Information management – a skills gap?

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Purpose

The aim of this paper is to explore very recent data about how large organizations are dealing with a shortage of information and communications technology (ICT) specialists, in terms of its implications for information management.

Design/methodology/approach

This paper is based on qualitative interview-based research with eleven large European companies, with an estimated ICT workforce of around 400,000 (about 14% of ICT professionals in Europe), covering hiring, retention, and upskilling of ICT staff, and expectations concerning graduates from European universities. This data is combined with IDC analyst reports on the demand for different categories of ICT products and services, and data from the authors' consulting work.

Findings

Larger organizations expect hiring to be a challenge, with strong competition for talent, whether from existing users or from the many rapidly digitalizing companies – digitalizing their organizations, their products and services, and their relationships with customer, suppliers and business partners. Upskilling and retraining workforces is seen by large organizations as a better approach than hiring, allowing them to create the right skills balance and retain their workers better. However, softer skills, such as communication and problem solving, are seen as just as important. ICT workers will benefit from a lifelong approach to learning, acquiring new skills and adapting existing skills. Many ICT companies have created academies for developing employee skills and certifications related to their own technologies, while the education sector has been working on creating curricula (alone or sometimes in partnerships with vendors) to improve graduate employability.

Research limitations/implications

The research is based on a small sample of large companies. The situation may be different in other companies and smaller organisations,

Practical implications

Organizations can cope with the skills shortage by anticipating and working with the market forces rather than trying to oppose them.

Social implications

ICT employees will show the way for employees in other sectors where skills are scarce, by demonstrating how to reinvent themselves as the skills needed change.

Originality/value

This paper demonstrates that employers have changed their expectations of universities. They expect less that graduates will be ICT-employment ready, and more that they will have the skills to make and keep themselves employment ready. This has significant implications for university course design.

Keywords

Information and communications, technology, employability, hard and soft skills, universities, graduates

Paper type
Research paper

Introduction

This article uses the IDC study (Kolding et al., 2018) on the issues European companies face in hiring, retention and upskilling information management staff, to review how different function and sectors will manage information using information and communications technology (ICT), and what ICT skills they will need. According to the EU, there will be a shortage of 750,000 ICT people in the EU by 2020 (Hüsing *et al.,* 2015).

How big is the problem?

Lack of digital talent prevents organizations filling positions, forcing them to postpone projects, while lack of appropriate talent can restrict innovation and economic growth. According to IDC, 55% of European organizations were "stuck" in the early phases of digital transformation (Kolding *et al.,* 2017).

A report from 2017 found that 24% of 402 European enterprises said that having the right skills to execute objectives was their main obstacle (Aholrlu, 2017). 23% of respondents said that understanding what digital transformation is, who can help, and where to begin the journey was an important obstacle. While the first of these easily translates to a lack of ICT professionals with the right technical capabilities, the latter points toward a lack of digital leadership skills — the experienced people that can translate between business and ICT.

What are the sought-after skills?

Expertise in new technologies and digital is hard to find. Figure 1 shows the top 3 skills that the respondents sought: cloud, Big Data, and security. However, future demand for skills will be more varied, with a strong increase for Internet of Things (IoT), Artificial Intelligence (AI), and blockchain — technologies rapidly moving from proof of concept and piloting to implementation.
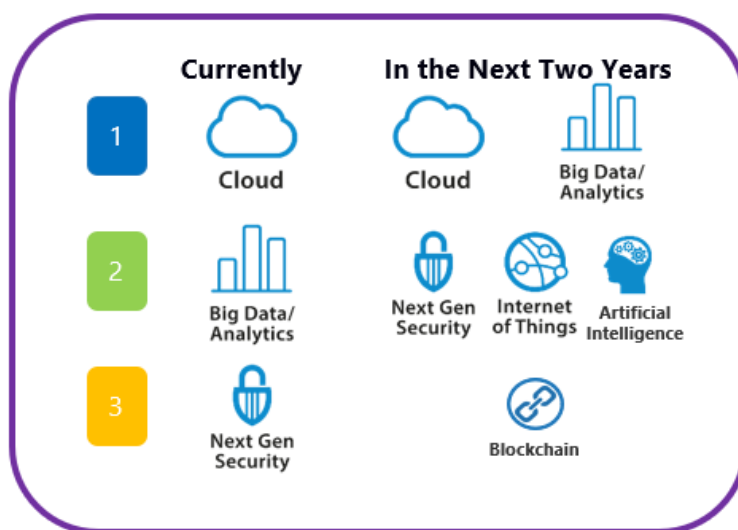

Figure 1 Top 3 skills hiring for now and in the next two years

Source: IDC

One respondent in the IDC research, in answer to a question about the extent of increase in their demand for ITC staff, said:

> *"Yes, with the development of Internet of Things, Smart Connected Operations & Augmented/Virtual Reality solutions, software editors and ICT consulting firms will face new complex software implementation projects, increasing the need for IT-related skills. Our company is growing, and the number of hires is related to this growth. Last year we had 40 new positions in Germany, but we have already hired more than 60 this year. We have R&D centers in other geographies (UK, Austria, Switzerland, Ireland…) seeking to hire 20 to 25 people per year. So, we need both new skills and more of the skills we already have."*

Another respondent confirmed this:

Our company is growing fast. We had a +20% increase 2017 over 2016 (600 new hires) and plan another +20% for 2018 vs 2017 (800 new hires). We have taken on another 250-300 through an acquisition. About 3/4 are for Datacentres - technicians and engineers. The next biggest is sales and sales operations.

This respondent echoed the other two:

We expect external hiring to increase, but not dramatically. One reason is that part of our business will be directly impacted by automation especially in IDM (infrastructure and data centre management business - including traditional outsourcing). The second is that we are reskilling. We have an "internal first" strategy - we want to have 80% of roles filled by internal talent - via reskilling and retraining. We think this is important from a career development perspective - it will make people stay if they can see prospects. It is cheaper than hiring from outside, particularly for scarce skills. We are still recruiting - about 12,000 a year, focusing on new technologies.

