

Contents

1. INTRODUCTION	3
2. THE UAE DIGITAL ECONOMY	8
A. Government	8
B. Retail	11
C. Financial services	13
D. Media	15
3. THE DIGITAL & COMPUTER SCIENCE SKILLS SHORTAGE IN THE UAE	19
How do UAE organisations meet these skills needs?	20
Building and updating digital services: The five capabilities needed	23
A. Project management	24
B. User experience	24
C. Programming	25
D. Data science	26
E. Cybersecurity	26
4. THE SUPPLY OF EMIRATI COMPUTER SCIENCE TALENT	29
A. Higher education: Student volume and curricula	29
B. The quality of degree programmes	35
C. Post-graduate employment	36
5. POLICYMAKERS' PLAYBOOK	38
CONCLUSION	49



Foreword

Powering the UAE digital economy is an Economist Intelligence Unit (EIU) report for Al Bayt Mitwahid that was commissioned by Google. The findings are based on an extensive literature review of more than 150 studies and an interview programme conducted by the EIU between August and December 2016. In total, more than 60 representatives from government entities, the private sector and academia were interviewed. The report's appendix contains a list of interviewees. The final draft of the report was completed in May 2017.

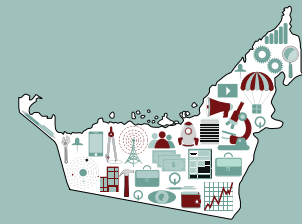
The EIU bears sole responsibility for the content of this report. The findings and views expressed do not necessarily reflect the views of the commissioner. The report was produced by a team of researchers, writers, editors, and graphic designers, including:

Conor Griffin – Project Director
Norah Alajaji – Project Manager
Louise Redvers – Researcher
Michael Martins – Researcher
Andrea Arricale – Researcher
Janet Sullivan Cross – Editor
Gareth Owen – Graphic Designer

For any enquiries about the report, please contact:

Conor Griffin
Principal, Public Policy
The Economist Intelligence Unit
Dubai | United Arab Emirates
E: conorgriffin@eiu.com
Tel: + 971 (0) 4 433 4216
Mob: +971 (0) 55 978 9040

Norah Alajaji
Consultant, Public Policy
The Economist Intelligence Unit
Dubai | United Arab Emirates
E: norahalajaji@eiu.com
Tel: + 971 (0) 4 446 3147
Mob: +971 (0) 52 825 1888



1. INTRODUCTION

Imagine for a moment that UAE government leaders had access to a unique portal, an innovative device that would allow them to explore the next 10 or 20 years. What would they see? Some trends are already clear. The mobile Web will become the nervous system of future civilisation. Backed by advances in machine learning, a growing share of everyday services will become *digital* and *personalised*. UAE customers will make purchases, pay bills and transfer money by speaking directly to their smartphone. UAE schools will use personalised learning platforms to address students' specific knowledge gaps. Before investing in the country, businesses will seek advice from the government's team of digital personal assistants.

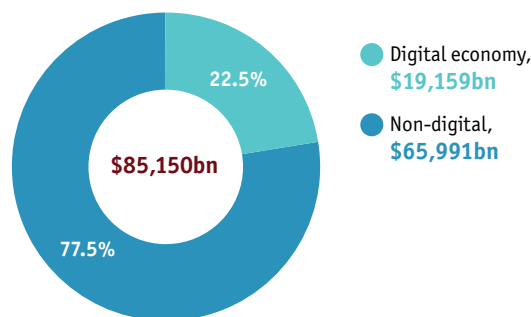
These shifts will have a profound impact on the make-up of the UAE economy and the types of jobs available locally. In particular, they will place a growing premium on employees with computer science skills. How should the UAE government prepare for such a future? This is the question that we address in this study.

The world's digital economy is outpacing its offline economy

The digital economy does not describe a new industry. Rather it describes the economic contribution to all industries made by digital technologies such as cloud computing, mobile devices,

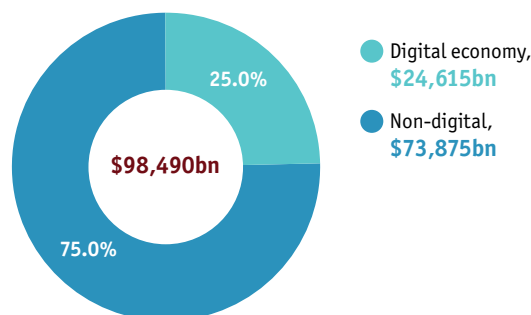
The world economy is becoming digitised

2015 global economy



machine learning, and others. At the heart of the digital economy is a new generation of services. In the digital world, the traditional distinction between products and services no longer applies. Digital "services" include *transactions* that are carried out entirely online, such as making a purchase on an ecommerce site, as well as *products* consumed entirely online, such as online games.

2020 global economy



Led by the rise of digital services, between 2016-20 the global digital economy will expand by more than 25%, in total, outpacing the non-digital economy's growth of 10%.¹ Owing to increased mobile penetration, which will reach more than 70% by 2020,² the total revenue generated by mobile apps will more than double by 2020, reaching almost US\$80bn.³ Global ecommerce sales will also more than double in the next five years, exceeding US\$4trn.⁴

Source: Accenture.



Powering the UAE digital economy

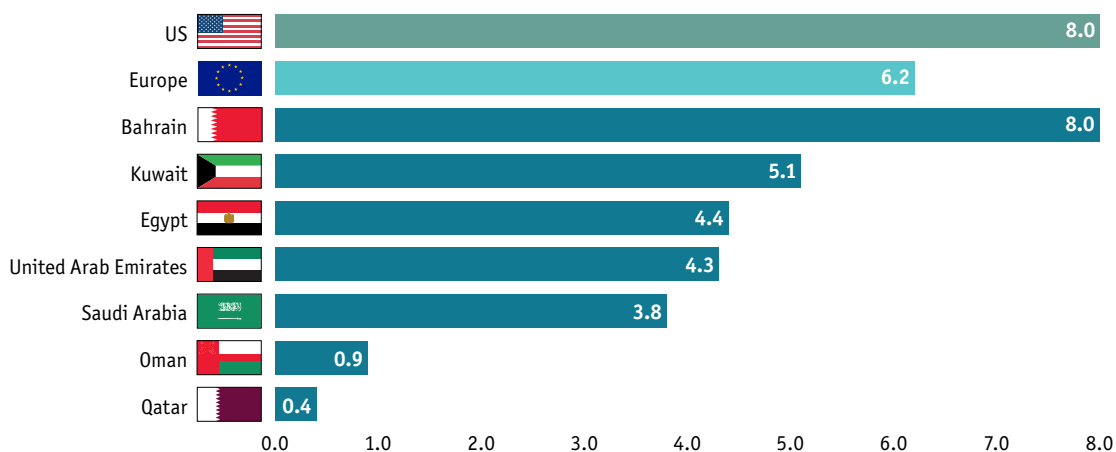
Developing the UAE's computer science talent

The UAE's digital economy is growing, but there is still significant scope for expansion

A recent Mckinsey study estimated that the UAE's digital economy accounts for just 4.3% of GDP, compared with 6.2% in Europe⁵ and 8% in the US, and that the country is capturing only 16% of its "digital potential".⁶ Notably, ecommerce in the UAE accounted for just 4% of retail sales in 2015, compared with almost 15% in the UK.^{7,8,9}

The contribution of the UAE's digital economy is low compared with international benchmarks

(Share of digital contribution to GDP, %)



Note. Europe includes France, Germany, Italy, Sweden, United Kingdom.

Source: Mckinsey.

However, demand for digital services among the UAE public is high, and so there is scope to expand the country's digital economy substantially. 85% of the country's population have at least one mobile phone, a world-leading rate. The average UAE user spends just over four hours per day on their phone, and estimates suggest that approximately 40% of app users regularly make in-app purchases, compared with a global average of less than 10%.^{10,11,12}

Partly owing to UAE consumers' high smartphone usage, more than 85% of them now prefer online banking to visiting a branch, while more than 80% of UAE residents would like to access more government services through digital channels.¹³ This desire for a digital experience will transform the country's key industries. For example, the 26% forecast growth in ecommerce in the UAE between 2016-20 significantly outpaces the country's overall retail sector, which will grow by just 2.9%.¹⁴

On current trends, the EIU expects annual UAE real GDP growth to average just over 3% over the next five years, down from 4.2% over the past five years. Expanding digital services could boost this GDP growth rate in two main ways. First, digital services are typically cheaper to provide than offline services, boosting productivity.¹⁵ Productivity in the UAE economy declined by almost 1% in 2016, so such a boost would be welcome.¹⁶

Second, digital services are cross-border in nature, enabling them to expand the market for UAE firms—the local ecommerce firm Souq.com already sells to customers across the region. To grow further, the UAE needs to encourage a greater number of internationally-focused *unicorns*—digital



startups with a market capitalisation of more than US\$1bn. To date, Souq.com is the UAE's only unicorn. However, the UAE's new venture capital laws could potentially transform the country's growing crop of digital startups, many of which are analysed in this report. While the new law is still in its early stages, it could open up access to new sources of funding and reduce the reliance of UAE startups on traditional investors (who are often family and friends).

The UAE's first challenge: Uneven investment in digital services

Based on interviews, the EIU has discovered that investment in digital services is markedly uneven across the UAE. While some companies and government entities are staking their futures on the digital economy, others remain focused on traditional offline services and have limited their digital investment. A recent survey by Strategy& and Siemens found that just 37% of UAE companies have a dedicated corporate strategy for how to leverage digital technologies, and just 4% believed they were at an advanced stage of their digital transformation.¹⁷

In the media industry, few of the UAE's main newspapers offer standalone *paid* digital subscriptions. In financial services, the UAE's main banks have not invested heavily in new fast-growing digital banking models, such as peer-to-business lending, unlike their peers in the US and the UK.¹⁸ For digital government services, some emirates have created "one-stop-shop" websites and apps that group services together, but others have yet to do so.

The UAE's second challenge: The need to improve computer science skills

Just over 2% of the UAE's workforce is made up of digital talent compared with almost 4% in the US and Europe.¹⁹ For UAE organisations investing in digital services, the importance of computer science skills in particular cannot be overstated. To launch and enhance digital services, UAE companies and government entities need employees with five core capabilities: programming, user experience, project management, data science and cybersecurity. Computer science is either a crucial prerequisite, or is increasingly important, to each of these capabilities.

However, the supply of local computer science talent in the UAE is severely limited. A global talent shortage is making expat computer science talent more expensive and the supply of Emirati talent more important. While there are approximately 5,000 Emirati students enrolled in IT-related degrees in the UAE, less than 5% are enrolled in computer science degrees. More than 80% are studying IT degrees, which were designed with "traditional IT" jobs, such as IT management, administration, and support, rather than digital economy jobs, in mind. The low number of Emirati students enrolling in computer science degrees is due to a lack of necessary skills in mathematics and programming; misperceptions about career prospects for computer science graduates; and financial and social incentives to pursue other degree programmes, such as engineering.

Owing to the constrained local supply of computer science skills, UAE state-owned companies, large corporates, and even many government bodies must rely on outsourcing, offshoring and individual contractors—an unsustainable model which cannot support long-term digital economy growth.



Powering the UAE digital economy

Developing the UAE's computer science talent

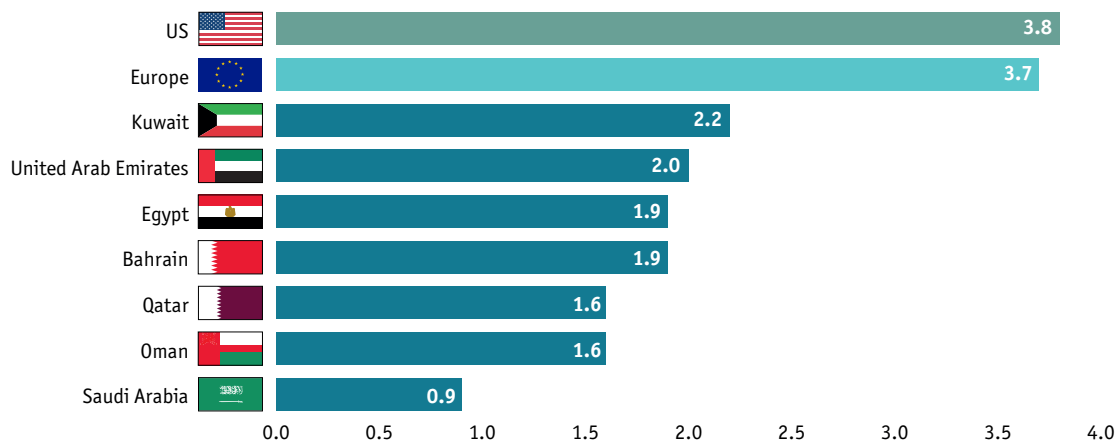
A playbook of recommendations for UAE government leaders

To address the UAE computer science skills shortage, this report maps out a playbook of recommendations for UAE government leaders to:

1. Popularise computer science among Emirati students and tackle misperceptions that a computer science degree limits students to "traditional IT" jobs
2. Boost the capacity of Emirati students to pursue digital economy and computer science careers by revamping the teaching of computer science in UAE schools and higher education institutes
3. Enable the UAE to attract and retain leading global experts and alleviate the local skills gap in the short term

The UAE is lacking digital talent

(Digital talent as share of total, %)

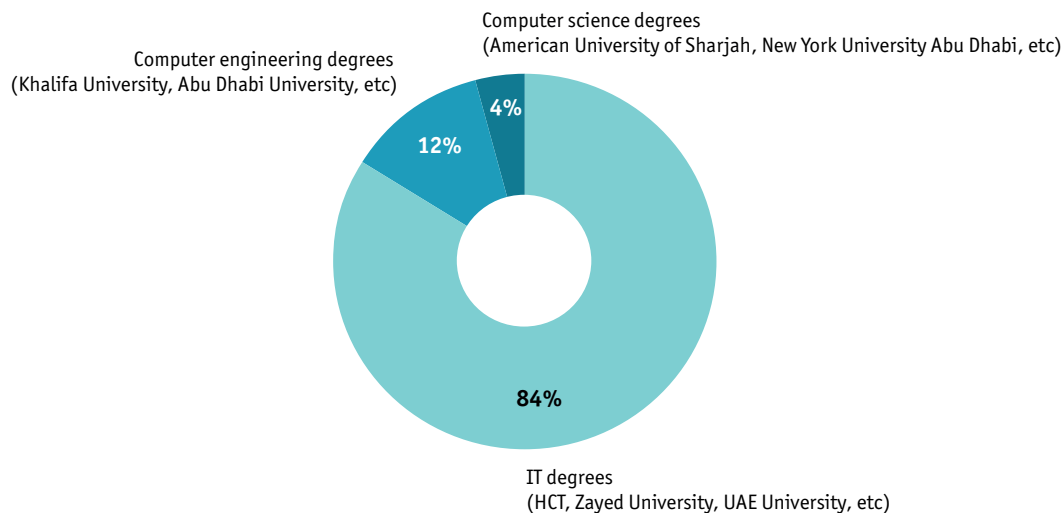


Note. Europe includes France, Germany, Italy, Norway, Spain, Sweden, United Kingdom.

Source: Mckinsey.

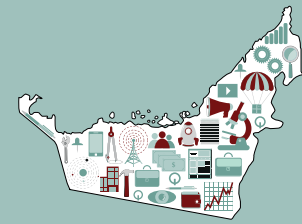
Most Emirati students are enrolled in IT programmes, not computer science

(Emirati students enrolled in IT-related degree programmes, by study area)



Note. These figures are estimates based on the number of students enrolled in major degree programmes.

Source: Economist Intelligence Unit.



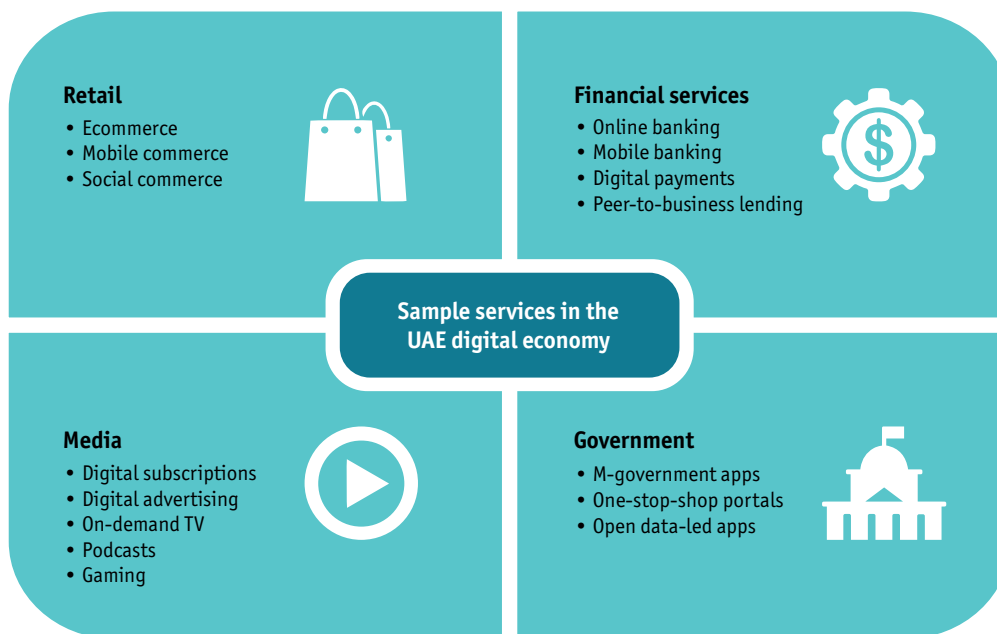
A breakdown of the report

The remainder of this report contains four sections. We first examine how digital services are transforming the UAE's government, media, financial services, and retail sectors. We analyse the government, financial services, and retail sectors because these are major employers and large contributors to the UAE non-oil economy. We analyse media because of long-term plans targeting it as a new growth sector.²⁰ Second, we examine the primary skills needs faced by UAE-based organisations launching and expanding digital services in these four strategic industries. Third, we analyse the current and future supply of Emirati computer science students, and the extent to which they will be able to meet UAE employers' skills needs. Finally, we conclude with a playbook of policy recommendations to address the UAE computer science skills shortage.



