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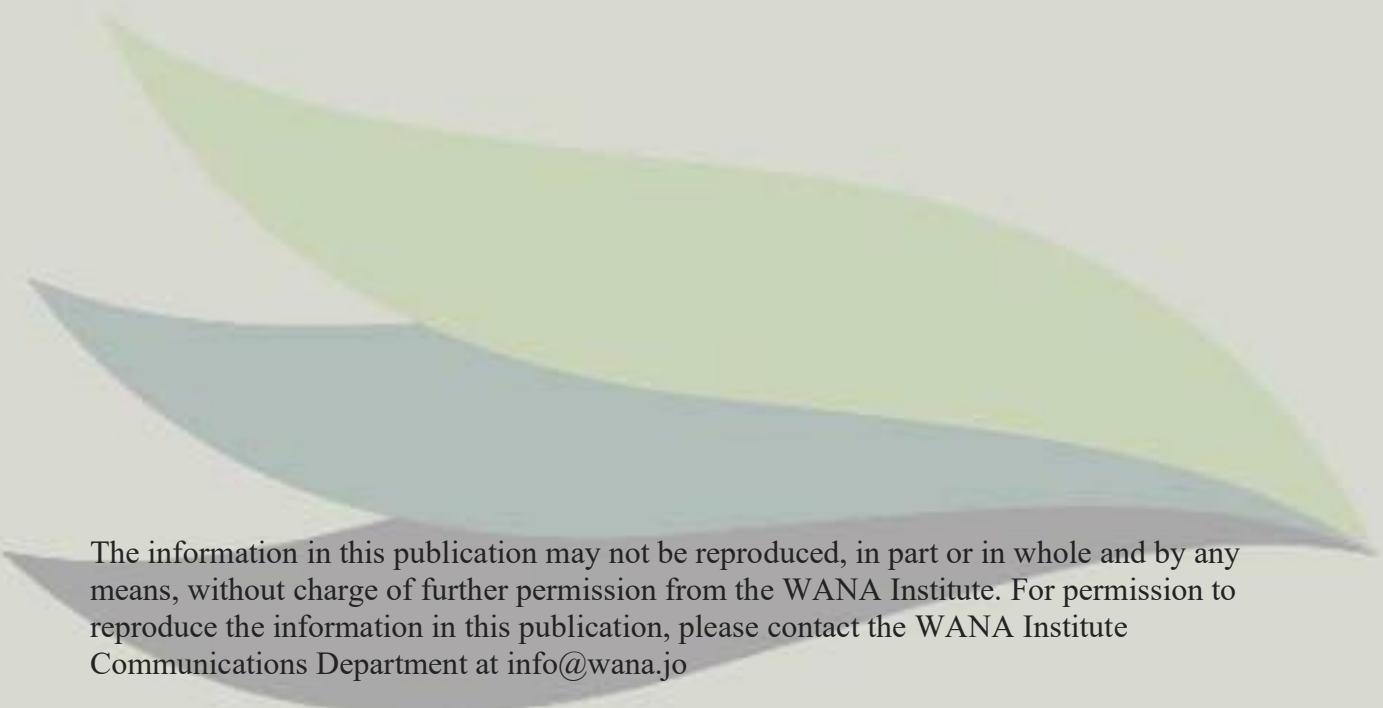
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# Bans, Restrictions, and Missed Opportunities in Jordan: *3D Printing and Drone Technology*



West Asia – North Africa Institute, February 2022



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## Executive Summary

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This study seeks to estimate the opportunity lost to Jordan's economy owing to the regulations governing two cross-cutting ICT technologies, commercial Unmanned Aerial Vehicles (drones) and 3D printers. It was commissioned by the Next Society in an effort to assess how restricted access to new technologies – namely 3D printers and drones – affects Jordan's economic growth and competitiveness. The study looks at the tax and regulatory framework surrounding the technologies in Jordan. It then looks at some major worldwide applications and uses of these technologies, and assesses the potential missed opportunity costs of Jordan restricting these technologies over the years. It then provides recommendations for the Jordanian government to incentivize the commercial adoption of these technologies in ways that accommodate their security concerns.