However, as we shall see later, one response of industry could be to reconsider where ICT talent is deployed. In answer to the same question, another respondent said:

"In terms of our total "boots on the ground" it will stay relatively flat but hiring for new techs and churn. We will probably target 100-150 hires a year. We are not aiming to grow huge legions of new capacity. But the challenge is moving from legacy to new tech. We will do a lot of reskilling and retraining to bring existing employees up to speed and manage the capacity by reskilling. Much level 1 and 2 services work will be handled from automation. We are expecting 40% efficiency gains here."

However, many could not resolve their problems, as this respondent reflected:

"The pool of talents with IT-related skills in most European countries doesn't fit with demand. As this concerns very new technology, only a few are already skilled in it. The challenge will be to identify those who can adapt to these new technologies. It's a combination of 3 factors: 1. We have a lot of hiring needs as a growing company; 2. In some markets, like Germany the Netherlands and the Nordics, there are more open position for engineers than engineers looking for a job; 3. We deal with technologies that didn't exist 5-6 years ago. These three factors make talent acquisition very difficult."

This was echoed by another respondent:

"Across Europe there is not enough skilled talent to meet the current or future demands, Talent movement across Europe is exacerbating this challenge for some regions - e.g. Spain, Portugal, Eastern Europe countries- who see a "brain drain" of talent to countries with higher earning potential. Our traditional competitors (Consulting and ICT Services) all seek the same skills and profiles. The limited supply of talent is creating fierce competition - not only from traditional competitors (Consulting, ICT Services) but increasingly start-ups. Competition is driving wage inflation. Start-ups often have more flexibility in salary bandings and ranges. This is so at entry level and experienced hiring. The start-up proposition is resonating much more strongly with millennials who want clarity on the work they will do, a flexible and non-hierarchal work environment, and to progress/advance quickly (UK, France, Belgium, Netherlands). The limited supply of talent is forcing alternative sourcing strategies, which are typically "more difficult" to execute e.g. cross-border sourcing for talent (already essential for Czech Republic, Poland, where overall unemployment is low)."

For some the picture was more mixed:

"It's becoming harder. We are now competing with different types of companies and they are all trying to fish from the same pond. So, it's not the skills per se but more the capacity. There are specific skills that are scarce and which we need a lot of. However, some skills are becoming less

scarce, as people are more educated/trained in certain areas and/or bring work experience from other companies."

This respondent agreed:

"It is very competitive, but it could be worse. Reskilling and redeployment is very important. The market is looking for end-to-end capabilities, so we need to be agile in how we fill the need."

This respondent gave more detail on the problem:

"You can't just say what the strategy is across the board as our company is so large. It really depends on the business unit, the skills we need, the speed, etc. Also, for a certain budget you can reskill a lot of people rather than hiring externally. Sometimes we bring in contractors if the skill is needed urgently for specific customer engagements or projects. We don't just let professionals learn on the job - there is a development program throughout people's careers. We urge people to think of their own skill development. The average time that people in the ICT industry stay with a company at the moment is 7 years. They could leave the company but also come back again. Training is also a form of retention. There used to be really fixed career paths, but this is no longer so. We are now developing curricula that in 6 months will need to be revamped, as skills have sifted. You also see a shift in types of education. It is now much more based on individual skills with a blended learning approach - online and face to face. Some career paths are the same (e.g. senior architect) but the skills that the architect needs are different from 20 years ago. The career paths are more like tracks, where the skills constantly shift - but the core of what makes an architect remains."

As did this:

"I would say the problem has become more "pronounced" due to the overall explosion in hiring numbers for technology roles and pace with which the technology skills market is moving (i.e. faster adoption of newer technologies, agile ways of working). In the last 5 years the diversification and frequency of training for new graduates has had to increase from what was historically standard "design, build, test" with some Java of C++, to different customized learning paths including multi-channel training plus practical approach covering new ICT and digital technologies with agile and rapid ways of working. Our clients are no longer willing to pay for upskilling entry level talent on the job, but expect job readiness from day 1. Our goal is to make continuous multiskilling/learning content available today, so our resources can proactively respond to the industry and market needs. It is not enough to react to a disruption; we must be understand demand and supply needs and predict the skills needed to support our clients."

Soft versus hard skills

There was a strong consensus among the respondents about this:

"Within R&D, we have a strong focus about the technical abilities of candidates (about programming for instance). For our other technical roles (Technical Sales Engineers, Technical Support Engineers, Customer Success Engineers, Solution Architects etc), a good technical level is of course a plus, but we are also looking for people who will work with our customers. Therefore, soft skills like Communication, Listening, Team Work or Customer Satisfaction are critical, too."

Another respondent stated:

"What we do need from graduates are soft skills, learning agility, critical thinking, problem solving - and then we can overlay with the training to bridge the gap."

One respondent reflected on the consequences of hiring people with these qualities:

"I think we underestimate the young sometimes. They have interesting ideas. They like learning and growing, otherwise they quit. They put pressure on the company. We used to put the young on boring projects, but they want to do cool stuff straight away. So, we hire high potential people and fast-track them. Our company is really good at mobility, letting employees move between jobs, and geos. This helps retention."

Another respondent gave a fuller explanation of the same issues:

We are working a lot to improve our benefits and career paths, to be attractive for graduates. For example, we have a graduate training program for consultants, and then a 10- grade career path. We are building something similar for sales too. For example, the company offers each employee a day off for their birthday and ensures everywhere in the World that each employee who gets or adopts a child to have a 3-months full pay leave. We know that younger generations are very conscious of social networking, ethics, lifestyle and environmental issues: for example, we offer our employees a social networking experience once a week (many of them are often out with clients during the week), we give free time for volunteering activities, we drive some ecology initiatives in areas near our offices and we provide a flexible work environment (work from home initiatives). Something that we think is very attractive is that we are a "small-sized" global company, where you can make a difference, and always be at the forefront of technology. We also offer work in different countries, which is very attractive for younger generations.