2. THE UAE DIGITAL ECONOMY

Sample services in the UAE digital economy



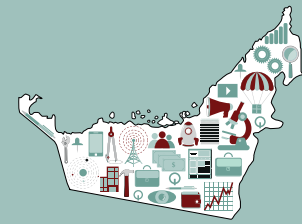
Source: The Economist Intelligence Unit.

A. Government

UAE government entities are digitising their services for two reasons. First, citizens expect it. A 2014 report found that 81% of UAE residents would like to access more government services through digital channels.²¹ The second reason is economic. According to UK Cabinet Office estimates, a digital transaction is up to 20 times cheaper than one made by telephone; 30 times cheaper than one made by post; and 50 times cheaper than a face-to-face transaction.²² A 2016 Smart Dubai Office report estimated that every dirham the emirate invested in its digital services led to almost three dirhams in savings for the government, through reduced expenditure on infrastructure, support services and personnel.²³ To boost savings further, digital services may start to leverage blockchain technology - a distributed database that maintains a list of ordered records called blocks. In October 2016, the Dubai government announced plans to shift all its transactions to blockchain by 2020. According to the government's estimates, the move will save 25m man-hours per year.

UAE government entities have a high online presence

All emirates in the UAE have government websites that, in some instances, allow citizens, residents and businesses to dispense with the need to visit a government service centre in person. As a testament to its progress, the UAE ranked 12th on the 2016 UN Government Online Service Index. The index assesses 193 UN member states on the extent to which they offer information and services online (the



UK ranked first). A 2014 study found that more than 40% of UAE residents use the government's digital services more than once a week.²⁴

The quality of digital services differs by emirate and entity

In the UAE, public data on the use of the government's digital services is limited. The Boston Consulting Group found that more than 40% of UAE residents used the government's digital services more than once a week in 2014. 52% of those surveyed were satisfied with the services' quality.

The 48% who were not satisfied cited a desire for services that were easier to use and more personalised, and the ability to sign in to multiple services with a single username and password.

The quality of the UAE government digital services varies by emirate and entity. However, across the board, there are three main opportunities for improvement: developing comprehensive "one-stop-shop" portals that incorporate all core services in a single site and app; designing services around user needs; and developing open-data led services in partnership with the private sector.

1. One-stop-shop portals should include all relevant services

In most cases, the UAE's digital services are provided by a single entity, such as the Ministry of Interior, whose popular app²⁵ allows people to register their car, pay fines and renew passports and visas. To motivate government entities to launch and improve their apps, the World Government Summit runs an annual "Best Mobile Government Services" award. In 2017, winning apps included those provided by the Abu Dhabi Tourism and Culture Authority, Dubai Roads and Transport Authority, and Dubai Police.

However, to offer a better experience to UAE end-users, government entities are starting to group their services on "one-stop-shop" portals, such as mRAK, launched by the Electronic Government Authority in Ras Al Khaimah. However, the number of services that UAE users can access varies markedly by emirate, and generally lags those of global leaders such as the UK, whose Gov.uk portal integrates digital services from 25 ministries into a single website.²⁶ The UK tops the UN's annual E-government survey.²⁷

In the UAE, the DubaiNow app is arguably the most comprehensive one-stop-shop portal. It provides users with access to more than 50 government services from 22 entities. Residents can use the app to pay utility, Internet and municipality bills; view school ratings; send pictures of traffic violations; and view the status of court cases. In Abu Dhabi, the eGovernment gateway fulfills a similar role, although there are fewer services. In the Northern Emirates portals are less common. In Sharjah, for instance, citizens and residents must navigate different websites and offline channels to access the services contained in DubaiNow.

2. Services should be designed around user needs

Rather than simply moving an existing offline government service online, "user-centred design" ensures that digital services are designed around users' lives and needs. To do this, government entities must study users' lives and habits, engage them early on with basic prototypes, obtain feedback, and then return with new iterations. This is the process followed in the UK, a global pioneer in adopting user-centred design for government services. All services housed on the Gov.uk portal must also adhere to common design guidelines and re-use the same chunks of open-source code.^{28,29}



Powering the UAE digital economy

Developing the UAE's computer science talent

The EIU has discovered, through an extensive interview programme, that awareness about user-centred design in UAE government entities is relatively low, as are the budgets allocated to it. However, individual examples are emerging. Two years ago, Smart Dubai Government³⁰ set up a user experience lab with an “eye tracker” machine to assess how users responded to different website and application designs. This work fed into the DubaiNow mobile app. The app still has some bugs to iron out, but its rating on both the Apple iTunes and Google Play stores exceeds four out of five stars, based on almost 1,000 reviews.^{31,32}

Another way UAE government entities can make their digital services more responsive to user needs is by implementing chatbots. The Singapore government is trialling chatbots to allow citizens to speak and type their query and receive instructions on a 24/7 basis, rather than having to navigate menus and pages of text. UAE government entities have started to adopt similar approaches, although few chatbots have yet gone live. In 2016, the Smart Dubai Office and the Dubai Department of Economic Development launched Saad, a chatbot that answers a range of questions from potential investors about how to set up a business in Dubai.

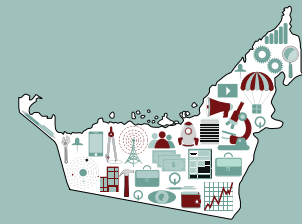
3. The government should work with the private sector to develop open-data apps

Globally, a new suite of digital services are emerging that draw on open government data but that are created outside of government. These open-data apps can directly boost the size of the digital economy. Partly owing to these apps, the UK government estimated the economic value of releasing open data in 2012/13 at £1.8bn (US\$2.2bn).³³

One example is Citymapper which allows users to plan their journey across almost 40 major cities in the world, based on real-time traffic, public transport and weather updates.³⁴ The app draws on data released by government bodies, such as Transport for London, but UAE cities are not included. Similarly, Zoopla is a website where buyers can browse properties for sale or rent. For UK properties, it includes an estimate of value, based on government transaction data. However, estimates are not available for UAE properties listed on the site.

For open-data apps to emerge in the UAE, the government would have to release more government data, encourage companies and individuals to use it, and clarify regulations about how the subsequent apps could be sold. In Dubai, the Data Law that came into effect in 2015 mandates that all data within the emirate, excluding that which is “personal, sensitive or confidential”, be made open for public use, by default, in common formats. The accompanying *Dubai Data Manual* stipulates that government entities are responsible for working with private sector partners to promote the use of the data in new innovative services.³⁵ However, it remains unclear how the requirement to share data will be balanced with personal and commercial privacy.

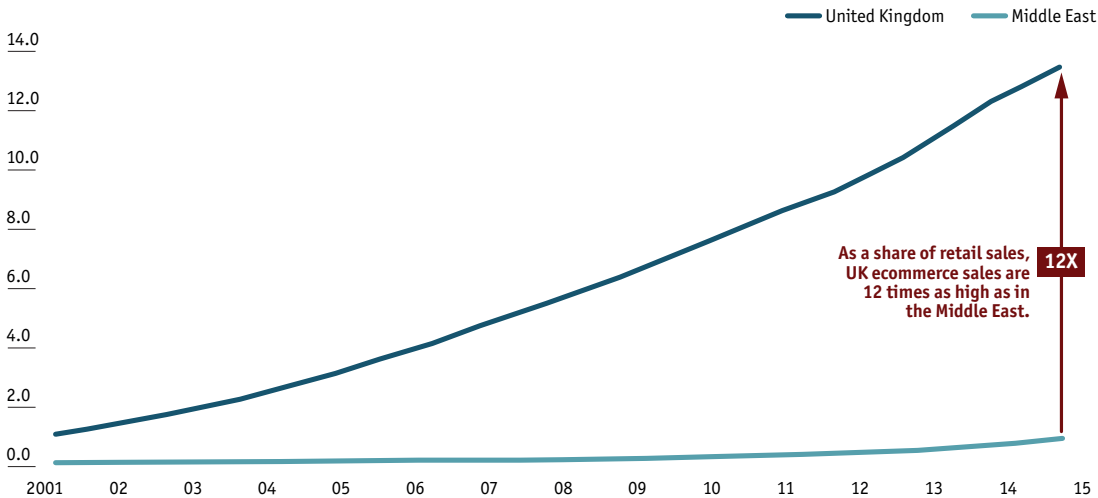
To date, the actual release of government data remains limited, and the UAE ranks 98th on the Global Open Data Index, just behind Côte d'Ivoire.³⁶ The index measures the extent to which government bodies in each country have released 13 key types of data, such as detailed maps and company register data. Although bodies such as the Open Data Institute have established themselves in the UAE, and “hackathons” take place from time to time, in most cases government agencies do not take part in these hackathons, unlike in the countries that perform best on the Global Open Data Index, such as Denmark and Taiwan.



B. Retail

The Middle East ecommerce market has considerable potential to grow

(Ecommerce sales as a percentage of total retail sales)



Source: Euromonitor, McKinsey.

UAE retail sales are slowing, but ecommerce is growing rapidly

The UAE is a leading global shopping destination and its retail sector is one of the most important components of the non-oil economy, accounting for almost 13% of GDP in 2015, when total retail sales topped US\$67bn.³⁷ However, the EIU estimates that retail sales declined by more than 2% in 2016, as low oil prices curtailed domestic consumer spending and higher-spending tourists from oil-exporting countries such as Russia.

Ecommerce could reignite the UAE retail sector's growth. Globally, the UAE is a relative ecommerce laggard. Just under 4% of retail sales were made online in 2015 (US\$2.5bn), compared with approximately 7% in Singapore, 8% in the US, and almost 15% in the UK.^{38,39,40} However, this is starting to change and the UAE's ecommerce sales are forecast to grow by an average of 26% per year between 2016-20.⁴¹ As a result, ecommerce sales in the UAE are forecast to exceed US\$8bn in four years.

UAE ecommerce firms serve the wider Middle East

A 2015 survey by Mastercard found that Souq.com was the most popular site among UAE ecommerce customers, with over 45% of respondents having made a purchase from the site during the previous three months.⁴² Souq.com claims to be the largest ecommerce platform in the Arab world and offers over 1.5m products across 31 product categories. It completed a new funding round last year, and was recently acquired by the US giant Amazon for almost US\$600m. According to Mastercard's study, Amazon is the second most popular ecommerce site in the UAE, with 16% of respondents having made a purchase from the site in the previous three months. Other UAE ecommerce platforms focus on more niche segments, such as Namshi and MarkaVIP (fashion), and Dubizzle (second-hand goods). A new startup, Shedd, caters to the UAE's transient expat population by providing departing residents with a platform on which to sell their luxury fashion items.



Powering the UAE digital economy

Developing the UAE's computer science talent

The larger UAE ecommerce firms sell across the Middle East, and the regional market will be crucial to their future growth prospects. Ecommerce in the Middle East accounts for just 1% of GDP—considerably less than the rates seen in China, the UK and US, according to data from Gartner, a consultancy firm. However, the region's growth prospects are robust.⁴³ In Saudi Arabia, ecommerce is set to grow even faster than in the UAE, at 37% per year to 2020.⁴⁴ Recognising the market potential, Mohamed Alabbar, chairman of property giant Emaar, recently announced the launch of a new US\$1bn ecommerce platform, Noon.com, with Saudi Arabia's Public Investment Fund. The firm will be headquartered in Riyadh, but is constructing the world's largest warehouse in the UAE to support its business operations across the Middle East.

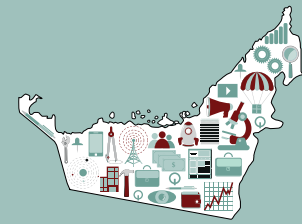
To expand sales, UAE ecommerce firms are investing in mobile and social media

A 2015 survey found that one-third of all UAE online purchases are made on smartphones, consistent with the global average of 35%.⁴⁵ However, mobile shopping rates are higher on UAE ecommerce platforms which have invested more heavily in an enhanced mobile shopping experience. According to Souq.com, almost 50% of all purchases on its site are made on mobiles.⁴⁶ This explains why mobile programmers are increasingly sought after by UAE ecommerce firms (see section 3 below).

To boost the mobile shopping experience, UAE ecommerce firms are focusing on personalising the shopping experience. In principle this is nothing new: Amazon's algorithms have long suggested products based on consumers' previous searches. However, as machine learning evolves, more sophisticated forms of personalisation are becoming possible. Souq.com is exploring whether personal assistants, such as Apple's Siri, could interact directly with ecommerce customers and advise them on what to purchase. Machine learning is also improving real-time translation, which could allow firms to cater to users in their native language.

Global examples of machine-learning-based personal assistants demonstrate their potential to drive ecommerce sales, although they are continuing to iron out bugs. For example, The North Face, an outdoor clothing and equipment company, recently used IBM's Watson platform to create a personal shopper app that allows customers to ask questions such as: "I'm heading on a desert trip to UAE in December—what jacket should I purchase?", before directing them to the most appropriate product. These trends highlight why data scientists and machine-learning experts are in growing demand.

With over 70% of the UAE's population using social media daily, compared with a global average of just over 30%,⁴⁷ UAE ecommerce firms are also exploring the world of *social commerce*—that is, using social media and messaging platforms such as WhatsApp to engage and sell to customers. Over the past five years, individual UAE entrepreneurs have used Instagram and YouTube to sell handmade jewellery, and established firms such as the airline Emirates are now following suit. As explained in interviews with the EIU, UAE ecommerce platforms such as Souq.com have also noted how a growing proportion of WhatsApp users are sending voice messages rather than typing out text messages, and are exploring whether their sites can offer a voice-based shopping experience. Such trends help to explain the growing demand among UAE ecommerce firms for user experience architects and programmers (see section 3 below).



To keep pace, traditional retailers must ramp up their ecommerce efforts

Only 41% of the UAE's major retailers offer ecommerce services, compared with almost 60% in the US.⁴⁸ Franchises are often not allowed to offer online sales, and when they do they typically offer only a fraction of the products available on their global sites. The UAE's largest grocery retailers—Majid Al Futtaim's Carrefour and Lulu—offer home delivery and also allow online customers to pick up items in store, but the functionality of the sites is quite basic and only a limited range of items are available.

There are some exceptions. Landmark Group launched LandmarkShops.com in 2012. Between 2013-16, the site's revenue grew by 135% per year and the firm now has an in-house digital team of more than 150 people.⁴⁹ In November 2016 Landmark announced a new strategy to equip seven of its core brands, including Splash, Babyshop, Centrepoint and Home Centre, with dedicated ecommerce websites and apps.⁵⁰

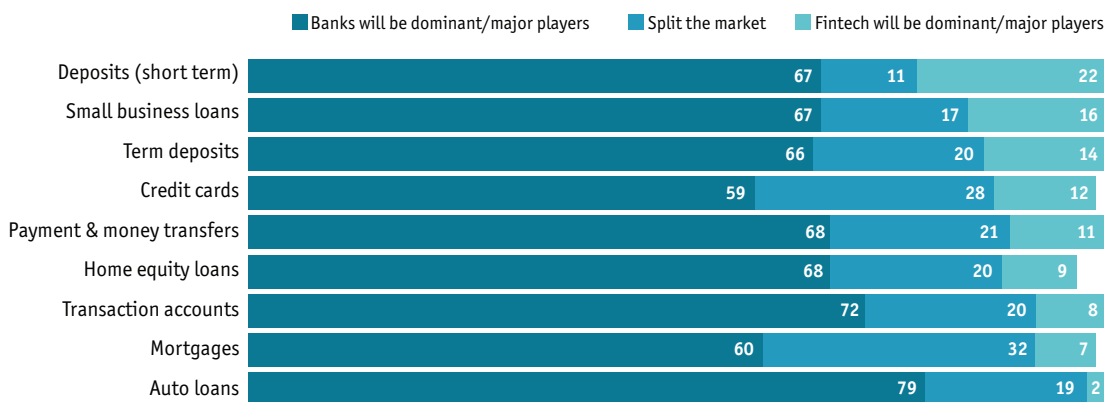
C. Financial services

Like the retail industry, the UAE's financial services sector is one of the most important components of the country's non-oil economy, comprising almost 10% of GDP in 2015.⁵¹ Globally, digital services are disrupting the financial services industry at an unprecedented pace. Traditional banks are launching more sophisticated digital and mobile banking services, while financial technology—"fintech"—startups are launching new digital services that are eating into banks' traditional revenue streams. Unlike banks, fintech firms typically focus on one service, such as loans, payments, or foreign exchange remittances.

A 2015 EIU global survey found that fintech firms are likely to take a sizeable chunk of global banking business by 2020—as shown in the graphic below. In the UK alone, investment in fintech increased by 35% in 2015, and fintech firms generated more than £6.6bn (US\$8.2bn) worth of revenue.⁵² As the home of a global banking hub, these developments are highly relevant to the UAE, as they suggest the country will need to boost its local fintech sector if it is to remain a global financial services leader.

Fintech firms will account for a greater share of banking services by 2020

(Survey of global executives - what is the expected balance between banking and fintech in 2020?)



Note: Owing to "don't know" replies, answers do not all sum to 100.

Source: EIU, HP.



Powering the UAE digital economy

Developing the UAE's computer science talent

Digital banking in the UAE: Going mobile

Over the past decade, UAE-based banks and insurance companies have rolled out ever-more sophisticated websites, and the ten largest domestic banks now have mobile apps.⁵³ Some of these apps, such as those of Emirates NBD and Abu Dhabi Islamic Bank, are cutting-edge. Emirates NBD's app even allows users to snap a picture of a cheque and deposit it directly through their phone. However, not all banks provide sophisticated digital banking. 55% of mobile banking users in the UAE are dissatisfied with the current mobile service offered, owing to frequent difficulties in accessing services, slow transaction speeds, poor user experience, and a lack of real-time support.⁵⁴

As a result, only 34% of the UAE population regularly used a mobile banking app in 2015—higher than in Kuwait (27%), Qatar (19%), and Saudi Arabia (15%), but behind the US (51%) and Turkey (45%).^{55,56} UAE mobile banking is typically used for basic services such as balance-checking, rather than more complex transactions such as opening and closing accounts or applying for loans. These interactions still require a visit to a branch or call to a customer support centre, and customers opening bank accounts—particularly those on lower incomes—must navigate a considerable amount of red tape. This is a common challenge across the region. A 2016 Nielsen study found that the Middle East and Africa had the lowest adoption of complex mobile banking services in the world. This makes the UAE's cost of banking higher than in countries with more sophisticated mobile banking services.

