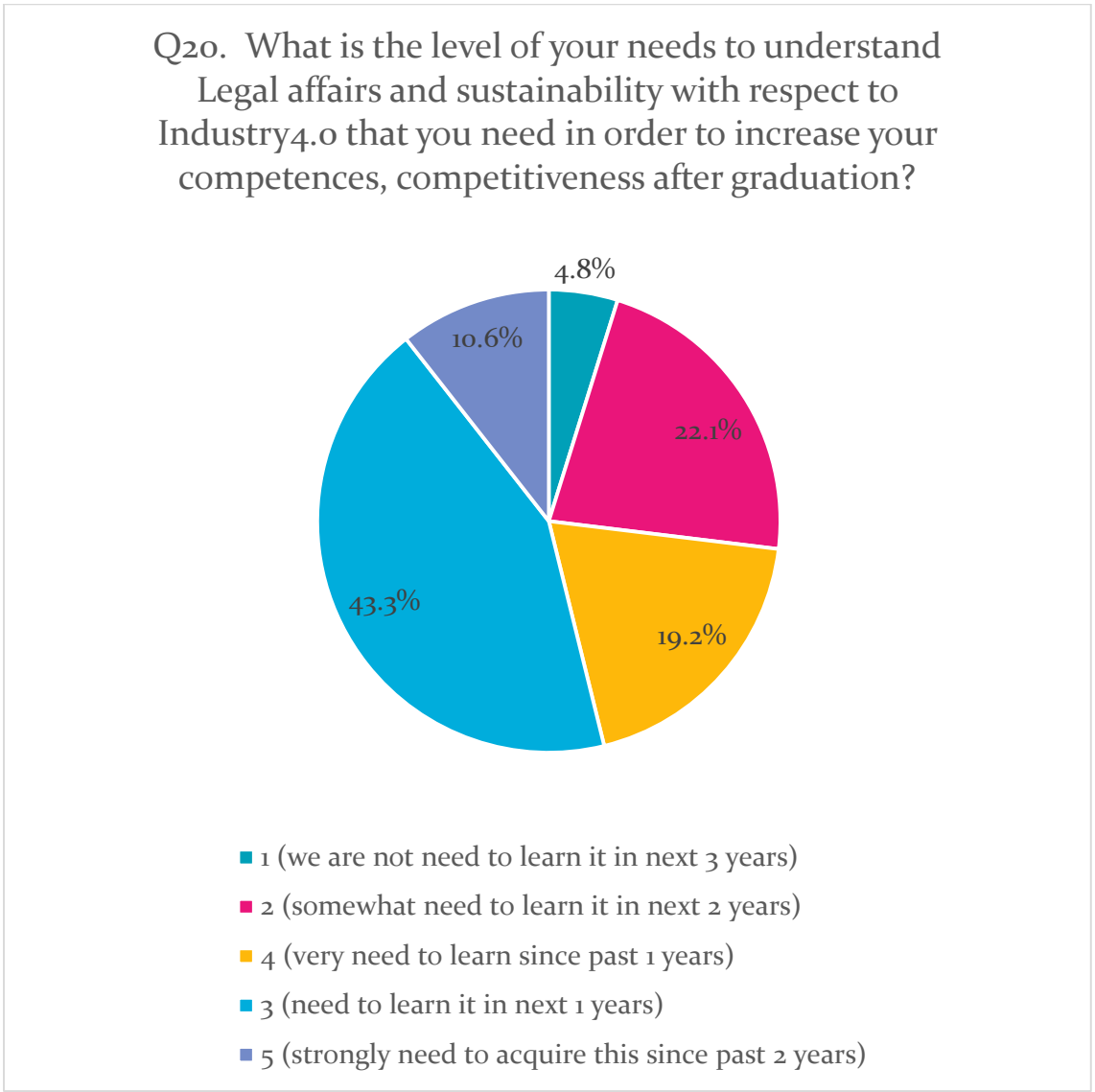


Figure 232 Q20. What is the level of your needs to understand Legal affairs and sustainability with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

Q21. What is the level of your needs to understand self and time management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

- ☐ 1 (we are not need to learn it in next 3 years)
- ☐ 2 (**somewhat** need to learn it in next 2 years)
- ☐ 3 (need to learn it in next 1 years)
- ☐ 4 (**very** need to learn since past 1 years)
- ☐ 5 (**strongly** need to acquire this since past 2 years)