Another respondent explained how their hiring behaviour had changed:

"We have now a special hiring programme focused on soft skills, creativity, problem solving and finding new ways to tackle new situations, but also passion for technology. This means we must change the way we recruit, structure the interviews to be competency-based and ensure a great candidate experience. We must also change hiring managers' focus from finding someone that fits the position to finding someone that can adopt to new technologies and has potential to grow. We are hiring for tomorrow, not for today. We are also changing tools for hiring managers and talent attraction using, for example, educational institutions and hackathons. Our special hiring programme is global, not limited to Europe, but it's a main focus here, as Europe has more gaps in terms of technical skills than other geographies."

The demand for "business understanding"

The importance of business understanding was highlighted by one respondent as follows:

"When you have a big data transformation project, you need strong engineering skills but also strong business skills. To help customers develop new business models we need mixed skills. These are very complex projects. Combinations of skills are becoming more and more critical – the right mix of technology, business and change, plus analytical to understand the market."

In some cases, the need is for training in approaches that work across sectors and functions, as one respondent pointed out:

"How do we complement people's skills so that they can potentially have a new and different role? We are seeing a convergence of different types of roles and experiences – based more on the needs of the capabilities. We are trying some new things – but it's a world of exploration. All our VPs will go through a digital experience certification. This helps us explain to our clients where to go in digital experience. But it's a different way of managing people. We are running our teams through new digital curricula – content and delivery."

Industry sectors

This demand varies by industry sector and by function, so in the next two sections, we give our views on the most important areas of demand, in a sample of sectors and functions. Although the details may differ, there is high commonality, but also a sense that the opportunities for deploying new approaches to ICT, particularly in big data, analytics, artificial intelligence and cloud/platform deployment, are endless. Put simply, it is by probing into the details of how ICT will be deployed that it becomes clear how much information will be flowing between and within organizations and the requirement for skilled staff to support and manage this information generation and exploitation. The data for the sector and functional/line of business analysis was derived from the consultancy practice of one of the authors, combined with data from two recent IDC reports on digitalization (IDCa, 2018; IDCb 2018).

Agriculture

Agriculture is fundamentally a business-to-business operation, with most output sold under contract to food processors or similar, unless a farm has its own retail operation, when points covered in the retail

section below may apply. Requirements vary by type and size of farm, but unsurprisingly, the biggest demand relates to helping farmers managing a large geographical area to optimize yield and growth remotely, increasingly involving drones, tablet computing, digital mapping and mobile communications.

Table I summarises the main ICT applications for agriculture.

Land management	Growth/yield/soil state/air/humidity/wind/ice/weather tracking/visualization; programmable control for accurate dispensing (irrigation, fertilizer, herbicide, pesticide); readiness sensing (sowing, fertilization, irrigation, harvest), problem sensing (infection, pests, distress), sap flow, yield metering, quality tracking, crop variety management
Livestock management	Programmable control for feed/nutrition management; immunization, sensing (insemination readiness, birth, body weight, milking); problem control (e.g. digestion, disease), valuation, return on investment, quality tracking
Equipment management	Deployment/utilization (including driverless and other robotization), productivity, maintenance, return on investment, problem sensing
People / contractor management	Input management, productivity, financials, online training, field communications
Buildings management	Sensing of temperature, humidity, problems, maintenance requirements, smart stalls
Distribution	Picking, packaging, inventory management
Supplier management	Input ordering, financials, return on investment
Customer management	Registering/tracking of orders, payments, communications
Testing	Seeds, fertilizer, pesticide, sowing pattern, harvest technique
Planning/finance	Planning/tracking implementation of the above; producing accounts, forecasting

Table I Main application areas of ICT in agriculture

High tech industry

This includes ICT, advanced engineering, aerospace, biotechnology, nanotechnology, robotics, precision instruments and semiconductors. It overlaps with two other industries covered in this paper, manufacturing and professional services. Where the latter is concerned, in many cases the revenue from products now comes as a service revenue, to which is added revenue from professional services to assist with implementation, rather than the sale of units. These industries are characterized by extensive (usually global) ecosystems, where many companies innovate, often together, and by the speed of product rise and fall, so profits must be made as soon as the product is launched, as product prices may begin to fall soon after launch. So, real-time commercial data and analytics are critical. The high-tech industry depends on intimate knowledge of how its customers, usually other businesses, use its products, but may also depend on its customers for ideas about new products, using crowdsourcing techniques for idea generation. Application of ICT is of special significance for high tech companies, as it involves them taking their own medicine. The main ICT application areas given in Table II.

Complexity reduction	Reducing complexity throughout the entire business, to get new technology to market faster.
New models	Identifying and creating new, flexible pricing, sales and business models, including bundled solutions, based on accurate and real-time data.
New product launches	Gathering real-time insight into speed of take-up and use of new products/services
New product design	Injecting intelligence into all new products and services
Customer experience	Creating a unified, consistent, customer experience across products/channels
Accelerating growth	Driving sustainable growth without adding bureaucracy and complexity.
Adjustment to customer needs	Matching manufacturing or fulfilment to changing consumer demands, enabling response to new opportunities while creating consistent customer experiences, co-creation of products and services
Ecosystem/supply	Coordinating and collaborating with suppliers and partners around the globe to

| chain management | shorten the path to growth |

Table II Main application areas of ICT in high technology

Professional services

Professional services include ICT services (including outsourcing), accountancy, law and management consulting. They have many opportunities for application of advanced IT, but professional services companies sometimes fail to take their own medicine, preferring to substitute high cost labour for clever digitalization. However, things are changing, with content creation, delivery and curation being key foci, closely followed by social media, to attract, retain and develop clients. Customer relationship management (CRM) is also an area of focus, with the important need to join digital and offline customer experiences. Given that much of the delivery of professional services are through people and IT, professional services share many of the functional application areas of general management, human resources and information technology functions identified in this paper. The areas of opportunity listed in the Table III are the main ones.

Content management	Creation, delivery, curation and user-involvement, use of analytics to link use of content with customer value and cost reduction
CRM	Linking customers, content, projects and outcomes
Efficiency	Optimizing resource use, reducing travel time and cost
Analytics	Identifying areas of highest and quickest pay-off for existing services
Planning and budgeting	Improved allocation of resources and calculation of return on investment, better accounting
Process management	Improved process standardization and reporting
Human resources	Ensuring mutual accessibility of client and company personnel, using mobile technology to maximize availability, development of digitalization talent, improving staff engagement
Social media	Involving customers in co-creation of solutions

Table III Main application areas of ICT in professional services

Consumer insurance– motor, household etc.