Boosting user experience and introducing “digital-only” banks

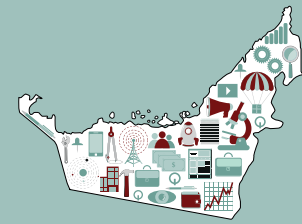
To boost the adoption of digital banking, leading UAE banks are trying to improve customer experience. Emirates NBD plans to invest AED500m (US\$136m) over the next three years in digital technologies, and recently launched a “fintech competition” to source ideas. One of the winners, The Fluid Motion, uses machine learning to allow devices to recognise human gestures and movements. This could allow customers to open accounts or apply for loans by swiping at a screen in their home.

UAE banks are also launching “digital-only banks”. Abu Dhabi Islamic Bank believes that millennial customers—those born between the early 1990s and 2000s—expect digital services and will stop using traditional banking. With this in mind, it recently announced a partnership to bring Fidor, a German digital-only bank, to the UAE and the Middle East. It will compete against a growing number of UAE banks, including Commercial Bank of Dubai and Emirates NBD, which have also announced new digital-only banks.

Digital payments: The UAE's march to a cashless society

Two of the primary barriers to boosting UAE ecommerce are the high cost of accepting online credit card transactions (for merchants) and trust concerns (for consumers). As a result, 80% of the UAE's online purchases are settled with cash-on-delivery, compared with just 11% in the UK, and 20% and 24% in the US and EU, respectively.⁵⁷ This high use of cash is inefficient and increases security and compliance costs for retailers based in the UAE.

A broad range of companies in the UAE, many of them outside the traditional banking sector, are now offering UAE retailers secure, low-cost channels for accepting online payments. One example is PayFort, a UAE payments provider that works with more than 1,000 retailers across the UAE to help them accept online payments.



The future evolution of digital payments in the UAE is still very much up for grabs. Mobile wallets offered by leading global technology firms, such as Apple Pay and Android Pay, allow consumers to pay for items through a smartphone app. However, the app is still linked to a user's credit card.

To move away from credit cards, some UAE startups are taking a different approach to digital payments. The UAE financial technology startup Bridg allows customers to use any smartphone to pay for ecommerce purchases on delivery. The delivery person also has a handset and uses bluetooth to process the transaction between the two devices. CashU, the UAE-based Arabic equivalent of PayPal, enables the estimated 140m people in the Arab world without a bank account or credit card to shop online, by providing them with a digital wallet tied to their phone subscription, which they can use on more than 1,000 ecommerce sites.

Peer-to-business lending: A new funding source for UAE SMEs?

A more nascent form of fintech in the UAE is peer-to-business lending—a type of crowdfunding in which businesses borrow from a group of individuals and investors. These online loans are typically unsecured—that is, no collateral is required—and do not involve a bank. In recent years, as small and medium-sized enterprises (SMEs) across the world struggled to raise finance, and investors faced ever-lower interest rates, peer-to-business lending platforms expanded, particularly in global finance hubs that compete with the UAE, such as the UK, US and Singapore. For example, Funding Circle, a British platform that is also active in the US, has disbursed more than £1.6bn (US\$2bn) in loans in the UK.⁵⁸

The rise of peer-to-business lending could be highly pertinent to the UAE's goal of supporting SMEs. SMEs contribute 60% to the UAE's non-oil economy, but their share of total bank lending is estimated at less than 5%. Beehive—the UAE's first online peer-to-business marketplace—was launched in 2014 and has already funded more than AED50m (US\$14m) in loans to small businesses.⁵⁹ While the firm's loans account for a tiny share of the US\$375bn in lending that was disbursed in the UAE in 2016,⁶⁰ the government is signalling its support. In 2016, Abu Dhabi Global Market announced plans to promote the UAE capital as a fintech hub for the Gulf Cooperation Council. As many fintech startups operate in a regulatory grey zone, the financial free zone wants to create a regulatory laboratory, or "sandbox", where new firms can be launched under less onerous regulations, akin to those seen in the UK and Singapore.

D. Media

The UAE's media industry is relatively small and the Federal Competitiveness and Statistics Authority does not provide data measuring its size or economic contribution, yet the 2016 Arab Media Outlook estimated the industry's annual revenues in the UAE at just over US\$2.1bn (AED7.7bn)—less than 1% of GDP.

UAE media consumption is clearly shifting to digital modes. 81% of the country's Internet users use YouTube and 55% use Twitter. 55% regularly access news online and almost 30% watch films online at least once a week.⁶¹ In 2015, almost 60% of the population paid for digital media in some form, with 10% paying for online news.⁶² In response new digital Arabic-language offerings have come on stream, in the UAE and across the region, such as Istikana (videos) and Anghami (music). However, the market for high-quality Arabic digital content is still relatively untapped—just 3% of the world's digital content is in Arabic, even though more than 5% of the world's population speaks Arabic.⁶³



Powering the UAE digital economy

Developing the UAE's computer science talent

Print circulation and advertising is falling in the UAE

21 major newspaper titles were published in the UAE in 2015 and total circulation was approximately 1.5m.⁶⁴ The UAE is also a publishing hub for regional magazine franchises such as *Grazia*, *Stylist* and *Cosmopolitan*, with total circulation reaching almost 12m in 2015.⁶⁵ However, UAE newspapers and magazines are suffering a sharp fall in print circulation and advertising. Between 2010-15, newspaper circulation in the UAE fell by almost 10% while newspaper advertising fell by almost 30%—from US\$473m to \$335m (from AED1,737m to 470m). Magazine advertising declined slightly over the same period to just over \$80m (AED294m).⁶⁶ Feeling the effects, in November 2016, the free daily newspaper *7Days* announced that it was ending operations after failing to find a sustainable business model.

The quality of digital services offered by UAE newspapers and magazines is mixed. On the positive side, all of the country's leading newspapers and nine of the top ten magazines have active websites. Leading publications such as *Al Bayan* and *Al Khaleej* also offer mobile apps and maintain active social media accounts. New digital media outlets have also emerged. The Sharjah-based UAE Barq was launched in 2009. It notifies users about new content through SMS messages and active social media accounts. Supported by advertisements, it has become a key news source for individuals in the UAE.

However, other sites offer a less-optimal user experience. According to interviewees, some leading titles do not use search engine optimisation techniques—such as tagging articles with relevant keywords—to ensure their articles are visible in online search results. Only six of the top ten magazines in the UAE have a YouTube channel, and most publications are not available on popular digital aggregators, such as Apple News and Flipboard.

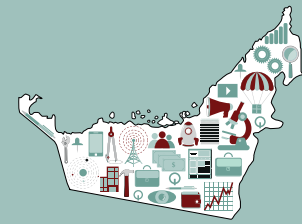
This mixed digital presence partly explains why digital subscription models have yet to take off in the UAE. Many leading international newspapers have moved to a “freemium” model, with users getting access to a small set of free articles online before paying for a digital subscription. However, few leading UAE papers offer standalone *paid* digital subscriptions, limiting their ability to develop new digital revenue streams that could offset the fall in print circulation and advertising.

Revenue pressures are forcing UAE firms to enhance their digital offering

To boost their digital advertising revenue, UAE newspapers and magazines are starting to invest more in the digital services. Condé Nast International and its UAE-based partner, Nevora, launched the bilingual *Vogue Arabia* website in 2016. This was the first-ever “digital first” launch for the *Vogue* brand and the print publication will not launch until later in 2017.

Globally, digital advertising has grown by almost 20% per year over the past five years, while newspaper and television advertising has declined. At just over US\$550m, firms based in the Middle East accounted for less than 1% of global digital advertising spend in 2015. However, their expenditure is growing at almost 40% per year, the highest regional growth rate in the world.⁶⁷ Much of this expenditure is routed through the UAE, as approximately one-third of the region's advertising companies are based in the UAE, partly owing to its supportive free zones.

To build better digital services and attract more advertising revenue, UAE newspapers and magazines have started investing more heavily in their digital teams. Some publications have established in-house digital teams that are using data science to evaluate the quality and reach of

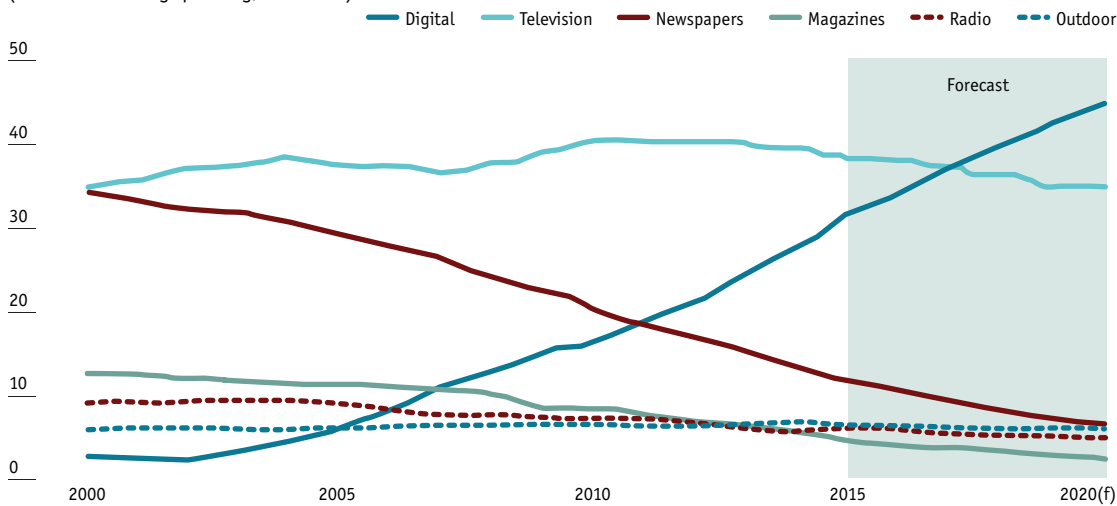


their digital content. Whereas stories and news content have traditionally been selected according to the preferences and decisions of individual journalists and editors, media firms are now investing in data science to monitor what type of articles, layouts, colours and videos drive more “clicks”, leading to demand for data scientists and programmers.

Gulf News is developing a “robo journalism” app that will deliver a bespoke news service, based on reader profiles. Such a service could be well-suited to the UAE, where readers are culturally diverse and there is a need to target content more precisely to meet user needs. Beyond news, *Gulf News* is branching out into ecommerce by becoming a “one-stop-digital-shop” for venues, events and dining out. These new product launches demonstrate how UAE newspapers will need to evolve if they are to stay relevant, and continue to grow, in the digital economy era.

Digital advertising is set to grow, while newspaper and television are set to decline

(Global advertising spending, % of total)



(f) Forecast.

Source: The Economist Intelligence Unit.

UAE firms have been slow to invest in more sophisticated digital advertising models

To boost digital advertising revenue further, newspapers and magazines will need to deploy more sophisticated advertising models. In the US, “programmatic” advertising sales—in other words, those automated by technology—will account for more than two-thirds of online display advertisements sold in 2017. In the real-time-bidding model, algorithms allow advertisers to bid for space on a webpage that a consumer has just clicked on, based on information drawn from cookies and tags that are tracking their online activities. An auction is held, and the “winning” advertisement is displayed to the consumer.

This real-time-bidding process takes place within milliseconds, without human involvement. It allows publishers get the best price for their slots, and advertisers to get the best return on their investments, by targeting their advertising more precisely. Some UAE publishers and media-buying units use programmatic advertising, but it remains relatively rare—estimated at between 15-25% of the UAE’s digital advertising spend.⁶⁸ Brand-sponsored digital content⁶⁹ such as articles or videos also



Powering the UAE digital economy

Developing the UAE's computer science talent

accounts for a negligible share of advertising revenue in the UAE. The failure to deploy these more sophisticated advertising models on a larger scale is hurting attempts to grow advertising revenue in the UAE.

In the television segment, video-on-demand services are growing

More than 90% of the UAE population watch television on a weekly basis. Approximately 80% of these households subscribe to pay-tv services, with this group split almost equally between telecoms companies Du and Etisalat, and pay-tv operators such as OSN.⁷⁰ In 2015, pay-tv revenues in the UAE rose 33% to almost US\$360m, and are forecast to exceed \$520m by 2020, an increase of almost 45%. The UAE-based OSN is the Middle East's largest pay-tv operator, with almost 1.3m subscribers across the region.⁷¹

Across the Middle East, television advertising totalled almost US\$2.4bn in 2015, of which almost 90% is "Pan-Arab", targeting audiences across the region. Precise breakdowns for the share spent in the UAE are not available, but 15% of the region's "free" channels are located in the country, led by MBC, a Saudi-owned regional broadcasting company based in Dubai.⁷² Some estimates put total TV advertising spend in the UAE as high as US\$1bn.⁷³ To boost advertising further, more than 40% of leading TV channels in the UAE have introduced online streaming, with 50% hosting online advertising.⁷⁴

With almost 60% of the UAE population watching YouTube on a daily basis, and one in five prepared to pay for movies online, local television operators are looking to boost digital video-on-demand services.⁷⁵ OSN has a sophisticated on-demand streaming service, OSNGo, which is available as a smartphone and tablet app. The UAE-based Istikana provides a similar service, while the success of MBC's free Shahid.net service led the platform to introduce a subscription model, Shahid Plus.⁷⁶

Gaming and podcasts are future avenues of growth

Beyond digitising newspapers, magazines and television, gaming and podcasts are possible avenues for UAE media companies to boost revenue growth.

Gaming: Over 50% of the UAE population play video games, compared with a global average of approximately 18%.⁷⁷ 71% of UAE smartphone owners play games on their phone, with almost one in five playing several times per day.⁷⁸ Newzoo estimates the total size of the gaming market in the UAE at just over US\$230m in 2016 (AED845m).⁷⁹ A study by Strategy& estimated the value of the Middle East's video games industry at more than US\$1.5bn in 2014 (AED5.5bn), and forecast that this will nearly triple to \$4.4bn by 2022 (AED16.2bn).^{80,81}

Podcasts: Radio's popularity in the UAE is growing. There are now more than 45 radio stations headquartered in the country—an increase of almost 25% since 2011. However, radio advertising revenues are relatively small, at just over US\$50m in 2015, or 8% of the UAE's total advertising market.⁸² Globally, a growing number of radio stations have started to offer podcasts in recent years, helped by new low-cost podcast-creation tools. This has helped to grow the advertising market for radio stations in countries such as the US, where the number of podcasts downloaded has grown by more than 30% per year in recent years. UAE radio stations have a strong digital presence, with the top five stations all having dedicated websites and four having a mobile app. However, the UAE podcast segment has been slower to develop. Only one of the top five radio stations has a podcast.⁸³



3. THE DIGITAL & COMPUTER SCIENCE SKILLS SHORTAGE IN THE UAE

To support the growth of the UAE digital economy, the UAE needs to increase the country's supply of digital skills. Broadly speaking, three types of digital skills are needed to power the UAE's digital economy and the new era of digital services: basic digital skills, complementary digital skills, and specialist technology skills.⁸⁴

The types of skills needed to power new digital services



1. Basic digital skills

- How to use new digital services
eg How to use a new mobile banking app



2. Complementary digital skills

- How to work with new digital services
eg digital marketing; digital ad sales



3. Specialist technology skills

- How to build new digital services
eg programming, cybersecurity



Source: The Economist Intelligence Unit.

This section of the report assesses the demand among UAE employers for category 3—*specialist technology skills*—and the supply of talent within the UAE. Based on the EIU's extensive research, we found no single, robust, publicly-available dataset on the number of specialist technology jobs in the UAE. However, our interviews with more than 50 UAE-based experts, as well as data shared with us by leading UAE job portals,⁸⁵ revealed that organisations launching and expanding their digital services face a severe talent shortage for specialist technology roles. Almost 90% of interviewees believed there was a “moderate” or “severe” skills gap for these roles in the UAE. The shortage is driven by sharply rising demand and limited supply (see section 4 below). According to data from Bayt.com, one of the UAE's leading job portals, the number of specialist technology roles posted in the UAE increased by 55% in 2016, and by 155% over the past five years.⁸⁶

According to UAE employers in the retail, financial services, media and government sectors, the skills gap is most pronounced for five capabilities: project management; user experience;



Powering the UAE digital economy
 Developing the UAE's computer science talent

programming; data science; and cybersecurity. What the five capabilities share is a growing need for computer science skills. Some, such as programming and cybersecurity, require a solid theoretical grounding in computer science. For others, such as data science, user experience and project management, computer science is increasingly important—a machine-learning expert, for instance, must understand statistics and probability, but also be able to code. A project manager overseeing the design and build of a new mobile app must be able to interact comfortably with programming, user experience and cybersecurity professionals.

Beyond being in high demand among UAE employers, these five capabilities are particularly important, because:⁸⁷

- They are in demand across industries, for both junior and senior roles
- There is a preference among UAE employers to hire locally in the UAE, rather than relying exclusively on outsourcing and offshoring
- There is a global skills shortage for these five capabilities, which makes expat hires increasingly expensive

The five most in-demand capabilities among UAE employers

Project management	Data science	User experience	Programming	Cybersecurity
Manage the design, delivery and maintenance of new digital services.	Generate, store, analyse and display the big data that underpins new digital services.	Ensure that digital services are designed around users' lives, habits, and needs.	Develop the digital service and carry out regular updates.	Protect the data and intellectual property that underpin a new service. This includes an organisation's own data and that of its customers or citizens.
Employers increasingly look for candidates with a combination of several capabilities.				

Source: The Economist Intelligence Unit.

How do UAE organisations meet these skills needs?