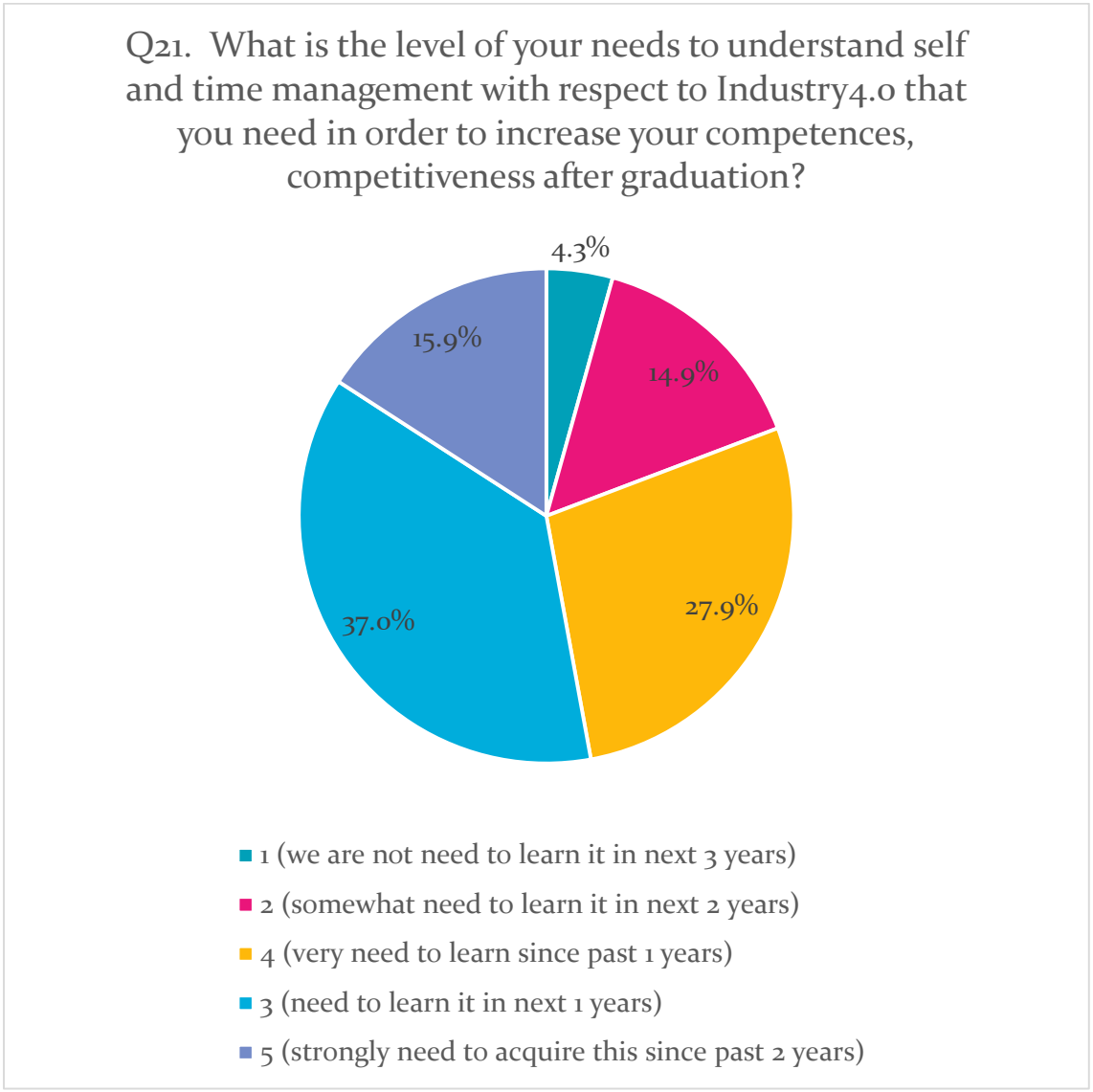


Figure 233 Q21. What is the level of your needs to understand self and time management with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

Q22. What is the level of your needs to understand adaptability and ability to change in new technologies with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ 1 (we are not need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