Consumer insurance is full of opportunities to apply ICT, in all areas, from managing prospects, customers and intermediaries to claims management and fraud reduction. Table IV summarises application areas for ICT in insurance.

Customer experience	Managing the acquisition/retention cycle – pre-purchase, purchase, servicing - including self-service, renewals, claims and payments, life-stage management, adaptation of offer/proposition for digital natives, omni-channel, working with apps, including navigation (motor), synchronization. moments of truth, self-service; customer feedback and restitution; website quality; content management, including training/advice (for customers/sales staff)
Strategy and marketing	New business models, including ecosystem types – connected objects using IoT, one stop shop, segment of one; new digital product development, reduction of development time; use of social brokers, peer to peer; usage-based insurance/pricing; insuring the sharing economy; allowing switching between different insurance categories (e.g. business/personal, personalization and customization, encouraging customers to reduce risk by better/healthier behaviour; digital campaign management
Sharing / partnering / distribution	integration with third party systems - aggregators, e-brokerage, claims management etc., affinity marketing, working with partnerships; collaboration with tech suppliers; data links with government/registration authorities; commission management
Risk management	Privacy, security, trust and anti-fraud; risk assessment
Technology and data	Internet of Things (IoT), in-car telematics, driverless cars, navigation, hazard avoidance; use of drones to assess accidents/claims/risks; analytics, including streaming - coming from IoT, algorithms to warn of impending changes (floods, fraud etc.); social media use for lifestyle data gathering, for risk analysis

Operations	Operational processes fully digitalized, removal of paper, workflow management, straight-through processing,

Table IV Main application areas of ICT in consumer insurance

Manufacturing

ICT innovation is having a big effect on manufacturing, connecting plant floor with head office and with the ecosystem of suppliers and customers, leading to reduction or removal of supply chain disruption, matching production to demand better and improving asset utilization, quality and customer satisfaction. It includes digitalization (e.g. by sensor/control device-inclusion) of manufactured products themselves (Internet of Things) and their components themselves and the use of robotization. Feeds from upstream suppliers and from downstream marketing increase the possibilities of optimization. Table V summarizes the opportunities for applying advanced ICT in manufacturing.

Vertical value chain integration	Digitalization and integration of vertical value, across the entire organization, from product development and purchasing, through manufacturing, logistics and service. All data about operations processes, process efficiency and quality management, as well as operations planning are available real-time, supported by augmented reality and optimized in an integrated network.
Horizontal value chain integration	This includes suppliers, customers and all key value chain partners, with technologies from track and trace devices to real-time integrated planning with execution.
Digitalized product and service offerings	This includes expansion of existing products, e.g. by adding smart sensors or communication devices that can be used with data analytics tools, as well as creating new digitized products that focus on completely integrated solutions, generating data on product use and allowing products to be improved. This includes, new data-based services. Products, systems and services will be more customized to customer needs.
Advanced analytics	This takes data arising from any of the above, translating it into anything from real-time reports on problems, opportunities or quality to production line optimization and senior management decisions on resource acquisition and allocation.

Table V Main application areas of ICT in manufacturing

Retail

Retail covers many business types, from high stock-turn standard grocery retailing, through services retailing e.g. hairdressing, restaurants and coffee shops, to department stores and automotive sales, as well as pure-play online retail. They all have in common that customers are in the driving seat, selecting merchandise and managing transactions, and that retail is increasingly moving online, creating problems for classic retailers. Table VI summarizes opportunities for retail application of advanced ICT.

Marketing	This includes customer web review and stock checks; purchasing; click & collect; home delivery using own/partners technology and logistics; receiving targeted advertising and marketing through email, social media, online advertising on search engines; banner ads on mobile devices or websites and via affiliate programs, in app couponing; push notification re offers; loyalty management; chat functionality to get advice; customer feedback loop management – from initial customer input to results; integration with social media; gamification to incentivize micro-moments – check in; socialize, fashion shows, vote for friends, coupons

Store operations	This includes customization in-store; smart-fitting rooms with virtual reality/interactive outfit recommendations using customer measurements/trend/occasion; instore product printing; interactive signage and smart advertising targeted at customers passing; customer analytics in store, including from video; kiosks, including viewing endless aisles; instore navigation; real-time pricing; check out optimization, using video cameras to monitor and predict queue lengths, reduce customer wait times and improve cashier efficiency; customer self-checkout; instore chat; instore Wi-Fi; smart lockers for collection; instore push notification re offers; messaging to locality via geofencing; real-time information on queues, staff locations and store problems; staff with knowledge devices to resolve queries; smart security and anti-theft/fraud - IP-based surveillance systems; video analytics to identify suspicious behaviour and reduce theft; detection of digital threats
Supply chain	This includes end to end visibility to ensure in stock; rapid procuring, ordering and replenishment; automated picking of deliveries; use of sensors and tagging - RFID of outer packaging as well as inners, Bluetooth Low Energy beacons, Internet of Things
Finance	This includes mobile and online payments, instant loans for known customers, biometrics payment authorization: items tagged with RFID to facilitate whole basket scanning; smart financial reporting, with real-time information on the finances of every aspect of business; prediction of issues and problems
HR	This includes instore analytics store to improve workforce efficiency via dashboards; dynamic online staff recruitment and management; access to information on policies, procedures, sales campaigns etc., to ensure easy staff scheduling and optimize staff retention and engagement
Information and communications technology	Most elements are already included in the list above, but the key additional factor is the supporting infrastructure, cloud-based, high capacity and high speed, operating with high security, combined with rapid analytics and communication to support any planning or operational requirements.

Table VI Main application areas of ICT in retail

Pharmaceuticals

Many manufacturing and retail points also apply here, but there are some specific additional points, partly due to changes in relationships between patients, medical professionals and institutions, manufacturers, funders and retailers. Patients are no longer passive recipients of therapies, some even co-designing their therapeutic and treatment approaches with their physicians, using apps in some cases. Physicians are taking a new consultative role, requiring them to master the high volumes of information now available on treatments and on their patients, who may be wearing devices that allow more precise and continuous data capture, analysis and diagnosis than before, allowing treatments to be optically administered and effectiveness to be maximized. The main opportunities for application of advanced ICT, over and above those identified in manufacturing and retailing, are shown in Table VII below.