The capabilities needed differ from traditional IT work

Traditionally, much of an organisation's IT work revolved around maintaining infrastructure, such as networks and data centres, and implementing enterprise-wide software programs. Many UAE firms and government entities outsource this IT work to partners and retain small in-house IT teams to manage the process and ensure accountability. UAE organisations' reliance on outsourcing increased after the global financial crisis as IT budgets came under pressure.

It is difficult to outsource these capabilities

Outsourcing will remain popular for traditional IT work and certain niche requirements, but the UAE's heavy reliance on outsourcing is less viable when it comes to creating and enhancing digital services.



First, today's digital services are increasingly designed using a process known as "agile delivery", which involves a rolling stream of small, quick updates to websites and apps—a sharp contrast to the long-term nature of traditional IT projects. Once a new digital service is launched it needs to be constantly refined. By the time it takes a third-party vendor to understand what a UAE organisation wants, the market has often moved on, leaving the original solution outdated. This need for "agility" has led some UAE organisations to end their reliance on outsourcing companies, and invest more heavily in their in-house teams.

Second, as digital services become more important to an organisation's revenue stream, the risks attached to outsourcing increase. Senior leaders are becoming less willing to accept a "blackbox" app that in-house employees are unable to tweak or fix as required. Moreover, the intellectual property underpinning critical digital services is becoming a valuable asset and was a key driver for firms such as Gulf News in reducing their dependence on outsourcing.

A three-pronged approach to meeting their skills needs

With outsourcing increasingly unviable, organisations in the UAE are using a combination of three approaches to meet their specialist skills needs: hiring individual contractors; offshoring to lower-cost locations; and hiring larger local teams in the UAE.

A. Individual contractors

Building and upgrading digital services is project-based work and so UAE organisations need flexible workforces that can be scaled up and down as needs dictate. Today's leading data scientists and user experience architects often prefer to work independently. They know they are in high demand, and working independently allows them to work for multiple clients, boosting their income while keeping their skills sharp.

Unlike the UK or the US, or regional markets such as Jordan and Lebanon, the UAE lacks a large local community of independent digital freelancers, such as programmers or data scientists, who can work for several firms or government entities on a rolling basis. This is due to strict regulations that require employees in the UAE to have full-time contracts and sponsors. Some UAE free zones, such as Dubai Internet City and twofour54, have started to offer freelance visas, although a limited number have been issued to date.

Digital freelancers looking to obtain visas in the UAE can also set up their own business. By global standards the process in the UAE is relatively fast and straightforward, particularly in free zones, where costs are lower. However, the country still lags behind leading global performers. The UAE ranks 53rd on the World Bank's "ease of starting a business" indicator, due to the number of procedures required and the cost: even in leading free zones, the set-up costs can exceed AED40,000 once licence fees, registration fees, visa costs and other operating expenses are included. These costs could be lowered if some traditional requirements—such as the need to maintain an office—were relaxed for new digital startups for whom they are less relevant.

As a result, UAE organisations looking for short-term technical expertise rely heavily on resourcing companies that provide individual contractors on a project-by-project basis. However, these firms have drawbacks when compared with having a local community of independent freelancers. Individual



Powering the UAE digital economy

Developing the UAE's computer science talent

freelancers can work for companies on an ongoing basis and become embedded in a team. However, this is typically more difficult to do through a resourcing firm which allocates contractors on a project-by-project basis.

B. Offshoring to lower-cost locations

Some of the UAE-based firms spearheading the new generation of digital services such as Souq.com, GulfTalent and PayFort, are unable to find cost-effective local talent in the UAE, so they hire full-time staff remotely (offshoring), with Jordan being a popular location. However, offshoring carries costs because those delivering new digital services must work alongside an organisation's sales, marketing, finance and strategy teams, which are typically based in the UAE. When fintech startup Beehive developed its peer-to-business lending platform in the UAE, collaboration with the marketing and credit teams was key to ensuring a successful roll-out. This also explains why HSBC is building a larger data science team in Dubai, even though the company already has "digital centres of excellence" in India, the Philippines and Egypt.

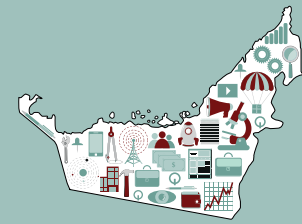
C. Larger local teams in the UAE

Almost 90% of employers interviewed by the EIU cited a desire to hire more specialist technology talent in the UAE. Several, such as Gulf News Media, Dubizzle and EY (formerly known as Ernst & Young), have expanded their local teams in the UAE in recent years. However, many employers are unable to find a sufficient pool of cost-effective local talent within a short time frame.

The first challenge to finding UAE-based talent is that few Emiratis apply for specialist technology roles. Almost 85% of private sector employers⁸⁸ interviewed by the EIU said that no Emiratis worked in specialist technology roles in their organisations, with 80% claiming that none had ever applied for these roles. Even in firms with relatively high Emiratisation rates, Emiratis rarely apply for specialist technology roles. HSBC, for instance, has increased fivefold the number of Emirati graduates it is hiring every year—from ten five years ago to closer to sixty today. However, the vast majority work in banking, accounting, and general business, because HSBC typically does not receive Emirati applications for technology roles. Government entities and government-owned businesses generally perform better. Emirates Group, for instance, has more than 2,700 full-time technology employees, of whom 11% are Emiratis.

As few Emiratis apply for private sector technology roles, firms looking to hire locally rely almost exclusively on expats. However, the expat population is transient, making it difficult to build entire new digital teams and services around them. There is also a significant *global* skills gap for these positions. A 2016 EIU report found that more than 90% of employers across the world faced a "moderate to severe" skills gap for digital skills.⁸⁹ The report also found that the best candidates typically prefer to work in leading tech hubs around the world. This means that UAE employers will need to offer substantial financial packages to attract them.

However, according to the executive search firm Korn Ferry, real wages in the UAE are forecast to rise by just 0.5% in 2017. This is the lowest rate in a decade and well below the wage growth expected in places where demand for skilled technology professionals is growing rapidly, such as Singapore (4.7%), Ireland (2.0%), the UK (1.9%), US (1.9%), and Hong Kong (1.5%). All UAE-based recruitment







firms interviewed by the EIU confirmed that less generous salaries are hurting the ability to attract top talent to the UAE.⁹⁰

The future model: A hybrid of local teams, independent contractors and remote workers

UAE organisations increasingly need a hybrid approach—one that combines a larger in-house team with a body of individual contractors who can be used when needed, and “offshore” resources for certain roles. The primary obstacle to this approach will be the small supply of local Emirati talent coming on stream—see section 4, below.

How do UAE organisations meet their skills needs?

	 Outsourcing	 Individual contractors	 Offshoring	 Larger teams in the UAE
	Outsource the design and maintenance of digital services to third-party vendors	Hire individual specialists on a short-term basis	Hire full-time employees in lower-cost locations, such as Jordan	Hire full-time employees in the UAE
Pros	<ul style="list-style-type: none"> No need to build up in-house team Less risk for employers 	<ul style="list-style-type: none"> Less risk for employers Well-suited to project-based work Many specialists prefer to work independently 	<ul style="list-style-type: none"> Lower cost Employees can collaborate remotely with colleagues - eg sales, marketing policy etc 	<ul style="list-style-type: none"> Clear "ownership" of digital services Understand UAE local context Can work alongside sales, marketing and policymakers Can input directly into strategy
Cons	<ul style="list-style-type: none"> Difficult to respond quickly to customer needs Difficult to maintain intellectual property Risk of "blackbox" solutions 	<ul style="list-style-type: none"> Difficult to vet individuals Transactional relationship Legal restrictions in UAE Contracting firms are expensive 	<ul style="list-style-type: none"> Difficult for remote employees to provide input into wider strategy Some roles must be based in UAE for legal reasons (eg cybersecurity) More challenging for remote workers to understand UAE customer needs 	<ul style="list-style-type: none"> Shortage of Emirati talent Shortage of cost-effective expat talent
In future, UAE organisations will use a hybrid of these three approaches				

Source: The Economist Intelligence Unit.

Building and updating digital services: The five capabilities needed

The five capabilities—project management, user experience, programming, data science and cybersecurity—are not mutually exclusive and many jobs cut across them. For instance, many UX designers also programme and must be adept at using data analysis to inform their work. Among employers interviewed by the EIU, there is a clear preference for flexible and adaptable employees who can turn their hand to two, three or more of the capabilities. As computer science provides a basis for all five capabilities, this makes it particularly important.



A. Project management

GulfTalent, the largest job portal in the region, maintains a database of technology professionals that UAE employers can subscribe to when they need to fill specialist technology roles. It is the primary hiring resource used by over 8,000 companies and recruitment agencies across the gulf region. In 2016, one-sixth of all technology professionals approached by UAE employers through the platform were project managers. However, a majority of employers interviewed by the EIU expressed disappointment in the quality of project management professionals in the UAE, with many applicants lacking extensive training.

Skills in demand among UAE employers: Scrum and product management

To ensure digital services are delivered in an agile manner, project managers typically use frameworks, such as “scrum”, which encourages technology teams work in short bursts of activity, known as “sprints”, with an intense focus on communication, collaboration and improvement. The 2015 Global State of Agile survey found that scrum was the primary project management framework used by companies developing software-based solutions, with 60% of respondents using it.⁹¹ UAE organisations are also using scrum more frequently and are seeking “scrum masters”—or project managers—to manage this. As they are required to work alongside a technical team in a highly collaborative manner, applicants with a thorough grounding in computer science have a distinct advantage. Once flagship websites and apps are launched, “product managers” are needed to track their performance and identify ways of enhancing them.

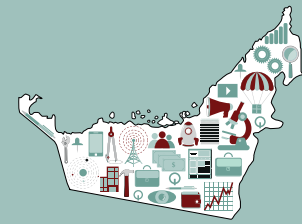
B. User experience

According to LinkedIn data, user interface design was the seventh most in-demand capability among UAE employers on their platform in 2016.⁹² This demand is driven by efforts to develop websites and apps that are designed around users’ day-to-day lives and habits. The user-experience talent pool in the UAE is very small, and according to interviewees, a small group of foreign firms carry out the bulk of projects. After searching without success for local talent, a government-owned firm in Abu Dhabi recently hired 12 user-experience employees from Norway. However, people brought in from overseas may struggle to grasp the local cultural nuances, language preferences, and day-to-day habits of citizens and residents, resulting in sub-par services being created.

Skills in demand among UAE employers: User research and prototyping

User experience sits between computer science and domains such as psychology, marketing and design. User-experience researchers first examine users’ day-to-day lives and understand how a proposed app or website fits into that. They must also understand the business case behind a new service, and assess data on how users interact with current offerings to prioritise areas for improvement.

Employees must then create low-cost prototypes that are gradually improved according to user feedback. More sophisticated prototypes will experiment with how the content on a page should be arranged and the types of labels, fonts and transitions that should be used. A/B testing can then be deployed to examine which pages are most successful. This iterative prototyping process represents a shift away from the traditional approach of spending many months creating a *pilot* website, by which



point it is too late to transform the underlying design. User-experience employees are also increasingly tasked with writing the code necessary to implement the design, highlighting how UAE employers need candidates with a combination of computer-science-based skills.

C. Programming

Web development and programming was the fourth most in-demand capability among UAE employers on LinkedIn in 2016.⁹³ One-third of all candidates on the GulfTalent portal that were contacted by UAE employers to fill technology roles in 2016 were programmers.

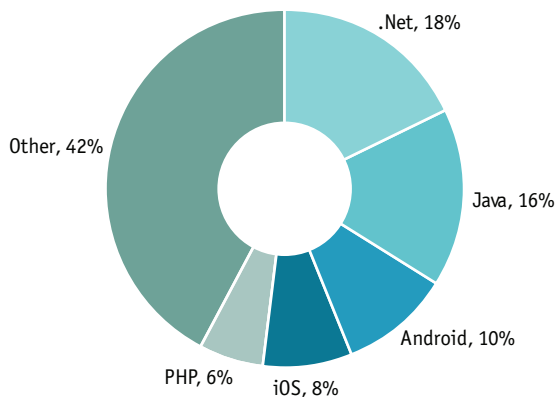
Skills in demand among UAE employers: Multiple languages, entrepreneurial and devops

For some roles, UAE employers can find UAE-based programmers at relatively low cost. For instance, if an employer is looking for a junior web-developer, they can usually find one quickly, at a monthly salary of AED12,000 or less.

However, UAE employers have found three other types of programming skills more difficult to source, and organisations such as Dubizzle have had to bring in talent from abroad, at considerably higher salaries. First, UAE organisations are looking for programmers who have the ability to work in multiple languages. Given the pace at which new languages are emerging, it is unrealistic to expect an individual to be an expert in all areas. Rather, UAE employers are looking for software programmers with a “functional” knowledge of many languages who are prepared to continue to build up their knowledge as needed.

UAE employers need expertise in various programming languages

(Programming languages requested by UAE employers in 2016)



Source: GulfTalent

Second, UAE organisations are also looking for “entrepreneurial” programmers who can work with commercial or strategy teams and propose strategic enhancements to services, rather than just execute requested technical improvements.

Finally, UAE organisations are looking for programmers to support their shift to a “devops” model. Traditionally, when adding new features, developers would take weeks or months to write the necessary code. After deployment, an operations team would monitor the website or application and flag any issues. However, customers now expect more rapid updates and devops has emerged



Powering the UAE digital economy

Developing the UAE's computer science talent

to address this need. The devops approach breaks down the silos between the developers and the operations team. Software is produced and shared in small chunks and code testing is automated, allowing new releases to be deployed in hours.

D. Data science

Data mining and algorithm design were the first and third most in-demand capabilities among UAE employers on LinkedIn in 2016.⁹⁴ Among Dubai government entities, the new Dubai Data Law will drive demand for data scientists. According to the accompanying *Dubai Data Manual*, all entities must create a suite of new roles, including a chief data officer, a data administrator, multiple data “stewards” and multiple data “specialists”.⁹⁵ These obligations will exacerbate the skills gap in the UAE as they cannot be outsourced, and this is not something that organisations can ask their IT teams to execute.

Skills in demand among UAE employers: Database administration, business intelligence and machine learning

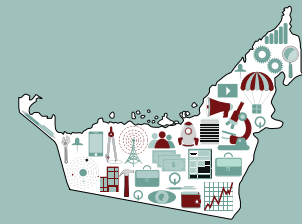
Traditionally, UAE organisations stored their data on large in-house databases. However, as the volume of data has grown, these databases have become inadequate, and new open-source databases and software tools⁹⁶ have emerged that allow organisations to carry out huge data analysis in minutes by splitting the workload across remote servers. Database administrators who can manage these services are in high demand in the UAE. However, vast “dumps” of data are of little use in and of themselves, and UAE organisations need business intelligence experts to draw out insights and make them relevant to senior leaders—for example, by crafting engaging dashboards and data visualisations.

A crucial difference between traditional data *analysis* and data *science* is that UAE employers want data scientists to go beyond simply extracting insights. They want data scientists to craft machine-learning algorithms to automate activities: the UAE ecommerce site JadoPado, which operates like eBay, wants to use algorithms to provide automated price recommendations to sellers on its platform, based on what other UAE consumers are buying on their site. This demand for machine-learning expertise explains why today's data scientists need programming skills alongside more traditional skills in mathematics and statistics.

E. Cybersecurity

Technology recruiters at Gulf Recruitment Group, a UAE-based recruitment firm, believe that cybersecurity (along with data science) will be the most in-demand capability in the UAE over the next five years. A 2015 Symantec report estimated that 2m UAE citizens experienced cybercrime in the previous 12 months, with each attack costing an average of AED2,331 per victim.⁹⁷ The most recent UAE Security Forum estimated that one-third of firms reported cybersecurity breaches in 2015.⁹⁸

Recent updates to the national cybercrime law (Federal Law No. 5 of 2012), and the compliance requirements set out by the National Electronic Security Authority, have raised cybersecurity standards among large public entities, driving demand for cybersecurity talent. As digital payments move beyond banks to ecommerce and government service apps, a growing number of organisations will need to adhere to these standards, as well as those set out by global bodies.⁹⁹ As with user-experience roles, UAE organisations interviewed by the EIU stressed the need for native Arabic-speaking cybersecurity specialists.



Skills in demand: Encryption, threat assessment and forensics

When a new digital service is launched, employers expect cybersecurity personnel to protect the organisation's critical data and that of its users. As a result, developing new encryption technology for voice, email, video, and data transfer is a primary goal. Another key capability is assessing the risk of specific threats and vulnerabilities. This increasingly includes ethical hacking—when somebody uses the same knowledge and tools as a malicious hacker, but in a lawful manner, to test a service. When incidents do occur, cybersecurity experts must examine evidence, known as forensics, and report incidents to authorities in line with the National Electronic Security Authority's guidelines. Demand for cybersecurity experts is also driven by firms' investments in specific technologies—for instance, demand for employees with cloud security certifications is growing in the UAE.

Beyond cybersecurity personnels' technical skills, they must have strategic mindsets so they can prioritise the threats to be addressed, bearing in mind constrained resources. They must also avoid over-engineering security controls to the point where they lead to poor user experience. Given the growing importance attached to cybersecurity risks within organisations, cybersecurity personnel must also be able to communicate their work effectively to senior commercial and government leaders.

When it comes to filling cybersecurity roles, UAE government entities have an advantage over their private sector peers since they attract the bulk of Emirati graduates. Among all five capabilities, cybersecurity is also the one best served by university programmes in the UAE—see section 4, below. However, given the sensitivity of government roles, some can be filled only by Emiratis, and the current supply of Emirati students is insufficient to meet future needs.

Emirati candidates with these five capabilities could earn substantial salaries

In 2016, UAE Prime Minister HH Sheikh Mohammed bin Rashid announced a government restructuring programme that pointed to a clear preference for a smaller public sector. As a result, UAE policymakers will need to find a new source of private sector jobs for the almost 14,000 Emirati students graduating every year. According to a recent GulfTalent survey, the average Emirati graduate expects a monthly salary of AED27,000 (US\$7,350), compared with AED9,000 (US\$2,450) among non-Emirati graduates who studied in the UAE.¹⁰⁰ While these high salary expectations may start to moderate if the number of government jobs declines, they still pose a challenge to the government's goal of increasing the number of Emirati graduates working in the private sector.