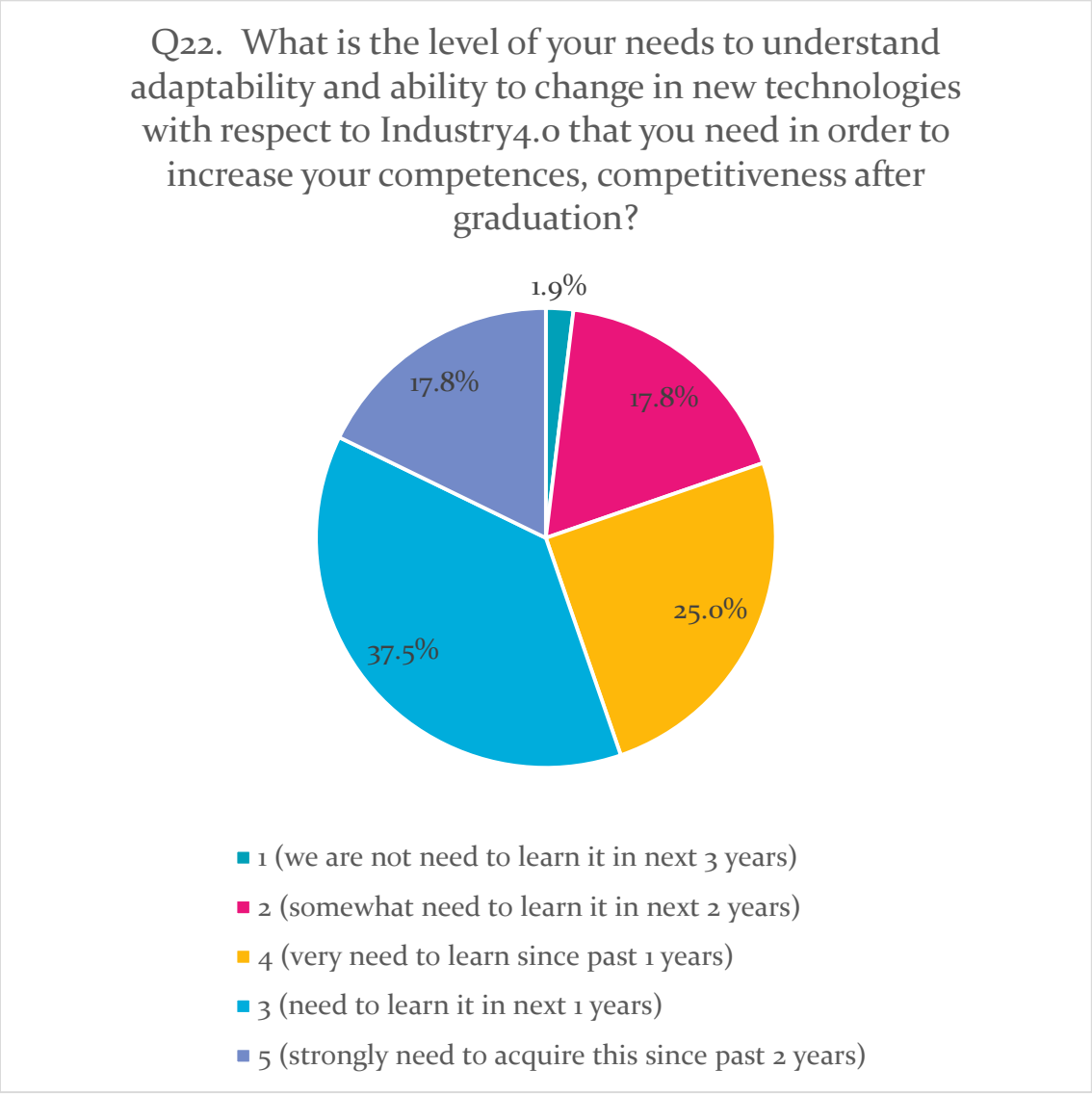


Figure 234 Q22. What is the level of your needs to understand adaptability and ability to change in new technologies with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

Q23. What is the level of your needs to understand team working abilities with respect to Industry4.0 that you <u>need</u> in order to increase your competences, competitiveness after graduation?