Customer engagement	Tracking customers/patients; matching treatment data from different sources e.g. prescriptions, sensor technology, ensuring correct diagnosis and treatment
Health management	Capturing data on symptoms and on administration and results of treatments, using apps, sensor technology, wearable devices, embedded chips in drug administration devices and in treatments themselves, optimizing timing of administration of treatments.
Product development	Building digitalization into new products and ensuring that trials are accelerated using digitalization
Partnering	Sharing data with health administration and insurance companies top optimize health management
Content management	Providing the content that physicians and patients need to determine appropriate treatments, review progress etc.
Analytics	Providing highly sophisticated analysis to identify which patients (trial or rollout) most benefit from which treatments, given patients specific characteristics
Social media	Tracking responses, reactions and capturing benefits of treatments

Table VII Main application areas of ICT in pharmaceuticals

Function/line of business

In this section, we consider the implication of ICT for information management in business functions. We focus not just on a function's internal ICT, but also on how ICT enables each function to deliver for the whole organization.

General management

ICT has moved from being the preserve of specific functions in a business to being a key responsibility of general management. While details of planning and implementing ICT may be devolved to specialist functions, ensuring that the entire business moves ahead with ICT cannot be delegated. The role of leading ICT strategy and process belongs to a business's leaders, though projects and programmes may be developed by a chief technology or digital officer or similar. Where the company has a business planning function, it may be responsible for coordinating all the activities required. The role of general management in is summarized in Table VIII.

Sponsoring and planning digitalization	Developing an understanding of what ICT can do for the business, and creating a vision and a plan to achieve it
Integration of digitalization into corporate/strategic planning	Ensuring that ICT is an integral part of the business's planning process, overall and in each sub-plan for each part of the business (e.g. business functions such as operations, purchasing, marketing, finance, human resources)
Digitalization business case	Building a business case for digitalization of the business, ideally based on use cases for application of digitalization to each part of the business
Constructing, implementing and measuring the impact of digital initiatives	Developing concrete plans to digitalize and ensuring that they are implemented and their success measured
Creating an innovative digital business model and fully digitalized processes	Where appropriate, innovating by creating a business model that is partly or fully digital, in terms of how revenue, profit and competitiveness are generated, and by ensuring digitalization of all business processes that can be cost-effectively digitalized
Digitalizing business offerings	Ensuring that opportunities for profit-generating and cost-effective digitalization of the business's products and services are taken
Ensuring customer-focused digitalization	Ensuring that relationships with customers, across all channels and whether managed by the company alone or with partners, are digitalized, from the creation and analysis of customer insight to how the customer journey is managed and measured
Digitalization skills, organization and systems infrastructure	Ensuring that the business has all the skills and organizational attributes as well as systems infrastructure (whether its own or partners) required to digitalize

Table VIII Role of general management in ICT application

Senior ICT management are evaluated with business-related and strategically-focused measures like the value of ICT to the business and its contribution to strategy and innovation, but also for operational quality e.g. cybersecurity, availability/up-time and ICT service quality (Kappelman et al., 2018).

Human resources (HR)

HR professionals are moving from managing hiring, payroll and holidays to a more strategic role, including changing how staff manage themselves and the information about them. At a basic level, this involves providing self-service tools allowing employees to manage their own information using their own devices, using data analytics to track trends and performance, gamification techniques to sustain employee interest in HR matters, and the use of social media for recruitment. But for full deployment of ITC, HR plays a much larger role, including talent management, as described in Table IX.

Ensuring the empowering of ITC and digital leadership	Identifying the type and focus of leadership required and working with the business's leaders to create and sustain the leadership
Filling the digital skills gap	Identifying extent and location of the gap (there are many kinds of digital skills and knowledge required, as well as the ability to work within and

	develop the digital culture), filling the gap through training, recruitment and outsourcing/partnering and ensuring that it stays firmly closed
Creating a ITC/digital skills lifecycle for staff	Ensuring that staff keep their ITC/digital skills current and that new development paths are created for staff whose ITC/digital expertise must be developed and retained
Deploying ITC in routine HR and talent management	Ensuring that big data, AI and other advanced ICT is used to manage the recruitment, retention and development of staff
Culture development	Helping employees adopt an agile and digital mind-set, developing a team approach to deployment of ITC and digitalization
Change management	Deciding on the kinds of change management required to achieve digitalization and implementing them
Organizational design	Structuring the organization to enable sustained digitalization
Digital operating model	Helping develop the new digital operating model of the business

Table IX Main application areas of ICT in HR

An example of this shifting role of HR was given by one of the IDC respondents:

> *"Our number one priority is to make sure we have the right talent and we prepare our people to work in the New. This year we will invest 40% more into New Skilling compared to last year. We look at how we can rapidly put in place programs so that we can develop expand certain skills areas quickly and efficiently. How do we get in front of competition and make sure that our people have the skills to be ahead of the game in new areas? We are planning on an annual basis of what skills our people should have. We review this quarterly basis as well as on an ongoing basis, based on client needs. There may be new technology that we couldn't have foreseen that we must rapidly upskill for. We are encouraging continuous learning. It's part of our culture. We must ensure that people understand what's happening in the market so that they can themselves upskill, reskill and continue to develop their careers as they would like to. This is not "one size fits all". We analyze people's roles, their aspirations and skills and customize for each. It must be focused on the individual – there are not told how many hours of training to do per year – it is more about the training they must do to continue to deliver value to clients."*

The role of HR in enabling organizations to digitalize and in providing the data that supports the drive towards agility, flexibility, versatility and speed and has been identified in many studies, including Stein (2015). The importance of a talent-focused approach, using big data and analytics, is highlighted in Miller (2014) and in Scully (2017).

Finance
In some companies, the finance function is on a journey like HR's, breaking beyond its traditional roles into ensuring pervasive, digitally-informed real-time, value-focused, customer-centred service design and decision making throughout the company. This means new roles, as indicated in Table X.