However, graduates with the five in-demand capabilities analysed above—project management, user experience, programming, data science and cybersecurity—can expect to earn high salaries in the private sector (see graphic below). As such, it is particularly important for UAE policymakers to rapidly expand the number of Emirati students studying computer science and developing these five capabilities.

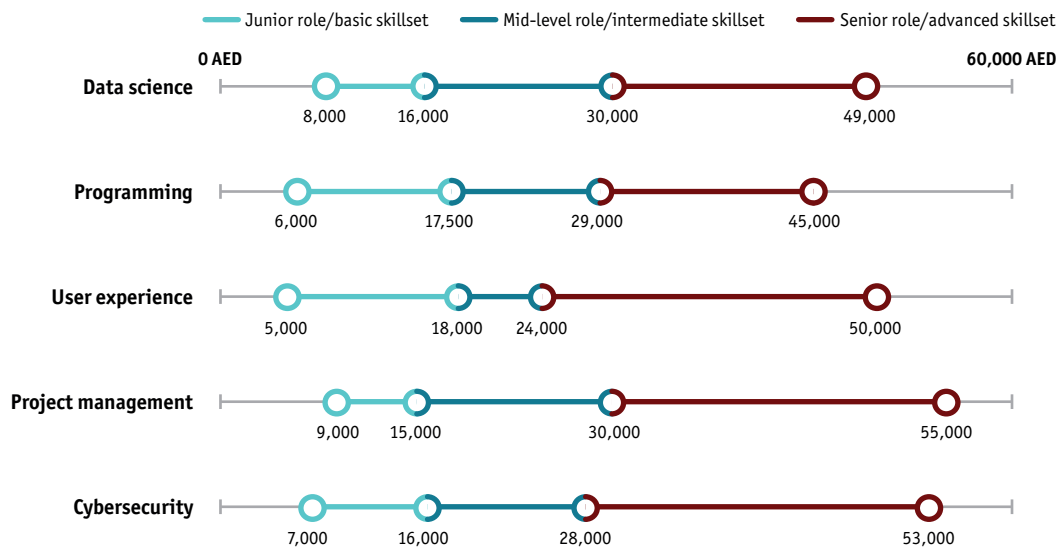


Powering the UAE digital economy

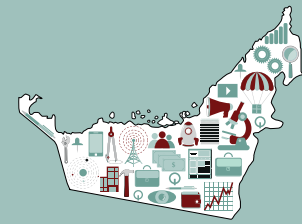
Developing the UAE's computer science talent

Employees with these capabilities in the UAE can earn high salaries

(Salary range based on sample jobs posted in the UAE (monthly, AED))



Source: JCA Associates, PayScale UAE, Robert Half.



4. THE SUPPLY OF EMIRATI COMPUTER SCIENCE TALENT

A. Higher education: Student volume and curricula

Computer science degrees develop the capabilities UAE employers are seeking

In 2013, the Association for Computing Machinery and the IEEE Computer Society produced recommendations for what a computer science degree should cover, based on input from more than 100 leading global experts.¹⁰¹ The study identified a set of “knowledge areas” that, taken together, would help graduates to develop the five in-demand capabilities: project management, user experience, programming, data science and cybersecurity. The knowledge areas should be taught through a mixture of core courses, elective courses, research projects and internships. The University of Oxford’s computer science degree loosely follows this structure.¹⁰² According to experts interviewed by the EIU, some knowledge areas, such as those related to programming, discrete structures and algorithms, underpin the rest and should be taught as core courses in years 1 and 2 of a computer science degree programme.¹⁰³

Computer science degrees help to develop all five capabilities

	1. Project management	2. User experience	3. Data science	4. Programming	5. Cybersecurity
Sample knowledge areas taught by computer science degrees	• Research projects		Algorithms		
		Computational science			• Information assurance & security
	• Graphics and visualisation	Discrete structures			
	• Human-computer interaction	Information management			
		Machine learning & intelligence systems			
				<ul style="list-style-type: none"> • Software development fundamentals • Platform-based development • Programming languages • Software engineering 	

* Knowledge area that supports one capability

* Knowledge area that supports multiple capabilities

Source: The Economist Intelligence Unit.



Powering the UAE digital economy
 Developing the UAE's computer science talent

A computer science degree is not the only way to develop these capabilities. For instance, UAE students enrolled in engineering or statistics degrees can develop these capabilities by taking a minor in computer science. Short online courses, such as those offered by Udacity, teach individuals programming or data science skills in 12-16-week bursts. In Jordan, ReBootKamp trains software programmers in just four months, using a curriculum developed by leading US bootcamp, Hack Reactor. It works with companies such as PayFort, Souq.com and SAP, which teach classes and commit to hiring graduates.

The primary value of a computer science degree is that it teaches students the core theoretical foundations they will need throughout their career, particularly as technology evolves at an increasingly rapid rate. For example, an individual in the UAE can take a short online course to learn how to code in HTML—a popular language. However, this is fundamentally different to the education received through a leading computer science degree in the UAE, such as that offered by New York University Abu Dhabi, which will teach students the theoretical foundations of programming. These theoretical foundations will equip students to learn other languages, as needed, throughout their career, as all programming languages are a manifestation of these theoretical principles.

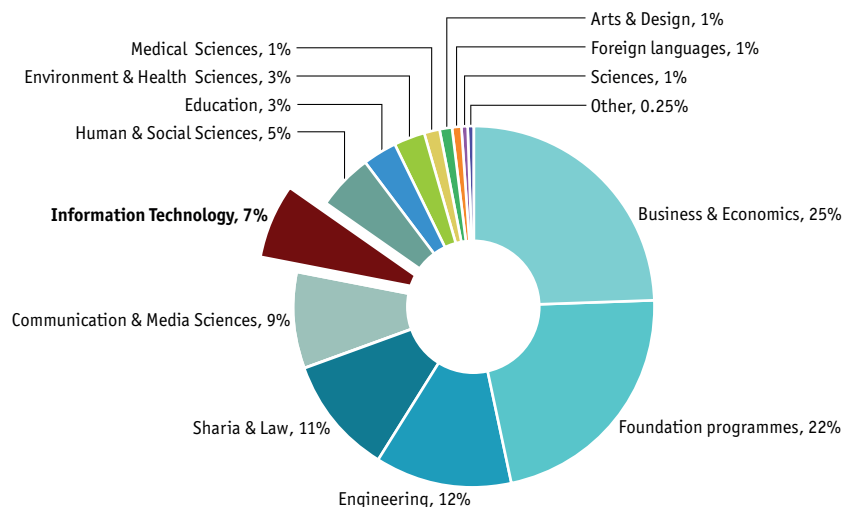
The number of Emirati students studying IT-related degrees is increasing

The Ministry of Education provides data on the number of Emiratis enrolled in “*IT-related degrees*”—a category that includes computer science, computer engineering and IT degrees.

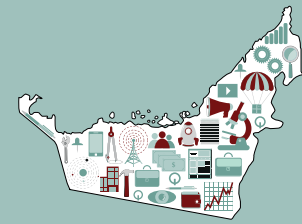
In the 2013/14 academic year, approximately 77,400 Emiratis were enrolled in degrees at universities and higher education institutes in the UAE.¹⁰⁴ Of those, just 7% were enrolled in IT-related degrees, compared with 25% enrolled in business and economics.¹⁰⁵ However, the 7% share is broadly in line with international peers such as Singapore,¹⁰⁶ and is higher than in the US (4%).¹⁰⁷ Between 2012-16, the number of Emiratis enrolled in IT-related degree programmes also rose by more than

Only 7% of Emirati students are enrolled in IT-related degrees

(Breakdown of Emirati higher education students by degree subject)



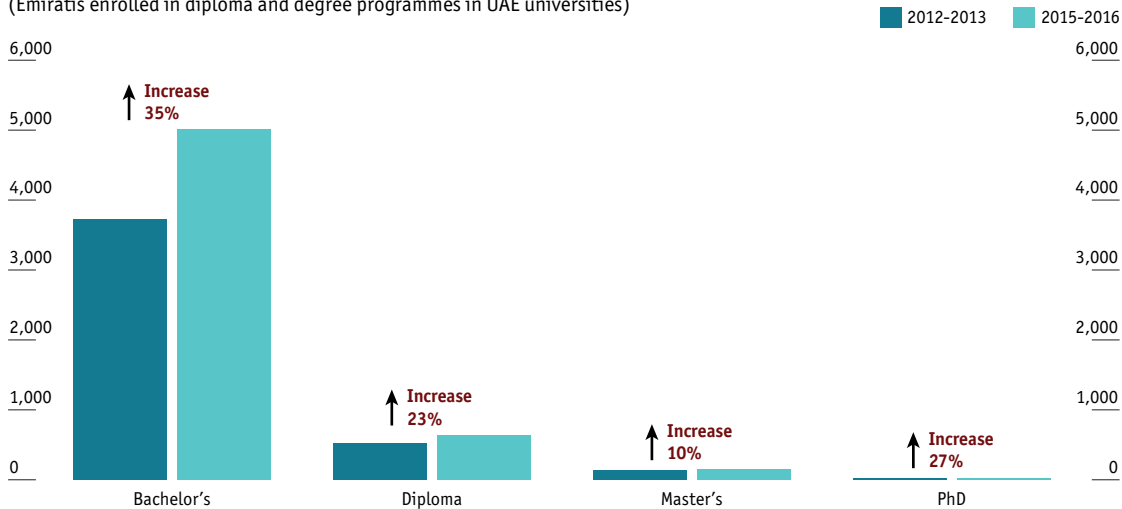
Note. Percentages are rounded so do not sum to 100.
 Source: UAE Ministry of Higher Education & Scientific Research (2013/14)



30%. Of particular note is the fact that 65% of Emirati IT students enrolled are female—one of the highest percentages in the world.^{108,109}

The number of Emirati students studying has increased over the past four years

(Emiratis enrolled in diploma and degree programmes in UAE universities)



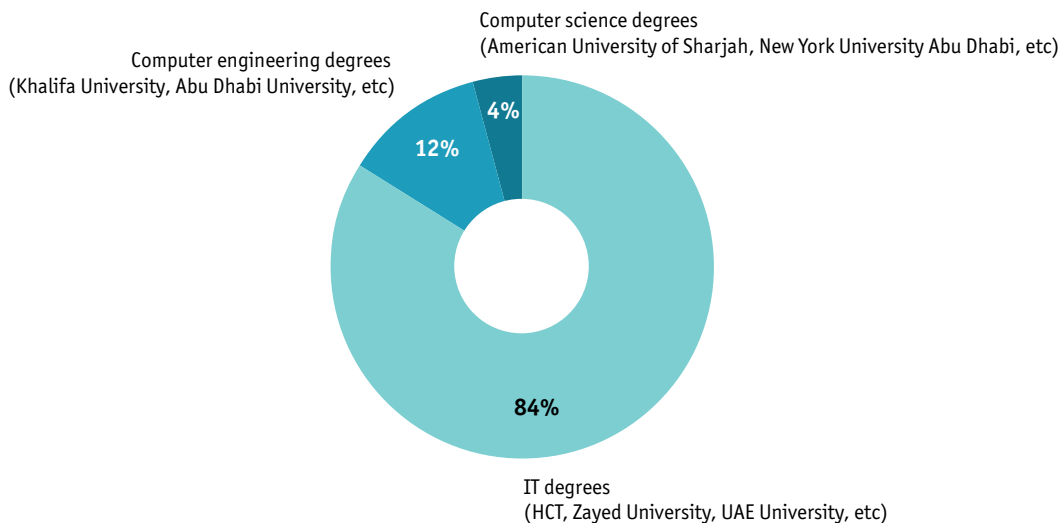
Source: Ministry of Higher Education and Scientific Research (2015/16)

Emirati students are mainly studying IT, not computer science

Almost 80% of Emirati students in IT-related programmes are enrolled in three public institutes: the Higher Colleges of Technology, Zayed University and UAE University—none of which offers a computer science degree. Rather they offer IT programmes, through which students can major in different fields, such as networks or cybersecurity.¹¹⁰

Most Emirati students are enrolled in IT programmes, not computer science

(Emirati students enrolled in IT-related degree programmes, by study area)



Note. These figures are estimates based on the number of students enrolled in major degree programmes.

Source: Economist Intelligence Unit.



Powering the UAE digital economy
 Developing the UAE’s computer science talent

The modules studied by Emirati IT students in the three public institutes vary by institute and programme but, broadly speaking, face four challenges: the curricula do not teach the in-demand digital economy capabilities; students primarily select “traditional IT” majors; programmes do not teach sufficient “soft” skills; and programmes also lack sufficient project work.

Challenge #1: Curricula do not teach the in-demand digital economy capabilities

The programmes’ curricula do not cover the internationally-recommended knowledge areas in sufficient depth. For instance, the IT degrees offered by the Higher Colleges of Technology and UAE University do not teach algorithms in their core courses. Zayed University’s IT degree does not teach algorithms, discrete structures, or the theoretical foundations of programming. Instead, the institutions’ curricula cover many general education modules. Zayed University’s degree has 40 modules, of which almost half are introductory or non-technology-related, such as English Composition and Global Awareness.

UAE IT programmes do not cover the knowledge areas in sufficient depth

(Extent to which recommended knowledge areas are covered in depth)

	University	Degree type	% of Emirati students in IT-related degrees
High coverage 	New York University Abu Dhabi	Computer Science	<1%
	American University of Sharjah	Computer Science	<3%
	Khalifa University	Computer Engineering	<5%
	HCT (Applications Development)	Information Technology	62%
	UAE University (Software Development)	Information Technology	10%
	Zayed University	Information Technology	8%
Low coverage			

Note: Indicative assessment based on number of areas covered and the number of hours and credits allocated to each. Simplified for display purposes. Source: The Economist Intelligence Unit.

Challenge #2: Students primarily select traditional IT majors

With the exception of cybersecurity, the majority of Emirati IT students select majors that are not linked to the capabilities that UAE employers are seeking. More than 30% of IT graduates from the Higher Colleges of Technology in 2014/15 majored in cybersecurity and forensics, followed by 16% in networks and engineering, and 12% in business solutions. Just 11% majored in app development. Among IT students at UAE University who have selected a major, 25% selected cybersecurity, 22% selected networking, and just 15% selected software development.¹¹¹

Challenge #3: Programmes do not teach sufficient soft skills

UAE employers interviewed by the EIU repeatedly cited a desire for computer science graduates who also have strong soft skills, such as teamwork, collaboration and problem-solving. Internship programmes are key to developing such skills. While the Higher Colleges of Technology and Zayed University both offer internship programmes, neither is longer than six weeks. Notably, the UAE has no “sandwich” degrees—those that include an optional year-long period of work experience. Globally,



sandwich degrees help to boost employability. According to the UK government's Shalbot review, just 6% of the UK's sandwich computer science students were unemployed after graduation, compared with 15% among non-sandwich computer science students.¹¹²

Challenge #4: Programmes lack sufficient project work

Computer science students need the ability to specialise in a certain area, such as machine learning or cybersecurity, through in-depth project work. This also helps them to develop project management expertise. While the IT degrees offered by the Higher Colleges of Technology, UAE University and Zayed University include project work, the amount of credits attached can be small—just 3 credits out of 128 in the case of Zayed University. The amount of project work is greater at UAE University and Khalifa University (6 out of 130 credits for UAE University's IT degree, and 6 out of 140 credits for Khalifa University's computer engineering degree). However the world's top-ranked computer science degrees, such as those offered by the Massachusetts Institute of Technology, Stanford University and University of Oxford, typically allocate 30-40% of credits in years 3 and 4 to project work.

More Emirati students study computer engineering than computer science

Approximately 12% of Emirati students enrolled in IT-related degree programmes study computer engineering. In 2015/16, Abu Dhabi University's computer engineering programme had 125 students enrolled, while Khalifa University's programme had 90.^{113,114} Neither university offers a computer science degree programme. Computer engineering degrees do help to develop the capabilities that UAE employers are seeking, such as programming and cybersecurity. Khalifa University's computer engineering programme, for instance, includes an optional specialisation in software engineering. In 2014, three students from the programme were awarded the "best ethical hackers" title at the du Cyber Security Conference. However, broadly speaking, computer engineering focuses more on hardware, processors, computer architecture, and electronics. Computer science focuses more on software, programming, databases, and operating systems, and is more closely linked to the capabilities that UAE employers are seeking.

Fewer than 100 Emirati students are enrolled in computer science degrees

Only a handful of private UAE universities offer computer science degrees and the number of Emirati students enrolled is very low.¹¹⁵ The programmes cited most positively by UAE employers interviewed by the EIU were those offered by New York University Abu Dhabi and the American University of Sharjah.¹¹⁶ The number of students enrolled at the latter reached 129 in 2015—an increase of almost 60% since 2013—but only an estimated 15% were Emirati.^{117,118} At New York University Abu Dhabi, the number of computer science students is growing rapidly, but from a lower base. Just six students will graduate this academic year, of which only a fraction are Emiratis. Al Ain University of Science and Technology and the University of Sharjah also offer computer science degrees, but both courses had fewer than 15 students enrolled in 2015/16.^{119,120}

Why do so few Emirati students enrol in computer science degrees?

No public university in the UAE offers a computer science degree, but that is not the primary obstacle to boosting enrolment among Emiratis. Indeed, both Zayed University and UAE University used to offer



Powering the UAE digital economy

Developing the UAE's computer science talent

computer science degrees but, as noted in interviews with the EIU, the programmes were cancelled due to a lack of interest among prospective students. Their experience highlights the four main obstacles to encouraging more Emirati high school students to enroll in computer science degrees: prospective students need to develop the necessary maths and programming skills; they have misperceptions about what a computer science degree entails; and cultural and financial incentives encourage these students to study other degrees, such as engineering.

Obstacle #1: Prospective students need to develop the necessary maths skills

For a high school student to enrol in a computer science degree programme, some prior knowledge is required, particularly in maths and programming. The 2016 Programme for International Student Assessment assessed 15,000 UAE students against those in 71 other countries. On maths abilities, the UAE ranked in the bottom third (47th), just behind Cyprus and Bulgaria, and well below its goal of reaching the top 20 by 2021. Although the UAE's ranking improved by one place since 2012, its overall score fell. Maths levels vary by emirate and by gender. In the most recent PISA assessment, boys in Ajman, Umm Al Quwain, and Fujairah particularly struggled. As a result, some Emirati students are reluctant to apply for computer science because they fear the amount of maths involved, and so they choose something less mathematical such as business.