- ☐ 1 (we are not need to learn it in next 3 years)
- ☐ 2 (**somewhat** need to learn it in next 2 years)
- ☐ 3 (need to learn it in next 1 years)
- ☐ 4 (**very** need to learn since past 1 years)
- ☐ 5 (**strongly** need to acquire this since past 2 years)

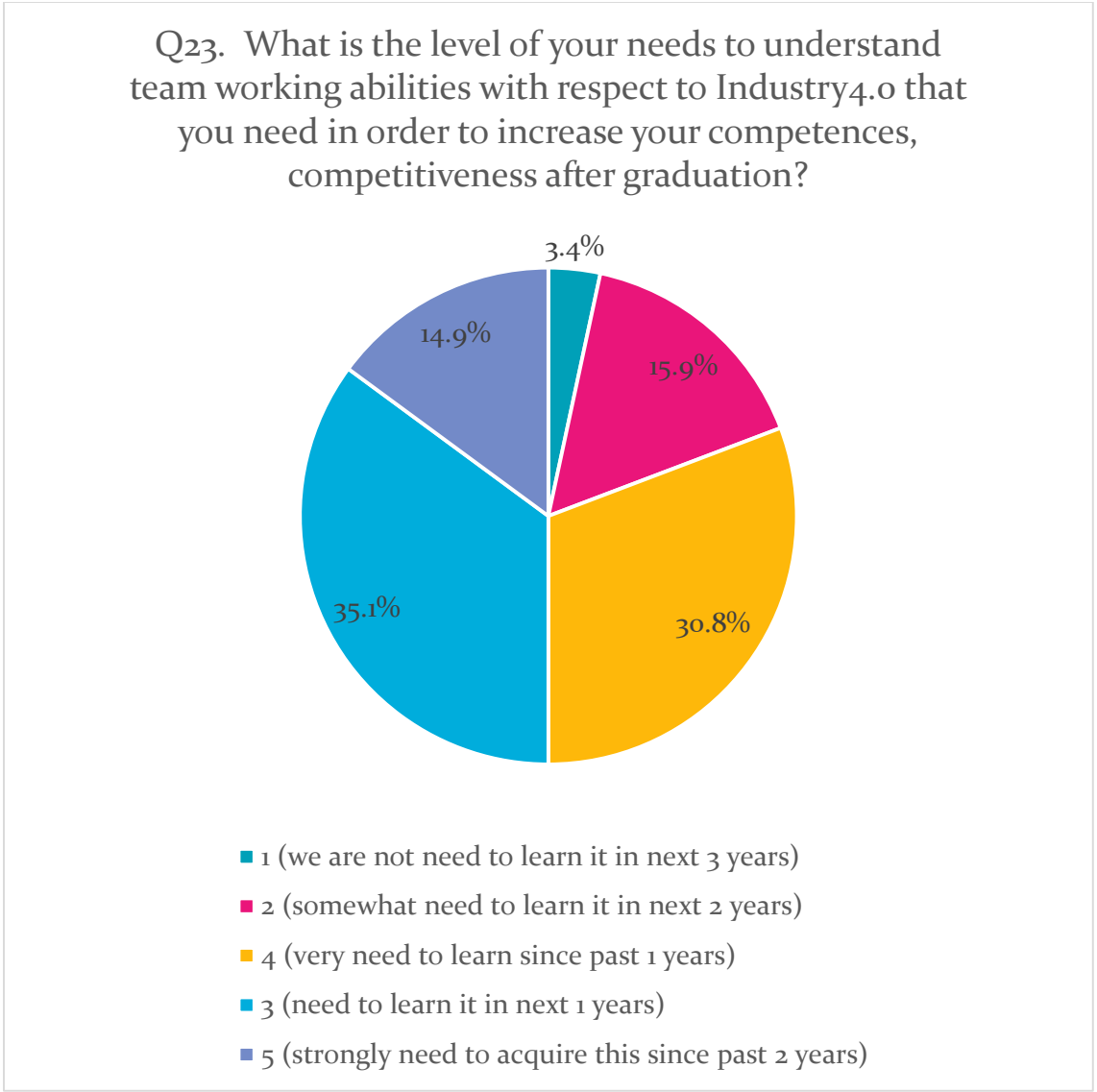


Figure 235 Q23. What is the level of your needs to understand team working abilities with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

Q24. What is the level of your needs to understand social skills with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