Automating basic transactions / finance processes	Reducing costs and accelerating cash flows,
Deploying robotics	To automate process decision making
Advanced analytics	To support all planning and decision making
Shifting the focus of financial management	From transactional work to higher value activities
Strategic focus	Supporting customer-focused business strategy. This shift of focus may require a lot of reskilling of the finance function.

Table X Main application areas of ICT in finance

Marketing, sales and customer service
Customer-facing functions are often at the forefront of ICT deployment of ICT and digitalization, partly because customers expect to use it do business with them quickly, easily and cost-effectively. How a digitalized business interfaces with customers depends on its sector, the product or service category, frequency of transaction, duration/depth of relationship and the type of customer (size, whether

business or consumer etc.). Deployment of advanced ICT through digitalization improves marketing, sales and customer service is shown in Table XI.

Product and brand	Creating/implementing new ways for customers to engage with brand, design of product to include digital interaction with customers, conversion of product to digital service, co-creation of products
Marketing communications	Application to all aspects, including website design, search engine optimization, PPC advertising, blogging and testimonials, campaign management, trigger analysis, attribution analysis, customer lifecycle management, CRM, personalization, testing, incorporation of social media, marketing automation, content management (creation, curation and deployment)
Customer experience/service	Creating digital means to manage/integrate different touchpoints, how-to and training videos, customer feedback, identifying service requirements and optimizing response
Pricing	Customization or pricing, yield management, auctioning
Distribution channels	Tracking products/services in channels, ensuring stock availability, allowing customers to view products/availability, real time stock allocation (many retail/logistics factors apply)
Sales	Ensuring sales people have latest information on products and availability, receiving feedback from customers, sales cycle management including social selling (from prospecting to account management)
Measurement and finance	Identifying cost and outcomes of any action, real-time RoI calculations and redeployment of budgets/resources
Customer data & insight	Integrating data from different sources, real-time analytics to support any of above activities, ensuring privacy

Table XI Main application areas of ICT in marketing, sales and customer service

Supply chain/logistics

Logistics is a business function and an industry – increasingly the latter as companies outsource it. It is closely linked to upstream activities such as manufacturing, and to industries such as retailing and distribution. Applying ICT and digitalization in these other functions and industries requires matched ICT development and digitalization in logistics. Digital platforms are essential in the logistics industry. They give companies global reach and compete with larger companies. The main areas of application of ICT are shown in Table XII.

Digitally enabled information services	Put data at the centre of logistics, via new vehicle control analytics and services, cutting operating costs while improving efficiency
Digitally enabled logistics services	Allows logistics functions and companies to achieve faster same-day deliveries
New delivery capabilities	Including autonomous trucks and drones for more efficient delivery
Circular economy	Creating a more sustainable product life cycle, reducing environmental costs
Shared logistics capabilities	Using shared warehouse and transport capabilities to increase asset utilization
Unique identifiers and associated sensors and transmitters	Applied to merchandise and transport equipment, allowing 100% digital management, using IoT technology
Platform development	Developing new business platforms which can be extended to supply chain partners, helping develop new business models
Cloud-based IT	Facilitating data sharing with e-supply chain and other functions that use it

Table XII Main application areas of ICT in supply chain and logistics

ICT

The department or function that provides ICT and the people who work in it, not to mention the many partners involved in supplying facilities on-premises and in the cloud, are creating new areas of opportunity and risk and ways of working with colleagues and business partners. The pervasiveness of digitalization means that ICT specialists support many new applications and many more staff. All this leads to new requirements for the digitalized ICT function, as shown in Table XIII.

Visualizing nearer/longer term futures and planning to make them happen	Working with leaders/board, individual functions/departments & across functions/departments, educating, leading, deciding, sustaining, acting as a growth enabler and catalyst, not just as reactive support, developing business and use cases based on transforming and on attacking (larger) competitors; investment planning
Making the futures happen	Properly prioritized change management, project/programme planning (based on test and learn, phasing, management and review, monetization), skills planning, acquisition and development, creating a true digital culture through facilitation and leadership, development of champions and centres of excellence, delivering through solid projects, with newly created frameworks for planning, delivery and governance
Innovating	Using strategic and operational insight to develop new functional and business model approaches, to create and manage ecosystems of suppliers, customers, partners, other stakeholders and to improve their journeys – within functions and in the entire relationship with the company
Automation/use of robots to provide information and support	Ensuring that support for a fully digitalized firm can be delivered quickly and economically
Self-service focus	Helping users to help themselves, rather than providing conventional ways of accessing ICT services
Involvement in planning and delivery of digitalization	Involving not only conventional user departments but also many more individuals seeking ways to digitalize their activities
Reporting and analysis on an enterprise scale	With so many new sources of information and points at which it is generated and applied, the ICT function must provide tools for all users to understand the data being generated in their areas and to analyse and apply it

Table XIII Main application areas of ICT in the ICT function

Conclusions from industry and sector analysis

These analyses demonstrate the pervasiveness from deployment of ICT, to create new approaches to information management which transform businesses through digitalization. The most important aspect of this is that the business cases for most of these approaches is very clear and strengthening with each new wave of technology. In turn, this contributes to the explosion of sources of data, and thence to the information management challenge experienced by companies in the IDC survey. It seems clear that the more that companies can automate the generation, application and exploitation of information through advanced and automated information management techniques, the more likely they are to achieve their business and competitive objectives,

Solving the problem

The IDC report identified that most respondent employers expect to see an increase in hiring over the next two to five years and that finding the right talent will continue to be hard. All employers mentioned severe competition for talent, not just from their traditional competitors, but increasingly from start-ups and companies focusing on building their products and services around technology. One respondent with operations across Europe said that it had observed a "brain drain" from some countries such as Portugal, Spain, and Eastern Europe to other parts of Europe where earning potential was higher In situations of severe economic mismanagement such as Greece, the drain is particularly acute (Fiscutean, 2015).