Obstacle #2: Prospective students need to develop the necessary programming skills

Few Emirati students in public primary and high schools study programming. To address this, the UAE's education ministry launched a new computer science curriculum in 2015 that will teach programming from kindergarten through to grade 12.¹²¹ Abu Dhabi Education Council also rolled out Google's *Computer Science First* programme to all public school students in grades 4-9, as well as to some private schools. The new curriculum is welcome. A survey of science, technology, engineering and maths teachers by researchers at Khalifa University revealed that 83% of those questioned did not feel that the previous curriculum met students' needs.¹²²

However, evidence also shows that for new curricula to be successful, high-quality, well-trained teachers will be the most important factor.¹²³ As noted by UAE education experts interviewed by the EIU, some teachers in UAE public schools have worked in their roles for a long time and have "generational issues" with new technology, as they are not used to using it. This makes it more difficult for them to create engaging classes for students. Moreover, to attract and retain top teachers, salaries will need to be increased. The Khalifa University study found that 93% of teachers were dissatisfied with their salaries, and 90% would be willing to leave the profession if they were offered a better-paid job elsewhere.

Obstacle #3: Prospective students have misperceptions about computer science

Some Emirati high school students continue to view a computer science degree as a stepping stone towards a career in "traditional IT", rather than towards the types of jobs highlighted in this report such as a data scientist. This deters students from applying for computer science degrees. It also means that IT students focus on traditional majors, such as networks, rather than more cutting-edge areas such as app development.



Obstacle #4: Financial incentives don't encourage computer science

The pipeline of Emirati computer science degree candidates is “leaking” because prospective students have a cultural preference for other degrees, such as engineering. This preference is supported by financial incentives from scholarship programmes run by state-backed oil and utility companies. By contrast, very few of the scholarships programmes available to prospective Emirati students cover computer science degrees.¹²⁴ The lack of scholarships also limits the number of Emirati students who study computer science abroad. According to data from the Ministry of Education, only eight Emirati students were studying IT and computer science abroad in 2015, compared with 80 in engineering and 45 in finance and banking.¹²⁵

B. The quality of degree programmes

Arguably the best way to evaluate the quality of UAE IT and computer science degree programmes is for third parties to independently assess the quality of “learning outcomes” among graduates—for example, by testing their capabilities. Such an assessment is beyond the scope of this report, but with respect to degree quality, our research shows that accreditation is uneven across programmes, and low levels of R&D limit the ability of UAE degree programmes to attract leading professors.

Accreditation is uneven across higher education institutions

The primary UAE federal accreditor is the Commission for Academic Accreditation. However, some programmes actively seek additional emirate-level and international-level accreditation. For instance, the American University of Sharjah computer science and computer engineering programmes are accredited by the Accreditation Board for Engineering and Technology, a leading US higher education accreditation agency. The Accreditation Board for Engineering and Technology also accredit the computer engineering degrees offered by Khalifa University and Abu Dhabi University.

However, international accreditation at UAE public institutions is more mixed. The Accreditation Board for Engineering and Technology accredits UAE University's bachelor of IT programme, and Zayed University's bachelor of IT programme that specialises in security and network technologies. However, it does not accredit Zayed University's bachelor of IT programme that specialises in enterprise computing. The US Middle States Commission on Higher Education accredits Zayed University, as an institution. However, while some Higher Colleges of Technology programmes have international accreditation, none of their IT-related programmes do, according to the latest public accreditation information.¹²⁶

Low levels of R&D affect master's degrees and teaching quality

The relative youth of UAE higher education institutions partly explains why they have yet to develop a strong culture of high R&D spending. Vision 2021 mandates that R&D in UAE spending should reach 1.5% of GDP by 2021, more than double the 2014 rate of 0.7%. SCImago's H index for computer science measures the number of academic publications and their “impact”—a measure based on the number of citations each publication receives. As of November 2016, the UAE ranks 58th in the world, just behind Bulgaria and Pakistan.¹²⁷



The low level of computer science R&D has two implications. First, it limits the number and attractiveness of master's and PhD degrees. Only 143 Emirati students pursued a master's degree in IT and computer science last year, while only 19 students pursued doctoral studies. Moreover, with the exception of cybersecurity, Emirati master's students focus on more traditional areas of IT. For instance, 22 Emiratis were enrolled in Zayed University's master's degree in IT in 2015, which specialises in cybersecurity. However, just six Emirati women and no men were enrolled in UAE University's software engineering master's degree in 2015. No UAE public institution offers master's degrees in project management, data science or user experience.¹²⁸

The UAE's low level of R&D spending also limits the quality of degree programmes because the world's top computer science professors are attracted to institutes with research funding. However, some notable R&D initiatives are emerging. For example, in 2008, the Telecommunication Regulatory Authority launched the ICT Fund, whose investments include EBTIC, a research and innovation centre, and Betha, which sponsors students studying IT or telecoms-related degrees.¹²⁹ New York University of Abu Dhabi has also shown a strong commitment to computer science R&D, creating a high-performance computer cluster containing the UAE's fastest computer.

C. Post-graduate employment

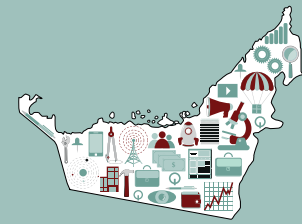
Employment rates are generally high, but for government roles

Typically, employment rates provide a market-based assessment of the quality of degree programmes: if graduates are deemed to be of high quality, they will find jobs and be actively sought out by employers. However, in the UAE these dynamics do not apply to the same extent, as many Emirati nationals secure employment in government roles.

After extensive research, the EIU found no federal-level survey that tracks the career destinations of Emirati IT-related graduates or their success at securing employment.¹³⁰ A small number of institutions, such as the Higher Colleges of Technology, publish their own data on graduate employment. According to the Higher Colleges of Technology's most recent survey, 93% of male graduates from its IT-related programmes are employed, compared with 69% of females. The higher female unemployment rate is also seen in the Higher Colleges of Technology's engineering, business and education programmes, and according to interviewees is linked to a broader challenge faced by female graduates in the Northern Emirates and Al Ain who feel less able to work in other emirates, where there are more jobs.¹³¹

A supply–demand mismatch between Dubai, Abu Dhabi and the Northern Emirates

The location of Emirati students enrolled in public IT degree programmes in the UAE is roughly in line with the relevant population of those emirates. For instance, of the more than 3,500 Emirati students enrolled at the Higher Colleges of Technology, 40% are located in colleges in Abu Dhabi; 21% in Dubai; 17% in Sharjah; 16% in Ras Al Khaimah; and 6% in Fujairah.¹³² This poses a potential problem as the majority of private sector computer-science-related jobs are located in Dubai, and to a lesser extent in Abu Dhabi. As a result, if the number of government jobs declines in the coming years, unemployment among graduates in the Northern Emirates, particularly among females, could rise.



Many graduates work in non-technology roles

The vast majority of Emirati IT and computer science graduates work in government and Government Related Entities, and most do not work in technology-related roles. One Emirati computer engineering graduate interviewed by the EIU noted that Emirati IT and computer science graduates who work in the public sector are often encouraged by their managers to take up administrative and strategy roles rather than technology roles. It could be argued that having computer science graduates in non-technical roles such as strategy and management is a welcome development. However, it also suggests that some IT and computer science graduates are either not learning the right things or do not see viable paths to fulfilling technical careers linked to their degrees.



5. POLICYMAKERS' PLAYBOOK

To support the digital economy, UAE policymakers need to address three core challenges:

- Popularise computer science among Emiratis and tackle misperceptions
- Boost the *capacity* of Emiratis to pursue digital-economy-related careers
- Enable the UAE to attract and retain leading global experts

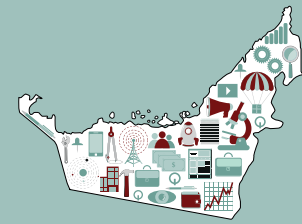
A summary of the three challenges, and a playbook of policy recommendations to address them and their various sub-components, is presented below.

A. Popularise computer science among Emiratis and tackle misperceptions

- Emirati primary and high school students often have misperceptions about what computer science is and associate it with traditional roles such as IT support, rather than emerging roles such as data science. This is partly explained by a lack of engaging computer science classes.
- When it comes to selecting university programmes, a lack of career guidance means that Emirati students' parents often become *de facto* career counsellors and encourage students to pursue traditional routes, such as engineering.¹³³ This preference is amplified by scholarships provided by government-related organisations, which also focus on other engineering majors.
- Emirati students who do enroll in IT degrees tend to major in more traditional areas, such as network engineering, rather than in in-demand areas such as user experience, data science and app development.
- After graduation, the vast majority of IT students work in the public sector, including in non-computer-science-related roles, rather than in the private sector.

B. Boost the *capacity* of Emiratis to pursue digital-economy-related careers

- Too few Emirati primary and high school students have sufficient maths and programming ability to enrol in computer science degrees.
- This is partly caused by the lack of high-quality teachers in UAE public schools. Although a new computer science curriculum is in place, a large proportion of teachers have never taught computer science and will need extensive training.
- Owing to inadequate maths and programming abilities, the IT degree programmes where more than 80% of Emirati IT and computer science students are enrolled expend considerable time teaching introductory courses rather than focusing on more complex areas.
- Across public IT degree programmes, there is uneven accreditation and a lack of R&D spending.
- As a result, current and past Emirati IT graduates have some of the in-demand capabilities, but not all, thus hindering their ability to fill the in-demand roles.



- Some Emirati IT graduates—particularly females in the Northern Emirates and Al Ain—are unable to take up job opportunities in other emirates due to family commitments.

C. Enable the UAE to attract and retain leading global experts

Organisations face challenges when it comes to hiring expats for full-time roles:

- Building and maintaining digital services is project-based work, and UAE organisations need to be able to scale up resources as required. Unlike the UK or the US, the UAE lacks a large local community of independent freelancers.
- Foreign talent is also less “sticky” than local talent, making these employees difficult to build new teams and services around.

A. Popularise computer science among Emiratis and tackle misperceptions

1. A media campaign

- The UAE should launch a media campaign to highlight the diverse range of high-value digital economy jobs that a computer science degree offers. The key ingredients for a successful campaign will be a message that resonates; relevant role models to represent the campaign; and amplifying the message via social media.
- *The message:* Evidence shows that a desire to contribute to the country's future plays a key role in Emirati students' degree selection, as do salary expectations.¹³⁴ The campaign should both build a case for the digital economy as a new engine of growth for the UAE as the importance of oil declines, and highlight the high-value jobs on offer.
- *Role models:* The campaign could be fronted by leading UAE technology entrepreneurs and past Emirati computer science graduates who are now working in “non-traditional IT” roles, such as those working at the Mohammed Bin Rashid Space Centre.

2. Active technology demonstrations in primary and high schools

- Evidence shows that practical demonstrations, using robots for example, help to explain computer science and mathematical concepts to students, while simultaneously demonstrating their practical application.¹³⁵
- Schools need low-cost ways to expose Emirati primary and high school students to practical demonstrations of computer science in action.
- For example, *The Assembly* is a “community space” located in Dubai Knowledge that runs free workshops every weekend that are open to participants of all ages. Recent workshops have focused on how to make a home “smart”; how to give a plant the power to Tweet; and how to control a “robotic arm” with a smartphone.



Powering the UAE digital economy

Developing the UAE's computer science talent

- Education authorities and regulators in the UAE could encourage schools to better utilise such clubs and community spaces to offer workshops to students through emirate- and federal-level programmes.
- Education authorities could also encourage public schools across the country to take part in high-profile international initiatives, such as *Hour of Code*.
- The Hour of Code organisation distributes materials, designed by a range of partners, to schools across the world so that they can host one-hour programming activities, including games, tutorials, and competitions.
- Schools can organise Hour of Code activities at any time. Globally, a popular time is during *Computer Science Education Week*, which is scheduled to take place on the week of December 4th-10th 2017. A number of schools across the UAE have already organised Hour of Code activities, so education authorities could look to roll these out across all public schools during Computer Science Education Week 2017.¹³⁶

3. Information packs for parents

- The pipeline of students who are capable of taking computer science degrees starts to weaken in high school, when potential candidates do not take up more advanced mathematics courses or programming classes.
- To prevent students dropping out of the computer science pipeline, a selection of UAE schools should trial a low-cost intervention where brochures and a website about the benefits of taking extra maths and programming courses are provided to parents.
- In a US trial, where parents were sent brochures of this nature, their children took, on average, nearly one semester more of mathematics than those in the control group, whose parents were not exposed.¹³⁷

4. Computer science careers portal

- UAE education authorities should create a localised, Arabic-language version of popular computer science career portals, such as ComputerScienceOnline.org, to demonstrate the new era of technology jobs in the UAE's private sector.¹³⁸
- To the extent that data permits, the site should provide job profiles, salary calculators and insights into career trends and future prospects. The site should also advertise jobs.
- While several UAE higher education institutes have online job portals, they are much less detailed than ComputerScienceOnline.org.

5. Best-practice guidelines for university careers offices

- UAE educational authorities should produce a set of voluntary guidelines for university careers centres on how to promote computer-science-related careers. These could form part of wider efforts to promote Science, Technology, Engineering and Maths (STEM) subjects and to promote other digital-economy-related careers to students.



- These guidelines can leverage international best practices, such as those provided by the University of Cambridge.¹³⁹ Sample best practices include:
 - Creating a “supporters club” of leading employers who can host computer-science-related events for students.
 - Promoting innovative types of career guidance, in partnership with the private sector. For instance, HSBC has set up an Interactive Trading Floor at American University of Sharjah to demonstrate how digital banking is evolving.

6. Expand scholarships to computer science degrees

- UAE education authorities should approach public and private entities at the heart of the digital economy to fund scholarships for Emirati students to enrol in leading computer science degrees, such as those offered by American University of Sharjah, New York University Abu Dhabi, and leading universities abroad.
- These new scholarships would build on similar initiatives already in place such as the Tamayuz Scholarship Program, sponsored by the National Electronic Security Authority, which provides Emirati students enrolling in computer engineering at Khalifa University with an AED8,000 (US\$2,180) monthly stipend.

7. Umbrella programme

- In line with the UK's *Year of Code* and the UAE's *Year of Giving*, the UAE could initiate an overarching programme dedicated to promoting the digital economy, digital skills and computer science, to primary, high school and higher education students, and the wider population.
- Backed by senior government leaders, the programme could provide an “umbrella” for the policy recommendations documented in this section, bringing coherence and senior government backing to the overall agenda of promoting the digital economy and computer science among Emiratis.

B. Boost the capacity of Emiratis to pursue digital-economy-related careers

1. Innovative teacher-hiring programme

- UAE education authorities should create a new hiring programme for computer science and maths teachers in primary and high schools. This should target high-performing domestic and international maths and computer science graduates who would not ordinarily be enticed by a teaching career.
- This recruitment programme could be modelled on *Teach For America* and *Teach First* in the UK. A quarter of European and Latin American countries, as well as Australia, China and India, have also launched similar programmes. Early evidence on the UK and US programmes' effectiveness has been positive, especially when it comes to boosting students' maths-related outcomes.¹⁴⁰



Powering the UAE digital economy

Developing the UAE's computer science talent

- A complementary option would be to extend *The Future Teachers* scholarship programme run by Khalifa University.¹⁴¹ This offers stipends to undergraduate students taking mathematics and statistics degrees, who are subsequently prioritised by the Ministry of Education when it comes to filling new teacher positions. This programme should be extended to cover students taking computer science degrees.

2. Training for computer science teachers

- When launching the new K12 computer science curricula, the UAE's Ministry of Education noted that considerable teacher training would be needed to make the curricula effective.
- The type of training required for computer science teachers in UAE schools will depend on the grade they teach and the complexity of the material they must master.
- In line with international evidence,¹⁴² educational authorities should ensure that three components are in place:
 - Formal training modules: This should be complemented by vetted online resources and lesson plans, such as those provided by CodeAvengers.
 - Peer support: When tasked with teaching new materials, teachers often lack confidence. To address this, UAE education authorities should create online forums and workshops where teachers can share best practice.
 - Master teachers: Master teachers are those who have undergone specific training, or who have a proven record in boosting students' computer science outcomes. In the UAE, these teachers should be identified so that they can mentor other teachers. In the UK, the British Computer Society set up a network of 400 master teachers across the country.

3. Encourage programming competitions

- Competitions can boost students' programming ability by providing a fun platform to practise, develop teamwork skills, and expose students' strengths and weaknesses.
- To boost Emirati students' success in programming competitions, education authorities could re-establish a national programme to train school pupils to participate in relevant national and international contests, such as the World Robot Olympiad and the International Olympiad in Informatics.
- To boost the frequency of domestic programming competitions in UAE public schools, leading universities could be tasked with organising competitions in exchange for degree credits.
- This university-led model would bring two additional benefits over traditional programming competitions: it would help refine the university students' soft skills, such as teamwork and communication; and it would boost the profile of the university's computer science degree among high school students, thereby helping subsequent enrolment numbers.¹⁴³



4. Use serious games as an instruction tool

- Serious games are video games that are designed to improve educational outcomes.
- For instance, CodeCombat teaches students programming logic as well as basic HTML and CSS skills. In 2012, the Bill & Melinda Gates Foundation helped launch the Games, Learning and Assessment Lab, which is exploring how existing, commercially-successful games can be used to teach and assess students in line with the US Common Core educational standards.¹⁴⁴
- Evidence on the impact of serious games on student outcomes is still being gathered, but a systematic literature review in 2016 was cautiously positive.¹⁴⁵
- In the UAE, education authorities should work with leading games developers and twofour54's games academy to identify serious games that could be trialled in UAE classrooms and, if needed, to develop new localised versions.