## 1 Background to the Problem

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### 1.1 3D Printers and Drones: Integral Parts of the ICT Economy

In the past few years, the rapid growth in the complexity and use of digital technologies has propelled the Information and Communications Technology (ICT) sector to become one of the main driving forces of the global economy. According to one estimate, the global digital economy is estimated to be worth USD 11.5 trillion, which is equivalent to 15.5 per cent of the global GDP.<sup>1</sup> In Jordan, the ICT sector constitutes around 12 per cent of the GDP, a treble growth since 2014.<sup>2</sup> But these figures hardly reveal the full picture of how ICT is driving economic growth, as the use of digital technologies – and their true GDP contribution – extend far beyond the ICT sector. Digital technologies also contribute to economic growth by enhancing productivity and innovation across sectors, including education, energy, transport, and health – something that Jordan's Economic Policy Council has recognised. Consequently, it has made ICT its greatest priority for economic growth.<sup>3</sup> In order to do this, Jordan would need to develop a regulatory framework that facilitates the development and use of cutting-edge ICT technologies, both software and hardware. **As things stand, Jordan's security and tax considerations continue to pose serious obstacles to the importation, production, and domestic use of key ICT technologies.**

3D printers and drones are both instrumental to what has been coined by Klaus Schwab as the Fourth Industrial Revolution, characterised by “a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres.”<sup>4</sup> Moreover, according to Schwab, these

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<sup>1</sup> Peña-López, Ismael. "Digital Spillover. Measuring the true impact of the Digital Economy." (2017).

<sup>2</sup> Jordan Investment Commission (JIC) (2018, April). ICT Sector Pro le (Rep.). Retrieved February 15, 2021, from Jordan Investment Commission (JIC) website: <https://www.jic.gov.jo/wp-content/uploads/2018/07/Sector-Pro-le-ICT-Final-Apr-2018-2.pdf>

<sup>3</sup> The Economic Policy Council (EPC) (2018, November). Jordan Economic Growth Plan: 2018-2022 (Rep.). Retrieved February 15, 2021, from The Economic Policy Council website: <https://www.ssif.gov.jo/UploadFiles/JEGProgramEnglish.pdf>

<sup>4</sup> Klaus Schwab, "The Fourth Industrial Revolution: What It Means and How to Respond," World Economic Forum, January 14, 2016, <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>.

technologies evolve at an exponential rather than linear pace, disrupting almost every industry in every country.<sup>5</sup> As such, this study features some key case studies of missed opportunity costs across Jordan's industries. However, there are many more cases – though harder to quantify – in which Jordan misses out from limiting the use of these technologies. It then proposes to the Jordanian government a tax incentive plan to encourage research and development, so that Jordanian companies can more easily adopt and develop these technologies.

## 2 Methodology

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The study is based on desk research and key informant interviews with Jordanian entrepreneurs and developers who have worked with these technologies, as well as Jordanian government officials involved in their regulation. To gather information on drones and 3D printers in Jordan, four researchers from West Asia – North Africa (WANA) Institute researched these two technologies' latest applications, their role in the global economy, their role in Jordan's economy, and the current regulatory framework surrounding them in Jordan. Based on this research, the researchers devised interview questions to gather primary information from Jordanian stakeholders.

The researchers then held virtual semi-structured interviews with 17 key stakeholders throughout August 2021. These stakeholders were from the Jordanian start-up/maker community, the Jordanian government, and the non-governmental sector. Eight interviews were conducted with stakeholders from the 3D printing sector, two of which were with medical professionals. Four interviews were conducted with experts from the drone sector. Several start-up/maker community stakeholders had started enterprises in Jordan but moved them abroad to EU countries and Turkey, from where they gave their interviews. Three interviews were conducted with governmental sector stakeholders from the Department of Income and Sales Tax Department and the University of Jordan's engineering department. Lastly, two interviews were conducted with stakeholders from the non-governmental sector, one representing an incubator and the other a technology-advocating interest group.

Before starting all interviews, researchers notified key informants that their information would be kept completely anonymous. Their input is reflected in places of the report where uncited but specific information is used. Researchers at the WANA Institute employed a rigorous process of stakeholder selection to ensure that all viewpoints were considered. Mostly conducted in English, these interviews were conducted through Zoom and averaged 45 minutes.

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<sup>5</sup> Ibid.

### 3 Jordan's General Regulatory Framework for 3D Printers and Drones

Since the commercial introduction of 3D printing and drone technologies, Jordanian industries have faced multiple constraints at the adoption phase, both in terms of importing fees and security regulations. While some of these constraints are common to Jordan's overall regulatory environment, interviewees mentioned others being a result of the misconceptions surrounding these technologies by officials in both the security and customs apparatuses. With years of bans and regulations on 3D printers and drones, respectively, some interviewees mentioned that this was a result of initial security fears concerning these technologies, coupled with inertia to develop the kinds of regulations that other states had developed to mitigate these concerns. Even when full bans were lifted, interviewees mentioned that security measures often meant that their imports were held up for months at customs entry points, with them having to make multiple visits in order to retrieve them. In terms of fees, some interviewees who had imported 3D printers discussed customs officials' lack of technical expertise in assessing the monetary value of these technologies, often charging them by weight or listed internet price, even when prototype machines. As the following regulatory framework sections show, even beyond the adoption phase, members of the start-up/maker community struggled with the local development of these technologies. One of the most prominent themes in interviews – albeit unquantifiable – was the repelling effect of Jordan's technology regulation environment on members of its start-up/maker community, leading them to move their businesses, workshops, and factories abroad.