Sourcing of talent

The IDC report identified that employers use several ways to source talent– with hiring ICT graduates straight from universities, hiring experienced people from other organizations, and retraining and upskilling existing staff being equally popular strategies. However, some hire graduates with non-ICT degrees and put them through special training programs. A few hire self-taught people without formal qualifications or experienced people from other industries. What mattered most was that new hires had relevant experience, exhibited the right attitude, and were a good fit for company culture.

Expectations on graduates' skills and knowledge

Respondents in the IDC study were satisfied that they could find graduates with the right skills sets, but while most hire ICT graduates, they are not primarily looking for hardcore technology skills. Only one vendor was specific in wanting graduates with degrees in either data science or engineering. The rest demand graduates with transversal or soft skills such as communication, logical and critical thinking, ability to learn, technology aptitude, willingness to develop, curiosity, cultural fit and collaboration transversal skills development, in contrast with basic skills such as literacy, linguistic ability, science and digital skills, and entrepreneurial skills.

How employers develop graduates

Graduate skills required depend on the post. As one ICT supplier in the IDC study put it,

> "If we are hiring into technology delivery centers, then technology/coding skills need to be there. Otherwise, the cost of new skills will be too high."

Employers do not expect recent graduates to be the finished product, but they need basic building blocks in place and rudimentary understanding of the business are where they will work. If graduates have good basic grounding, all IDC respondents said that they expect to train graduates to give them specific skills they need for their roles. Graduate training programs vary from three months of intensive training to two years in an intermittent training program, or just getting graduates to use established training programs for all employees. The IDC report identified that employers have now realized that it is hard for universities to keep curricula current, given the speed of technological change, so they prefer to hire graduates with soft skills and top up with relevant technology training.

Strategies to attract graduates

Most IDC respondents had a strategy to attract and retain talent, using graduate training programmes and possible career paths thereafter as incentives. They also felt that their company's brand and what it stood for were increasingly important in attracting talent, building employee loyalty and even "employee pride," as one respondent expressed it.

Developing existing employees

Research evidence has long supported the finding that organizations that both recruit and train for skills do better (Poston and Dhaliwal, 2015). In the IDC research, retraining and up-skilling existing employees offers considerable advantages and is used by most employers. The specific reasons for introducing such training programs included geographical relocation, technological developments, and employee retention. Respondents were also using training as an alternative to redundancies where automation or outsourcing made original employee functions superfluous. Organizations often link retraining (and retention) to broader societal impact (i.e., avoiding a reputation for disrupting communities vulnerable to automation). Interestingly, no respondents used outsourcing to bridge skills gaps.

Apart from providing core ICT staff with training in new technologies and functional staff with functional specific training, most IDC respondents provide functional staff with training in new technologies and ICT staff with functional-specific training. Emphasis on cross-functional skills and related training is in line with the increasing incidence of multidisciplinary workplaces, requiring a wide array of often unrelated skills.

One respondent highlighted the increasing emphasis on training:

> "There has been a skills gap for at least 10 years if not 20. Tech is changing so fast that you never catch up because the target keeps moving. You will continuously need to develop new skills. Once, training was in the background and it could be cut. But management now consider

that competence is important. Smaller and more nimble companies can lure away your talent. However, the younger generation doesn't stay around for as many years as previously."

Attracting and retaining experienced talent

High demand for specific skills has led to strong competition for experienced people, although salary levels have not increased dramatically apart from for specific skills, such as specialized developers and security experts. The IDC report noted greater variation in salary levels for skilled ICT workers between EU countries than within countries, where ICT salaries have generally followed wider salary trends over the past 10 years. Employers are examining non-monetary ways to attract talent and build loyalty.

Training plays a key role in retaining existing staff and in attracting experienced employees from the market. The speed of development in technology meant that employees must be constantly upskilled with refreshed training and must consider changing career paths, so candidates may join companies with strong focus on career development

As one employer stated,

> *"Training is a form of retention. There used to be really fixed career paths, but this is no longer the case. We are now developing curricula that in six months will need to be revamped, as skills needs have shifted."*

Another respondent confirmed the importance of training:

> *The skills gap is addressed primarily through internal learning and competence development, rather than recruiting. Recruiting is important, but the challenges for the company is to meet internal and customer digital transformation with existing staff. In sales, we need our people to challenge the customer, and to know more than the customer. As the customer changes, so must the company, but at a faster pace. In engineering, we are changing from Waterfall to Agile. In services, we need Project Management. In general, we need digital skills. We need to improve in 5G, IoT, Automation, Machine Learning, Blockchain. The Skills Gap in digital skills goes across the board. You need to develop what you sell, and you need to sell what you develop."*

One respondent decided to recruit by going to an earlier stage in an employee's life cycle:

> *"We are not hiring graduates. We are hiring students. Students engage with us through internships, BA and MA theses, and then decide to stay. This is mainly the consequence of highly competitive market for ICT skills; but we see the same trend coming up also in business roles."*

Is diversity the answer?

There is clear evidence (see Alamri *et al.,* 2018) that avoidance of bias in recruitment and management helps, and that particularly in the area of gender, narrow definitions of the ICT profession and entry points are a barrier to female participation (Cukier *et al.,* 2009).

As one respondent noted:

> *"In Central & Western Europe, ensuring diversity for hiring is a key to success. We don't have specific targets because we are already hiring for diversity. We train our Talent Acquisition & Human Resources teams, as well as our Hiring Managers, to avoid unconscious bias by hiring. Diversity helps us to reach our goals."*

The problems in this area were underlined by another respondent.