5. Revise curricula and accreditation for public IT degree programmes

- UAE University, Zayed University and the Higher Colleges of Technology cannot change the curricula of their IT degrees until incoming students have the capacity to cover the new modules. However, in the medium term, education authorities should task institutions with drawing up a roadmap to ensure that IT degrees:
 - Cover a greater proportion of recommended knowledge areas.
 - Include a substantial portion of research and project work, such as 30-40% in years 3 and 4.
 - Expand internship programmes to at least 3-6 months, and possibly to one year.
 - Are fully accredited by leading international accreditation agencies, such as Accreditation Board for Engineering and Technology.

6. Create new master's degrees and computer science minors

- A broader range of students, beyond those enrolled in computer science degrees, need the opportunity to develop computer science skills.
- Education authorities in the UAE should encourage public and private universities to increase the number of computer science minors and combined degree programmes. For example, the University of Oxford now offers combined degrees in mathematics and computer science, and in computer science and philosophy.
- Education authorities should also encourage public and private universities to create new master's programmes for capabilities that are not currently catered for in the UAE, such as project management, user experience, and data science.

7. Incentivise participation in vetted nano degrees

- Nano degrees teach individual skills within a short time period—often 12 weeks or less. They are typically delivered online.



Powering the UAE digital economy

Developing the UAE's computer science talent

- Nano degrees could provide a route for current and past Emirati IT graduates to further develop some of the in-demand capabilities and re-start a career as a digital specialist.
- However, Emirati students who want to pursue a nano degree must select the most appropriate programme from a broad range of options from providers across the world. They must also pay for the course.
- To support Emiratis who want to take nano degrees, UAE education authorities could trial an approach modelled on the US EQUIP programme. Education authorities could ask leading domestic universities to identify and vet nano degrees in areas such as data science and programming, and the authorities could then partly finance Emirati students to attend. To ensure that the courses are in line with private sector demands, local employers such as Souq.com could help to vet them.
- Following approval, the profiles of high-performing participants could be shared with private sector employers as potential employee candidates.

8. Expand flexible working rights

- The UAE does not have a history of flexible working—that is, allowing employees to work a customised set of hours, or to work remotely, according to their needs.
- However, as part of a new trial, the Ministry of Human Resources and Emiratisation will allow 70 randomly-selected ministry employees to work from home.
- The trial was initiated after a survey found that many female Emirati employees between the ages of 25-42 want the opportunity to work from home and be close to their family.
- Expanding flexible working would provide a route to increasing employment among IT graduates in the Northern Emirates, particularly among female parents.
- To do so, UAE authorities should emulate countries such as Japan, Spain and Switzerland, giving Emirati parents in certain roles the “absolute right” to work flexibly.¹⁴⁶

C. Enable the UAE to attract and retain leading global experts

1. Clarify freelance visas

- Free zones in the UAE should provide more clarity about their existing freelance visa programmes so that they can be taken up in greater numbers.
- To minimise concerns, freelance visas could be restricted to a relatively narrow set of specialist technology professionals, who can demonstrate their expertise in a verifiable manner.

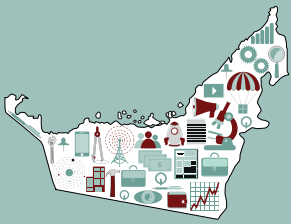
2. Reduce the cost of company set-up

- To make it easier and quicker for individual technology experts to set up their own businesses in the UAE, authorities could try to reduce the costs facing digital startups by removing certain requirements, such as the need to maintain a physical office space (which adds to a startup's operating expenses).



A. Popularise computer science among Emiratis and tackle misperceptions

Policy	Summary	Impact	Time to impact	Complexity	International benchmarks	UAE initiatives to build on	Key stakeholders
1. A media campaign	Promote the diverse range of high-value jobs that computer science offers.	Low	Short	Medium	Code.org's Programmers YouTube campaign		<ul style="list-style-type: none"> • MOHESR • Universities and former graduates • Technology firms
2. Active demonstrations in primary and high schools	Expose students to computer science in action, for example by attending The Assembly workshops.	Low	Short	Low	Computer Science Unplugged (US)	Robot labs in schools Hour of Code	<ul style="list-style-type: none"> • MOEd • ADEC, KHDA • Schools
3. Information packs for parents	Inform parents about the benefits of taking maths, programming and computer science classes.	Low	Short	Low	Wisconsin (US)		<ul style="list-style-type: none"> • MOEd • ADEC, KHDA • Schools and universities
4. Computer science careers portal	A localised, Arabic-language website to demonstrate the new era of technology jobs coming on stream in the UAE private sector.	Medium	Medium	High	<ul style="list-style-type: none"> • Computer Science Online.org • Prospects (UK) 	University career portals Tawteen Real Game	<ul style="list-style-type: none"> • MOEd • MOHRE • HRA • Job Portals (e.g. Bayt)
5. Best-practice guidelines for university careers offices	Voluntary guidelines including innovative career guidance with private sector partners.	Low	Short	Low	<ul style="list-style-type: none"> • Cambridge University (UK) • Technical Development Guides 		<ul style="list-style-type: none"> • MOHESR • ADEC, KHDA • University careers offices • Private sector employers
6. Expand scholarships to computer science degrees	Expand scholarships for Emirati students in computer science degrees in the UAE and abroad.	Medium	Medium	Medium	AFCEA STEM scholarships (US)	<ul style="list-style-type: none"> • ICT Fund • Elite Scholarship for Advanced Technology • ADEC/MOEd Scholarships 	<ul style="list-style-type: none"> • MOEd Scholarship Dept • MOPA Scholarship Office • Universities • Private sector employers
7. Umbrella programme	A programme to bring coherence and high-level government backing to the policy recommendations.	High	Short	High	Computer Science for All (US)	<ul style="list-style-type: none"> • Year of Giving 	<ul style="list-style-type: none"> • MOEd • MOCA



Powering the UAE digital economy
Developing the UAE's computer science talent

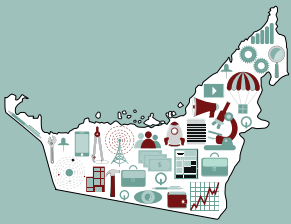
B. Boost the capacity of Emiratis to pursue digital-economy-related careers

Policy	Summary	Impact	Time to impact	Complexity	International benchmarks	UAE initiatives to build on	Key stakeholders
1. Innovative teacher hiring programme	Aimed at high-performing domestic and international maths and computer science graduates.	High	Long	High	<ul style="list-style-type: none"> Teach For America Teach First (UK) 	<ul style="list-style-type: none"> The Future Teachers programme (Khalifa University) 	<ul style="list-style-type: none"> MOEd ADEC, KHDA Universities
2. Training for computer science teachers	A programme including: formal training classes, peer support and Master Teacher mentoring.	High	Long	Medium	<ul style="list-style-type: none"> CS10k (US) UK Master Teachers 	<ul style="list-style-type: none"> New K12 CS curricula 	<ul style="list-style-type: none"> MOEd ADEC, KHDA
3. Encourage programming competitions	Train students to participate in national and international contests. Task universities with organising competitions in schools.	Medium	Medium	Medium	<ul style="list-style-type: none"> Robert Morris competitions (US) International Olympiad in Informatics 	<ul style="list-style-type: none"> World Robot Olympiad NYUAD Hackathons Gulf Programming Contest 	<ul style="list-style-type: none"> MOEd ADEC, KHDA NYUAD, AUS
4. Use "serious games" as an instruction tool	Trial the use of video games that are designed to improve computer science abilities.	Medium	Medium	Medium	<ul style="list-style-type: none"> Games, Learning and Assessment Lab (US) Mobile CSP 	<ul style="list-style-type: none"> twofour54's games academy CS First Tawteen RealGame 	<ul style="list-style-type: none"> MOEd ADEC, KHDA
5. Revise curricula and accreditation for public IT degree programmes	Include more knowledge areas, more research, more project work and longer internships.	High	Long	High	<ul style="list-style-type: none"> University of Oxford's computer science degree curricula 		<ul style="list-style-type: none"> MOE, CAA Zayed University, UAE University and HCT
6. Create new master's degrees and computer science minors	New master's in data science, user experience and project management.	Medium	Long	High	<ul style="list-style-type: none"> University of Oxford hybrid computer science degrees 		<ul style="list-style-type: none"> MOE, CAA Zayed University, UAE University
7. Incentivise participation in vetted nano degrees	Ask universities to identify online "nano degrees" and subsidise Emiratis to enrol in them.	Medium	Short	Medium	<ul style="list-style-type: none"> EQUIP programme to vet nano degrees (US Dept of Education) 	<ul style="list-style-type: none"> ArabCode.org 	<ul style="list-style-type: none"> MOEd Universities Private technology firms
8. Expand flexible working rights	Introduce an absolute right to flexible work among select UAE government employees.	Medium	Short	Medium	<ul style="list-style-type: none"> Flexible working rights in Japan, Spain and Switzerland 	<ul style="list-style-type: none"> MOHRE work-at-home trial 	<ul style="list-style-type: none"> MOHRE



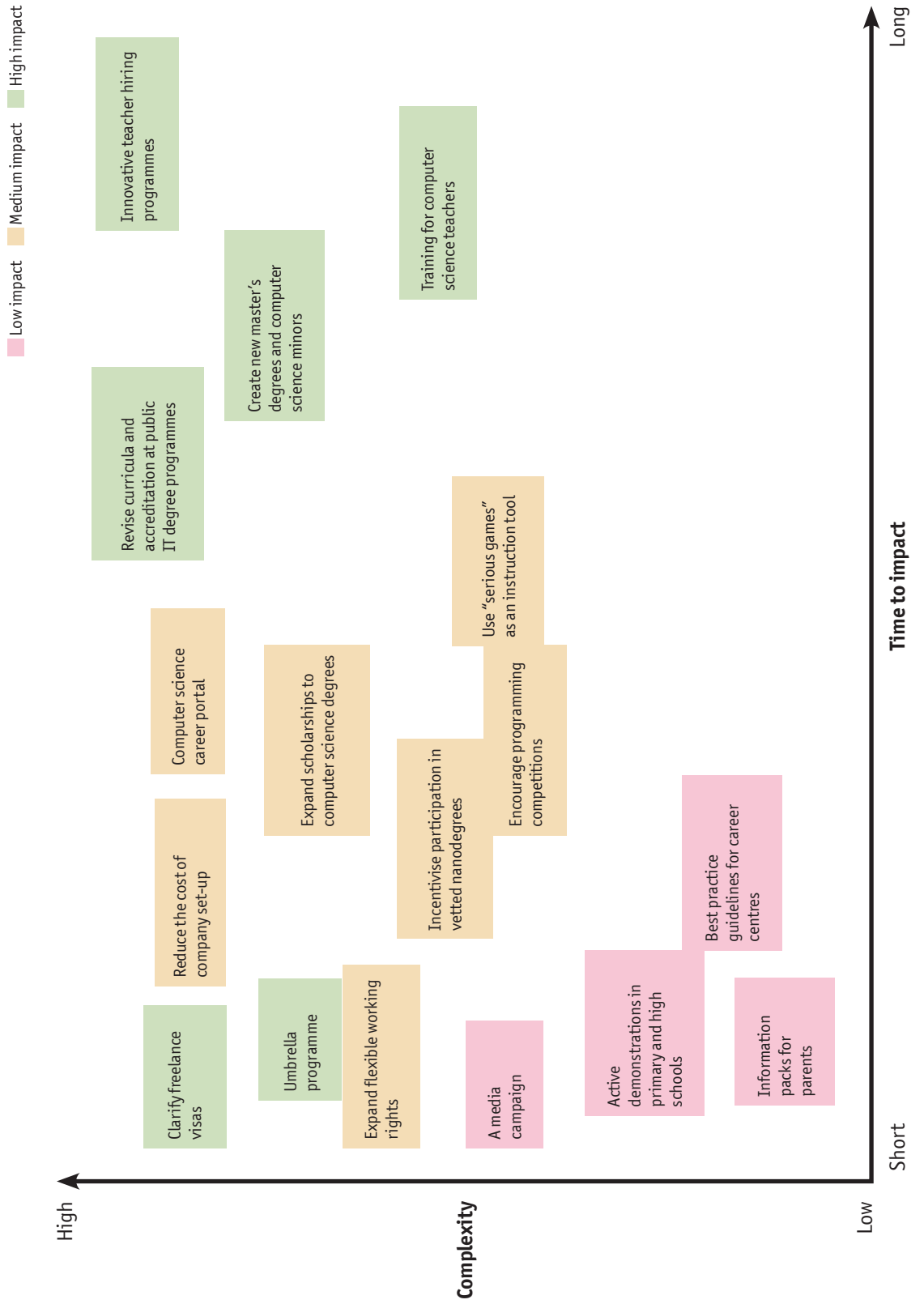
C. Attract and retain expats

Policy	Summary	Impact	Time to impact	Complexity	International benchmarks	UAE initiatives to build on	Key stakeholders
1. Clarify freelance visas	Clarify the process to acquire freelance visas for specialist technology roles and reduce the cost. Expand the programme beyond freezones.	High	Short	High	Germany (Freiberufler) visa	<ul style="list-style-type: none"> • twofour54 • freelance visa • Internet city • freelance visa 	<ul style="list-style-type: none"> • Free zones • MOI • MOHRE • MOE
2. Reduce the cost of company set-up	Remove some of the costs facing digital startups in the UAE, such as the need to maintain a physical office space	Medium	Short	High	Startup India		<ul style="list-style-type: none"> • DEDs • Khalifa Fund • Sheraa • Free zones • Chambers of Commerce



Powering the UAE digital economy

Developing the UAE's computer science talent





CONCLUSION

The growth in digital services, from ecommerce apps to government portals, will have a profound impact on the make-up of the UAE economy and the types of jobs that are available. In particular, it will place a growing premium on employees with digital and computer science skills. Today, the supply of local Emirati computer science talent is constrained because students study traditional IT, not computer science.

If UAE government leaders can succeed in popularising and demystifying computer science among students, it will transform the country's human capital base. This, in turn, will enable the country's private sector to sell digital services across the region, and enable the government to boost productivity and citizen satisfaction. The journey will not be quick, or easy, but given the UAE's ability to make decisive policy changes and investments, it is well-equipped to capitalise on the digital economy opportunity.

Appendix

The EIU would like to thank the following experts who participated in the interview programme.

Government/government-related entities

HE Huda Al Hashimi – Assistant Director General for Strategy and Innovation, Prime Minister's Office

Dr Ali al-Azzawi – City Experience Advisor, Smart Dubai Office

HE Dr Aisha Bin Bishr – Director General, Smart Dubai Office

Neetan Chopra – Senior Vice President of IT Strategic Services, Emirates Group

Ibrahim Ahmed Elbadawi – Co-founder and Managing Director, Exantium (a consultancy advising UAE government entities on creating digital services)

Dr Hesham Gomma – Manager, Planning and Performance Management, Abu Dhabi Education Council

Dr Fadi Salem – Director and Fellow of Governance and Innovation, Mohammed Bin Rashid School of Government

Financial services

Eman Abdulrazzaq – Regional Head MENA HR, HSBC

Luai Almulla – Director, Emirates NBD

Moussa Beidas – CEO, Bridg

Chris Dcosta – Head of IT Infrastructure, Finance House

Aruma George – HR Director, RSA Insurance

Michele Grosso – CEO, Democrance

Wael Ibrahim – COO, Emirates Islamic Bank

Jaser Mahmoud – Director of IT, CashU

Craig Moore – CEO, Beehive

SV Padmanabhan – CTO, Noor Investment Group

Retail

Abel Belcaid – Principal EMEA, A.T. Kearney

Wisam Daoud – COO, Souq.com

Omar Kassim – CEO, JadoPado

Olivier Leblan – CIO, Chalhoub Group

Alessandro Nadalin – VP of Technology, Namshi

Sebastian Ritter – Director of Engineering, Dubizzle.com

Omar Soudodi – Managing Director, PayFort

Digital

Mohammed H Al Abbadi – Senior Information Security Consultant, Al Hosn Information Security Consultancy

Idriss Al-Refai – Founder, Fetchr

Ghazi Atallah – CEO, NexGen Group

Rabih Dabboussi – Senior Vice President, DarkMatter

Clinton Firth – Partner, Cyber, Middle East and North Africa, EY

Prashant K (PK) Gulati – President and Member of the Governing Board, TiE Dubai

Rami Kayyali – CTO, the Kernel

Dr Hichem Maya – Head of Digital Transformation, SAP

Muhammad Mekki – Founding Partner, AstroLabs

Media

Fida Chaaban – Editor, Entrepreneur Middle East

Girish Chouhan – IT Manager, Motivate Publishing

Jonathan Richards – Group Digital Strategy Director, Gulf News Media Group

Recruitment

Kate Cerny – Principal Consultant (Technology Division), The Gulf Recruitment Group

Yasser Hatami – Managing Director, GulfTalent

Maliha Jilani – Principal, Heidrick & Struggles

Richard Smith – Director, SALT Digital Recruitment MENA

Academia

Fadi Aloul – Head, Department of Computer Science & Engineering, American University of Sharjah

Dr Zakaria Maamar – Dean of the College of Technological Innovation, Zayed University

Dr Natasha Ridge – Executive Director, Al Qasimi Foundation

Prof. Godfried T Toussaint – Head of Computer Science, New York University Abu Dhabi

Dr Hicham El Zabadani – Chair of the Department of Electrical and Computer Engineering, American University Dubai

Computer science graduates

Ahmad Abugosh – Learning & Development Manager, AstroLabs

Humaid Alshehhi – Senior System Analyst, Abu Dhabi Security Exchange

Sara Almaeeni – Expert, Space Systems Development Department, Mohammed Bin Rashid Space Centre

Asma Alzaabi – Information System Analyst, ADMA-OPCO

Joe Jean – Junior Software Engineer, Namshi.com

The EIU would also like to thank the following data providers:

The UAE Ministry of Higher Education and Scientific Research

Abu Dhabi Education Council

GulfTalent

Bayt.com

JCA Associates

SALT Technologies

Notes

¹ Measured in nominal terms. Estimate by Accenture: <https://www.accenture.com/ae-en/insight-digital-disruption-growth-multiplier>

² <https://www.gsmaintelligence.com/research/?file=e888862e19a8097c48291a8f66b4ddc5&download>

³ Ovum report: App Revenue to Double by 2020, Outpacing Download Growth. Available at <http://bit.ly/2h0L94S>

⁴ <https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/>

⁵ Europe includes France, Germany, Italy, Sweden, United Kingdom.