- ☐ 1 (we are not need to learn it in next 3 years)
- ☐ 2 (**somewhat** need to learn it in next 2 years)
- ☐ 3 (need to learn it in next 1 years)
- ☐ 4 (**very** need to learn since past 1 years)
- ☐ 5 (**strongly** need to acquire this since past 2 years)

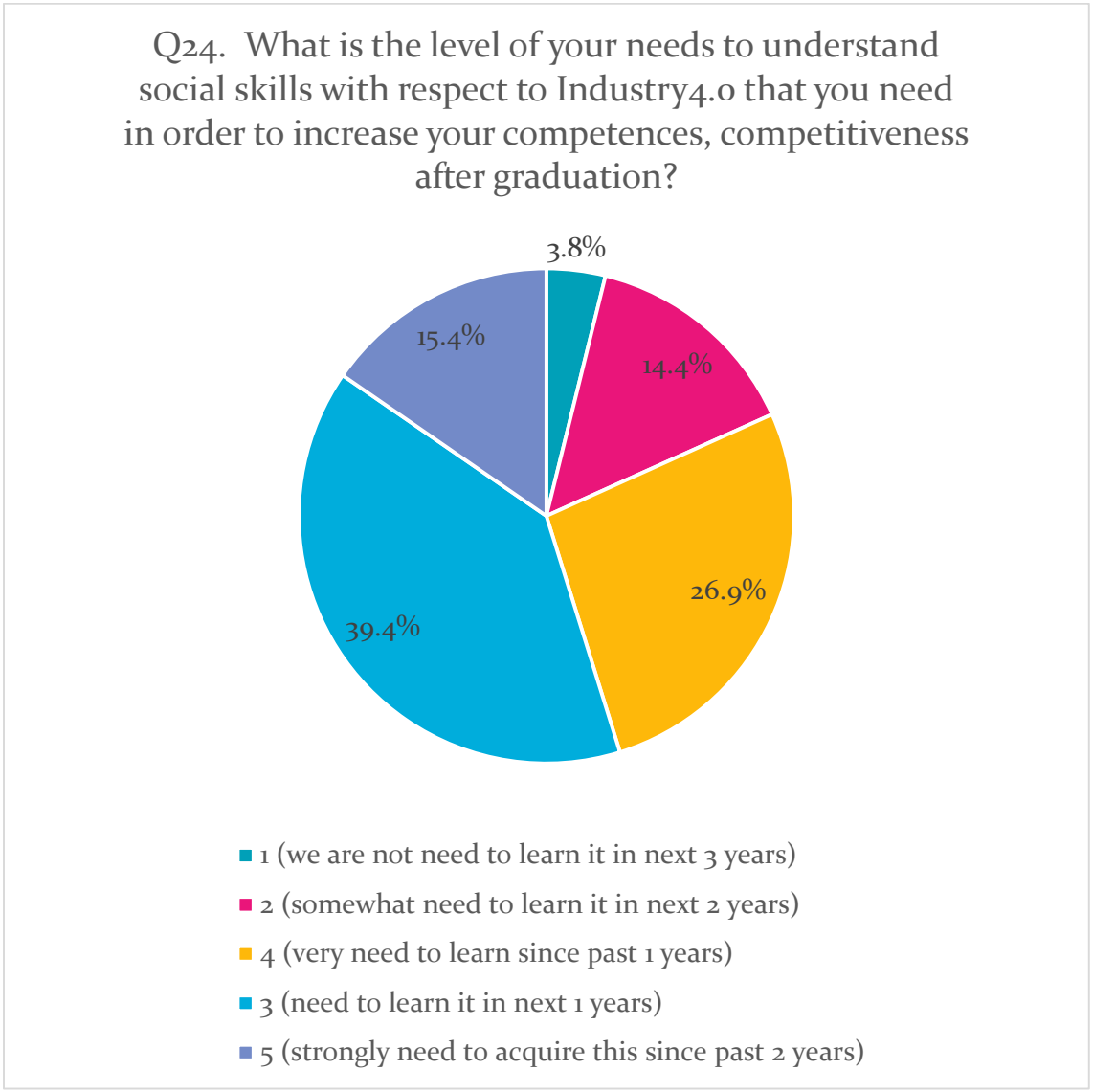


Figure 236 Q24. What is the level of your needs to understand social skills with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

Q25. What is the level of your needs to understand Communication skills with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?