#### 3.1 Tax and Regulatory Constraints

In terms of customs tariffs, the rate that applies to drones and 3D printers is standard to Jordan's imported machinery. However, tariffs might vary depending on if these technologies are imported from countries that have signed bilateral and multilateral trade agreements with Jordan. These agreements include The Greater Arab Free Trade Area (GAFTA), The Jordanian European partnership, Jordan-US Free Trade Agreement, The QIZ agreement, Jordan's trade agreement with the European Free Trade Association (EFTA), Jordan and Singapore's trade agreement, Jordan and Canada's trade agreement, The Jordanian British agreement and, Jordan's bilateral trade agreements with other Arab countries.

These rates are reflected in the table below:

| Name  | Unified Relative Fee | General Sales Tax | Special Sales Tax | Qualitative sales tax |
|---|----------------------|-------------------|-------------------|-----------------------|
| Ultrasound 3D printers                      | 0                    | 16 %              | 0                 | 0                     |
| 3D object shaping using glass and porcelain | 0                    | 16 %              | 0                 | 0                     |

|  |   |      |   |   |
|--|---|------|---|---|
| 3D printers, blow moulding machines, for rubber, plastics or products from these materials                     | 0 | 16 % | 0 | 0 |
| 3D printers, vacuum moulding machines and other thermoforming machines, for rubber, plastics or their products | 0 | 16 % | 0 | 0 |
| 3D printers, machines for working rubber or plastics or making products from these materials                   | 0 | 16 % | 0 | 0 |
| 3D printers to form three-dimensional objects using ink, powder or clay  | 0 | 16 % | 0 | 0 |

The taxes applied to 3D printing and drone technologies fall directly in line with Jordan's standard tax structure. Jordan's standard 16 per cent sales tax rate applies to them like any other product. Moreover, the income tax that applies to the companies utilising these technologies in their production processes is the same specified in the Jordanian income tax law of 2018. Therefore, any company that uses 3D printing or drones pays the same taxes as other companies in the same sector. These taxes vary by the sector of operations as shown in the following table:

| <b>Table 2: Effective Tax Rates by Sector in Jordan</b>                        |                        |                                       |                       |
|--|------------------------|---------------------------------------|-----------------------|
| <b>Sector</b>  | <b>Income tax rate</b> | <b>National contribution tax rate</b> | <b>Total tax rate</b> |
| Banks  | 35 %                   | 3 %                                   | 38 %                  |
| Electricity distribution and generation companies                              | 24 %                   | 3 %                                   | 27 %                  |
| Basic material mining companies  | 24 %                   | 7 %                                   | 31 %                  |
| Financial brokerage companies, financial companies, finance leasing activities | 24 %                   | 4 %                                   | 28 %                  |

|  |      |     |      |
|--|------|-----|------|
| Telecommunications, insurance, and reinsurance companies | 24 % | 2 % | 26 % |
| Drug and clothes manufacturing companies                 | 14 % | 1 % | 15 % |
| Other industrial companies                               | 16 % | 1 % | 17 % |
| Other sectors (standard rate)                            | 20 % | 1 % | 21 % |

Thus, the taxation challenges faced by 3D printing and drone technologies in Jordan are part of the overall tax challenges faced by other businesses in the Jordanian economy. Based on the above, to support the utilisation of 3D and drone technologies in the Jordanian economy, structural reform in terms of the overall business environment is needed. These reforms include reducing energy prices, removing regulatory barriers, and clarifying the unclear regulations that organise the use and importation of 3D printers and drones. Some of the more attainable reform recommendations are mentioned in the paper's final section.