⁶ Digital Middle East: Transforming the region into a leading digital economy, Mckinsey

⁷ Estimate based on A.T. Kearney ecommerce data and EIU data on retail sales in the UAE.

⁸ <http://www.middle-east.atkearney.com/documents/787838/8908433/Getting+in+on+the+GCC+E-Commerce+Game.pdf/f06b44f0-4fdc-44d3-b9b3-1e273e4eeb36>

⁹ <https://www.statista.com/statistics/285978/e-commerce-share-of-retail-sales-in-the-united-kingdom-uk/>

¹⁰ <http://www.mideastmedia.org/industry/2016/digital/>

¹¹ <https://www.gsmaintelligence.com/research/?file=7910cff3a3e6f96219cd50e31d6d3e1c&download>

¹² <https://www.appsflyer.com/resources/state-app-spending-global-benchmarks-data-study/>

¹³ https://www.bcgperspectives.com/Images/Digital_Government_Jun_2014_tcm80-162861.pdf

¹⁴ Estimate based on A.T. Kearney ecommerce data and EIU data on retail sales in the UAE.

¹⁵ The UK Cabinet Office estimates that a digital transaction is up to 20 times cheaper than one by telephone, 30 times cheaper than one by post, and 50 times cheaper than a face-to-face transaction.

¹⁶ Total Factor Productivity measure. EIU data.

¹⁷ http://www.middleeast.siemens.com/me/en/news_events/news/news-2016/siemens-and-strategy-joint-study-outlines-roadmap-for-a-digitalized-future-for-gcc-businesses.htm

¹⁸ Peer-to-business lending is a type of crowdfunding in which businesses borrow from a group of individuals and investors.

¹⁹ Estimates from Mckinsey.

²⁰ This can be seen in the growing number of industry free zones, such as Sharjah Media City, twofour54 in Abu Dhabi, and Dubai's Studio City and Production City.

²¹ https://www.bcgperspectives.com/Images/Digital_Government_Jun_2014_tcm80-162861.pdf

²² <https://www.gov.uk/government/publications/government-digital-strategy/government-digital-strategy>

²³ Detailed breakdowns of the methodology are not available. <http://www.smartdubai.ae/story0629.php>

²⁴ Federal or emirate level. See https://www.bcgperspectives.com/Images/Digital_Government_Jun_2014_tcm80-162861.pdf

²⁵ <https://itunes.apple.com/ae/app/moi-uae/id768665731?mt=8>

²⁶ A growing number of these services can be transacted entirely online. For services that still require an "offline" action, such as visiting a government office, Gov.uk directs the user to the appropriate next step.

²⁷ <https://publicadministration.un.org/egovkb/en-us/reports/un-e-government-survey-2016>

²⁸ <https://www.gov.uk/service-manual>

²⁹ <https://www.gov.uk/design-principles>

³⁰ Smart Dubai Government is now part of Smart Dubai Office.

³¹ <https://play.google.com/store/apps/details?id=com.deg.mdubai&hl=en>

- ³² <https://itunes.apple.com/ae/app/mdubai/id619712783?mt=8>
- ³³ <https://www.gov.uk/government/publications/public-sector-information-market-assessment>
- ³⁴ <https://itunes.apple.com/us/app/citymapper-ultimate-transit/id469463298?mt=8>
- ³⁵ <http://dubaidata.ae/pdf/Dubai-Data-Manual-20160612.pdf>
- ³⁶ <http://index.okfn.org/>
- ³⁷ According to data from the EIU and the Federal Competitiveness and Statistics Authority.
- ³⁸ UAE estimate based on A.T. Kearney ecommerce data and EIU data on retail sales in the UAE.
- ³⁹ <http://www.middle-east.atkearney.com/documents/787838/8908433/Getting+in+on+the+GCC+E-Commerce+Game.pdf/f06b44f0-4fdc-44d3-b9b3-1e273e4eeb36>
- ⁴⁰ US data based on Census Bureau quarterly ecommerce report.
- ⁴¹ Both growth rates are compound annual growth rates. The rate for overall retail sales is based on EIU data. The rate for ecommerce is based on A.T. Kearney forecasts.
- ⁴² <http://newsroom.mastercard.com/mea/press-releases/online-shopping-continues-to-gain-popularity-in-the-uae-mastercard-study/>
- ⁴³ http://www.middleeastevents.com/news/page/gartner_calls_for_more_business_participation_to_grow_digital_commerce_in_middle_east/27040#.WM9sxdKGNph
- ⁴⁴ <http://www.middle-east.atkearney.com/documents/787838/8908433/Getting+in+on+the+GCC+E-Commerce+Game.pdf/f06b44f0-4fdc-44d3-b9b3-1e273e4eeb36>
- ⁴⁵ <https://mofluid.com/blog/mobile-commerce-trends-in-2016-for-retailers/>
- ⁴⁶ <http://www.masterintelligence.com/content/intelligence/en/research/press-release/2015/online-shopping-popularity-in-the-uae.html>
- ⁴⁷ <http://www.smartinsights.com/social-media-marketing/social-media-strategy/new-global-social-media-research/>
- ⁴⁸ According to data from AT Kearney.
- ⁴⁹ As confirmed by an interviewee.
- ⁵⁰ https://www.zawya.com/mena/en/story/Dubais_Landmark_Group_switches_its_eCommerce_strategy-GN_28112016_291118/
- ⁵¹ According to data from the Federal Competitiveness and Statistics Authority.
- ⁵² https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/502995/UK_FinTech_-_On_the_cutting_edge_-_Full_Report.pdf
- ⁵³ Based on a ranking of domestic banks by asset size (2015). EIU estimate.
- ⁵⁴ [http://www.ey.com/Publication/vwLUAssets/EY-GCC-digital-banking-report-2015/\\$FILE/EY-GCC-digital-banking-report-2015.pdf](http://www.ey.com/Publication/vwLUAssets/EY-GCC-digital-banking-report-2015/$FILE/EY-GCC-digital-banking-report-2015.pdf)
- ⁵⁵ [http://www.ey.com/Publication/vwLUAssets/EY-GCC-digital-banking-report-2015/\\$FILE/EY-GCC-digital-banking-report-2015.pdf](http://www.ey.com/Publication/vwLUAssets/EY-GCC-digital-banking-report-2015/$FILE/EY-GCC-digital-banking-report-2015.pdf)
- ⁵⁶ A slightly higher proportion of UAE customers (39%) access online banking websites through a mobile browser.
- ⁵⁷ <http://www.middle-east.atkearney.com/documents/787838/8908433/Getting+in+on+the+GCC+E-Commerce+Game.pdf/f06b44f0-4fdc-44d3-b9b3-1e273e4eeb36>
- ⁵⁸ http://www.altfi.com/article/2364_funding_circle_smashes_its_own_uk_monthly_origination_record
- ⁵⁹ <https://www.beehive.ae/>
- ⁶⁰ According to EIU data.

⁶¹ <http://www.mideastmedia.org/>

⁶² <http://www.mideastmedia.org/survey/2016/interactive/online-and-social-media/paying-for-online-content.html>

⁶³ EIU estimate based on World Bank data.

⁶⁴ Figures are self-reported so should be treated with some caution.

⁶⁵ <http://www.mideastmedia.org/industry/2016/digital/>

⁶⁶ <http://www.mideastmedia.org/industry/2016/digital/>

⁶⁷ <http://www.mideastmedia.org/industry/2016/digital/>

⁶⁸ Estimate based on aggregation of market estimates. Precise data is lacking.

⁶⁹ Typically referred to as "native advertising".

⁷⁰ <http://www.mideastmedia.org/industry/2016/tv/#s13>

⁷¹ Middle East and North Africa

⁷² <http://www.mideastmedia.org/>

⁷³ <http://www.thenational.ae/business/media/approval-for-tv-audience-checker-could-lead-to-higher-uae-advertising-spending>

⁷⁴ <http://www.mideastmedia.org/>

⁷⁵ <http://www.mideastmedia.org/survey/2016/interactive/online-and-social-media/social-media-platforms-daily-use.html>

⁷⁶ <http://www.mideastmedia.org/industry/2016/tv/#s13>

⁷⁷ <http://www.mideastmedia.org/survey/2016/>

⁷⁸ <http://www.mideastmedia.org/>

⁷⁹ <https://newzoo.com/insights/rankings/top-100-countries-by-game-revenues/>

⁸⁰ http://www.strategyand.pwc.com/me/home/press_media/management_consulting_press_releases/details/55045519

⁸¹ To try to capitalise on this demand, Abu Dhabi's twofour54's free zone has established a games academy and has offered firms rebates on production expenditure.

⁸² <http://www.mideastmedia.org/industry/2016/radio/#s55>

⁸³ <http://www.mideastmedia.org/industry/2016/radio/#s55>

⁸⁴ [http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/IIS\(2015\)10/FINAL&docLanguage=En](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/IIS(2015)10/FINAL&docLanguage=En)

⁸⁵ The EIU approached the following providers for data: LinkedIn, Bayt.com, Laimoon, GulfTalent, Robert Half, Hays, Korn Ferry Hay Group, Monster Gulf, Cooper Fitch/Morgan McKinley, Emerald Technology, JCA Associates, SALT Technologies, Absher Initiative, Khayarat and Dubai eJob portal.

⁸⁶ According to non-public data shared with the EIU.

⁸⁷ Other capabilities such as network engineering, systems analysis and IT support are also in high demand.

⁸⁸ Private sector is defined here as those firms that have no government ownership.

⁸⁹ <https://www.eiuperspectives.economist.com/talent-education/quest-digital-skills>

⁹⁰ <http://www.kornferry.com/press/korn-ferry-hay-group-2017-salary-forecast-wage-increases-slow-globally/>

⁹¹ <https://versionone.com/pdf/VersionOne-10th-Annual-State-of-Agile-Report.pdf>

⁹² Note: This data includes both technical and non-technical capabilities.

⁹³ Note: This data includes both technical and non-technical capabilities.

⁹⁴ Note: This data includes both technical and non-technical capabilities.

⁹⁵ <http://dubaidata.ae/pdf/Dubai-Data-Manual-20160612.pdf>

⁹⁶ Examples include NoSQL and Hadoop.

⁹⁷ <http://www.cnmeonline.com/news/over-2-million-uae-consumers-experienced-cyber-crime-in-2015/>

⁹⁸ <http://www.agsiw.org/wp-content/uploads/2016/05/UAESF-Event-Report-Online2.pdf>

⁹⁹ Such as the International Organization for Standardization and Payment Card Industry Data Security Standards.

¹⁰⁰ Based on survey data shared by GulfTalent with the EIU.

¹⁰¹ <http://www.acm.org/education/CS2013-final-report.pdf>

¹⁰² <https://www.ox.ac.uk/admissions/undergraduate/courses-listing/computer-science?wssl=1>

¹⁰³ Discrete mathematics is the study of mathematical structures that are fundamentally discrete rather than continuous. Algorithms perform calculation, data-processing, and/or automated reasoning tasks.

¹⁰⁴ This number includes those studying diplomas, bachelor's, master's and doctorate degrees. It excludes some students studying certain programmes not accredited by the Commission of Academic Accreditation, such as at certain institutes in Dubai Knowledge Village.

¹⁰⁵ Among the 50,882 expatriate students, the share enrolled in IT-related degrees was even lower, at 4.7%.

¹⁰⁶ https://data.gov.sg/dataset/graduates-from-university-first-degree-courses-by-type-of-course?view_id=b8204fda-6f81-45d6-8a0a-3a095676f91e&resource_id=eb8b932c-503c-41e7-b513-114cffbe2338

¹⁰⁷ https://nces.ed.gov/programs/coe/indicator_cta.asp

¹⁰⁸ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/518575/ind-16-5-shadbolt-review-computer-science-graduate-employability.pdf

¹⁰⁹ In the UAE, a substantial number of Emirati males go directly from high school to jobs in the police and military (which increases the relative share of women at university).

¹¹⁰ UAE University claims to offer a computer science degree. However, according to its enrolment data from 2014/15, all 548 undergraduate students in the university's College of Information Technology are taking IT degrees rather than computer science degrees. http://www.uaeu.ac.ae/en/vc/paidd/pdf/spring_semester15.pdf

¹¹¹ http://www.uaeu.ac.ae/en/vc/paidd/pdf/spring_semester15.pdf

¹¹² https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/518575/ind-16-5-shadbolt-review-computer-science-graduate-employability.pdf

¹¹³ <http://www.kustar.ac.ae/source/pdfs/ku%20fact%20book%202015%20feb15%20low-res%20compressed.pdf>

¹¹⁴ <http://www.adu.ac.ae/en-us/programdetail.aspx?enc=kZdo4yRVS4gRExygXA1GyovlsNKUX4ETpaKnDvfuWBg=#.WChuzdJ95pi>. Approximately 6,000 students are enrolled in Abu Dhabi University, while approximately 1,300 are enrolled in Khalifa University.

¹¹⁵ Estimated by the EIU at less than 100, based on enrolment data for individual programmes.

¹¹⁶ Other examples include Heriot-Watt University in Dubai, University of Sharjah, Murdoch University, University of Wollongong, and the British University in Dubai, although their qualification is only at PhD level, not undergraduate level.

¹¹⁷ American University of Sharjah had almost 230 students enrolled in its computer engineering programme, compared with just 129 enrolled in computer science.

¹¹⁸ https://www.aus.edu/info/200135/undergraduate_programs/243/bachelor_of_science_in_computer_science

¹¹⁹ <http://engineering.aau.ac.ae/en/cs-facts-and-figures/>

¹²⁰ http://www.sharjah.ac.ae/en/Media/Publications/Documents/UOS%20Catalog/pdf/Sciences_English.pdf#CS

- ¹²¹ *Comprehensive Standards and Performance Criteria for K-12 Computer Science and Technology Education*
- ¹²² ieeexplore.ieee.org/iel7/7469053/7474513/07474666.pdf
- ¹²³ http://www.academia.edu/2456347/Grand_challenges_for_the_UK_Upskilling_teachers_to_teach_Computer_Science_within_the_Secondary_curriculum
- ¹²⁴ https://www.abudhabi.ae/portal/public/en/citizens/education/universities/gen_info15?docName=ADEGP_DF_116702_EN&_adf.ctrl-state=1df5mvt7x0_4&_afrLoop=12772008679205223#!
- ¹²⁵ <http://www.mohe.gov.ae/En/OpenData/Pages/ReportsandStatistics.aspx>
- ¹²⁶ <http://www.hct.ac.ae/en/programmes/accreditation/>
- ¹²⁷ <http://www.scimagojr.com/>
- ¹²⁸ Some private institutions offer master's degrees in project management in the UAE, such as the British University in Dubai. Globally, several institutions offer master's degrees across these subjects, such as Johns Hopkins University's master's degree in data science.
- ¹²⁹ <https://www.tra.gov.ae/ictfund/en/funding-categories/education/scholarships.aspx>
- ¹³⁰ The Abu Dhabi Education Council carries out a regular survey in Abu Dhabi, but data was not made public and despite requests could not be shared.
- ¹³¹ <http://www.hct.ac.ae/content/uploads/HCT-Factbook-1516-Graduate-Employment-Rates-1.pdf>
- ¹³² Colleges in Sharjah serve Ajman and Umm Al Quwaim.
- ¹³³ Expanding Women's Participation in Science, Technology and Engineering: The Case of the United Arab Emirates, Triple Helix Conference, 2010.
- ¹³⁴ http://www.alqasimifoundation.com/admin/Content/UserFiles/ENGLISH%20UAE%20Vision%20Women%20FULL%20-%20WEB_0.pdf
- ¹³⁵ See: http://www.ri.cmu.edu/pub_files/pub4/nourbakhsh_illah_2003_1/nourbakhsh_illah_2003_1.pdf
- ¹³⁶ See: <https://hourofcode.com/us/events/all/ae>
- ¹³⁷ <http://pss.sagepub.com/content/early/2012/07/02/0956797611435530.abstract>
- ¹³⁸ <https://www.prospects.ac.uk/careers-advice/what-can-i-do-with-my-degree/computer-science>
- ¹³⁹ <http://www.careers.cam.ac.uk/stuart/AnnualReport.pdf>
- ¹⁴⁰ <http://www.disabilitypolicyresearch.org/~media/publications/pdfs/education/effective%20teachers.pdf>
- ¹⁴¹ <http://www.kustar.ac.ae/pages/undergraduate-scholarships>
- ¹⁴² <https://itp.nz/files/wipsce-teachers-2013.pdf>
- ¹⁴³ *Challenges and Benefits of Programming Competitions as Outreach to High School Students*, Dr Sushil Acharya, Robert Morris University.
- ¹⁴⁴ <http://www.glasslabgames.org/>
- ¹⁴⁵ http://www.jstor.org/stable/jeductechsoci.15.3.288?seq=1#page_scan_tab_contents
- ¹⁴⁶ http://www.leavenetwork.org/fileadmin/Leavenetwork/Annual_reviews/2014_annual_review_korr.pdf

While every effort has been taken to verify the accuracy of this information, The Economist Intelligence Unit Ltd. cannot accept any responsibility or liability for reliance by any person on this report or any of the information, opinions or conclusions set out in this report.

LONDON

20 Cabot Square

London

E14 4QW

United Kingdom

Tel: +44 (0) 20 7576 8181

E-mail: london@eiu.com

NEW YORK

750 Third Avenue

5th Floor

New York, NY 10017

United States

Tel: + 1 212 698 9717

E-mail: americas@eiu.com

HONG KONG

1301 Cityplaza Four

12 Taikoo Wan Road

Taikoo Shing

Hong Kong

Tel: + 852 2802 7288

E-mail: asia@eiu.com

DUBAI

Office No. 1301A, Aurora Tower

Dubai Media City

PO Box No 450056

Dubai, United Arab Emirates

Tel: + 971 (0) 4 433 4202