☐ 1 (we are not need to learn it in next 3 years)

☐ 2 (**somewhat** need to learn it in next 2 years)

☐ 3 (need to learn it in next 1 years)

☐ 4 (**very** need to learn since past 1 years)

☐ 5 (**strongly** need to acquire this since past 2 years)

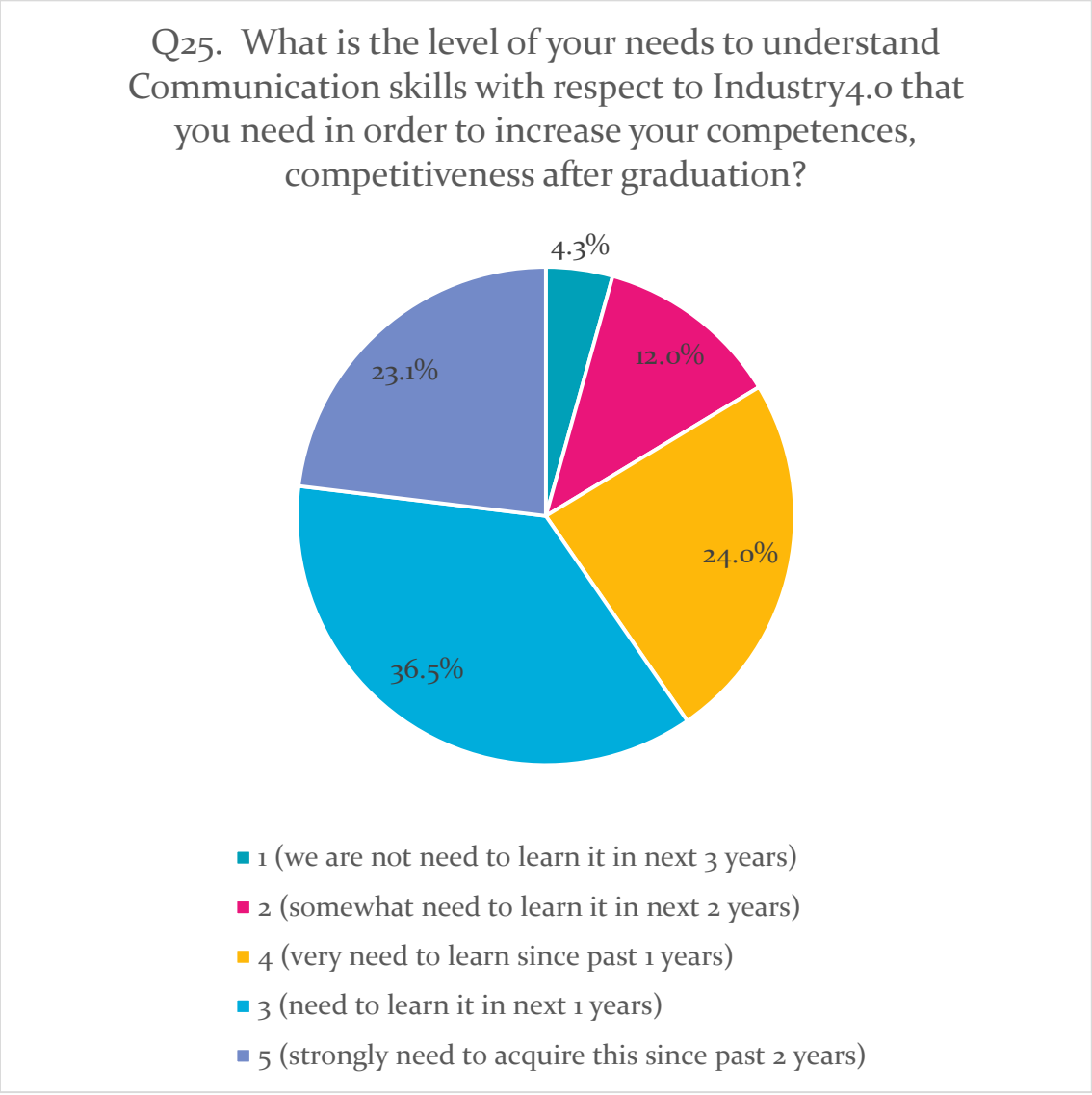


Figure 237 Q25. What is the level of your needs to understand Communication skills with respect to Industry4.0 that you need in order to increase your competences, competitiveness after graduation?