> *"Our gender commitment is 50/50 by 2025 - we know this will be difficult - we estimate that females are only 20% across Europe in computer science courses. We are succeeding when we look beyond STEM and Computer Science in the hiring process. Where we can do that there has been an increase of 10-15 % in the female proportion. Across Europe there is not enough skilled female talent to drive this commitment. The average % of females graduating in Computer Science degrees across Europe is just 10-15%; this increases to just 20-5% for STEM and Business Informatics courses. In many countries (e.g. Czech Republic, Poland, Turkey, UK) these % are decreasing year on year."*

Another respondent agreed:

> *"Diversity is a hot topic. The company has a long history on hiring and promoting females and being an inclusive company. We have specific targets and take this very seriously. Not for the target, but because it's our fundamental belief that diversity and inclusion drive better performance and engagement overall. We have special programs to help women come back after those crucial years including mentoring."*

Partnerships for talent development

The IDC report identified the need for more comprehensive partnerships within ICT ecosystems to address the skills gap. All respondents saw collaboration as key. The IDC report suggested that while in the past, cooperation between the ICT industry and the education sector was often seen as a hallmark of successful educational policy, success in the future would depend its depth and breadth, as well as cooperation between employers (ICT suppliers and large employers in other industries), with support from national and regional policymakers. Most major ICT suppliers now cooperate with universities on technical training programs, and this is spreading to other employers with large ICT employee bases. Many employers use apprenticeship programs, such as the UK government one. A career path starting with internship in a vendor company during studies and continuing with full-time job employment after graduation with the same company is quite common.

Some ICT vendors interviewed by IDC noted the need for more cooperation within the ICT industry itself. Others supported initiatives aimed at improvement of inclusivity (such as retraining ex-military staff to a career in IT) or at enlarging the talent pool by addressing current gender disparities in ICT employment, either at the education level (e.g.,www.stemettes.org) or by trying to attract women returning to the workplace into ICT, as, described above.

On the other hand…….

Despite concerns of industry, the public sector, education and government about skills shortages, there is evidence that a) signals concerning skills gaps may be inaccurate and b) if the signals are observed, the system rights itself through market forces. Capelli (2012) identified several sources of inaccuracy in skills shortage signaling, for reasons ranging from downsizing of human resources – so inadequate resources are devoted to recruitment, search for perfect fit, too narrow a focus (e.g. lack of diversity)

Self-righting forces include price (rising pay, leading to more entrants and better use of those already in, as well as replacement of humans by automation, particularly using artificial intelligence and robotization), labour movement (internal and external migration), corporate endeavour (a much stronger focus on how to recruit, train, retrain and keep employees in shortage areas) and individual behavioural economic factors (individuals accepting the opportunity and committing to retraining). The perceived ICT skills shortage, has some special "self-righting forces":

- The widespread and often free availability of online training in new ICT and information management approaches, so any worker who takes responsibility for developing their career has the solution on their own computer, table or mobile telephone
- ICT itself has evolved and continues to evolve away from being the domain of technical specialists, to one where individuals can choose how far they want to be technical and how far they want to be business-oriented. Factors in this include the move to a browser basis for many type of information management, and the wide availability (often online and often from small specialist suppliers, even in other countries) of any technical specialism that a user might need
- The fact that ICT can automate tasks of all kinds, whether technical or business, allowing corporations to economize on their use of skilled talent.

Recommendations to ICT skills employers, educators, and policymakers

IDC's recommendations were as follows:

- Elevate workforce training to a strategic initiative. Acquiring new talents with the right expertise is costly. Updating skills of current employee base is less so. Good talent planning should ensure that an organization's current and future business needs are met. Unless workforce training is a strategic

initiative tied to medium-term to long-term development goals and other enterprise-wide priorities, isolated initiatives are unlikely to produce the intended benefits.

- Prioritize learning initiatives that have synergic effects. A well-designed training program will improve skills, but also employee retention and loyalty, may expand the partner ecosystem (including universities) and demonstrate of corporate social responsibility. These effects will help making training investments more profitable.
- Balance the need for training in deep, specific skill sets with cross-functional training. The continuous pressure on achieving excellence may drive companies in the direction of focusing solely on training ICT staff in new technologies and functional staff in their respective functional areas. That would be a mistake, as some level of cross-domain understanding can help both areas. This is especially so in digital organizations and industries that are digitally transforming. Recurring themes in digital transformation include speed, agility, and responsiveness to market conditions and changing stakeholder expectations, requiring changes in working practices and ways of collaborating and different employee skill sets, with an emphasis on new and hybrid skills such as technology and business understanding, analytical capabilities, teamwork, and communication.
- Engage managers at all levels in talent planning i.e. for timely availability of skills. Career paths are becoming more fluid; new technologies are emerging more rapidly. Organizations need a conscious process of planning, reviewing, and executing skill development, both through training and on the job. The human resource function should focus on talent management.

For educators and policymakers, the main IDC recommendations were:

- Use your industry ecosystem. Use the industry ecosystem not only to channel your students and graduates into ICT industry jobs, but also to keep education relevant and attractive for students and future employers. Consider combining the theoretical base of science, technology, engineering, and mathematics (STEM) education with ICT industry context and connections (e.g., internships or workshops led by ICT industry experts) to provide more practical curricula elements.
- Enlarge your industry ecosystem. While having a major industry partner is helpful for any educational institution to ensure relevance of education, there are benefits to working with several industry stakeholders. The speed of change makes it risky to focus curricula on a narrowly defined set of technologies that may lose relevance. A broad ecosystem of industry partners ensures curriculum relevance for present employers, reducing dependence on one technology or vendor offering.
- Develop graduates with hybrid and soft skill sets. Soft skills such as communication, problem solving, and ability to learn are key graduate hiring criteria. Technology graduates are in higher demand if they have a reasonable understanding of the application of technology to business. In this digital age, broadening teaching about the impact of technology to different fields of study will benefit students. So, "cross pollination" between technology and other studies will be key for graduates' employability.
- Enable more active lifelong learning. Policymakers must remove obstacles relating to regulations and incentives for lifelong learning. Matching training with work-life balance and meeting business goals demands new incentives to take up lifelong learning. This ensure a continuous supply of a skilled workers and could support national and regional competitive advantage. Citizens should increasingly be encouraged to participate in education not just to get ready for work life, but throughout life as part of lifelong learning, especially since the retirement age is increasing in most European countries.

We would add to these recommendations the need for corporations to work "with the market", as described above, observing the market pressures at work and the responses of corporations, institutions and individuals to them, rather than trying to create their own solutions. In practice, a strong consensus is emerging about how the market must deal with the shortage, and what universities can and cannot do. Universities do play a key role in developing business understanding and soft skills, including lifelong learning capacity – perhaps a more important role than they might have thought – and a less important role in developing technical skills, with some specific exceptions.

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