## 4 3D Printers

### 4.1 Regulatory Framework of 3D Printers

3D printers have a number of commercial uses and benefits in the healthcare, automotive, and aerospace industries. There are three types of printers depending on the material input they need to print: Plastics (biodegradable materials), Powder (metal or gypsum), and Liquids (plastics and silicone). Collectively, these can produce prototypes, visual models, replacement parts, medical casts, and increasingly, infrastructure. From American, German, Belgian, and Dutch manufacturing hubs, 3D printing technologies are growing at a rate that will disrupt manufacturing trends, namely in terms of automation. The global 3D printing market size was valued at USD 13.78 billion in 2020 and is expected to expand at a compound annual growth rate (CAGR) of 21.0 per cent from 2021 to 2028. In terms of machines, 2.1 million units of 3D printers were shipped in 2020 and the shipments are expected to reach 15.3 million units by 2028.<sup>6</sup>

On a regional level, the United Arab Emirates leads the 3D printing industry. Having released a 3D Printing Strategy in 2016, the UAE has sought to make Dubai a global hub in the technology by using it in construction, medical products, and consumer products. The Strategy's plan for 3D

<sup>6</sup> "3D Printing Market Size & Share | Industry Trends Report, 2027," [www.grandviewresearch.com](https://www.grandviewresearch.com), May 2021, <https://www.grandviewresearch.com/industry-analysis/3d-printing-industry-analysis>.



printers in the construction sector focuses on lighting products, bases and foundations, construction joints, facilities and parks, as well as commercial and residential real estate, at a projected value of about AED3 billion by 2025.<sup>7</sup> In the medical products sector, the Strategy seeks to develop 3D printed teeth, bones, artificial organs, medical and surgical devices, and hearing aids, at a projected value of AED1.7 billion by 2025.<sup>8</sup> For consumer products, the Strategy focuses on household items, optics, fashion jewelry, children's games and fast food, at a projected value of AED2.8 billion by 2025.<sup>9</sup>

Jordan's economy has two key factors that would make its embrace of 3D technology almost intuitive. High energy prices make conventional manufacturing expensive in Jordan, and high customs make importing replacement parts costly. However, in the critical years of the technology's adoption phase, these factors did not weigh heavily enough against Jordan's regulatory considerations. In 2012 – at the earliest stages at the adoption phase – 3D printers were allowed unhindered, with many customs agents altogether unfamiliar with the technology. One interviewee mentioned that in that year, his start-up consulted with the Jordanian Armed Forces and conducted an awareness campaign on the radio and social media, as well as on the streets, in which he and his team would drive around their mobile workshop and educate students on the technology.

However, the government's reception began to change when a video surfaced from the dark web showing a person produce a functioning .22 calibre pistol from a 3D printer. This turned the Jordanian government's attention to the technology's potential military use, leading it to fully ban the technology in April 2014.<sup>10</sup> At the time, most of the 3D printers in Jordan could only produce plastic prototypes, meaning they could not produce guns, a factor which did not seem to be accounted for in the ban. Pioneering companies such as Third Reality had their printers confiscated. After intervention from the Crown Prince's office, the government lifted the ban in November 2016, but with strict conditions of use. By November 2017, these included: limiting 3D printer purchases to 3D printing companies, requiring all printer operators to first submit their names to the Ministry of Interior; requiring the user to inform the government of their printing activity on a monthly basis; requiring users to install a camera in the workshop where the printer is located, connected to the security forces 24-hours a day.<sup>11</sup> The overall scrutiny of the technology discouraged many Jordanians from adopting the technology, while the paperwork and processing time – sometimes three months – required for importing the technology soon pushed the bulk of the small 3D printing community to set up operations abroad.

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<sup>7</sup> Esraa Moran, "Mohammed Bin Rashid: 25% of Dubai's Buildings Will Be 3D Printed by 2030," *wam*, April 27, 2016, <https://wam.ae/en/details/1395294773443>.

<sup>8</sup> *Ibid.*

<sup>9</sup> *Ibid.*

<sup>10</sup> Akram Al-Humoud, الطباعة ثلاثية الأبعاد في الأردن وتعطيل المستقبل [3D Printing in Jordan and Disrupting the Future], *7iber | حبر*, May 9, 2016, <https://www.7iber.com/technology/3d-printing-in-jordan/>.

<sup>11</sup> Tala El Issa, "Jordan and 3D Printers: A Battle close to an End," *Wamda*, March 6, 2017, <https://www.wamda.com/memakersge/2017/03/jordan-3d-printers>.

The following sections show how the interruption of 3D printing adoption momentum has caused opportunity loss in the medical and aerospace industries. Moving forward in a more open regulatory environment, the following case studies can serve as a basis for the targeted regulatory encouragement of 3D printer use.

#### 4.1.1 Medical

Since 2003, Jordan has gained traction as a medical tourism destination. Its high number of doctors per capita and competitive treatment prices have helped maintain its regional standing. To maintain its qualitative edge, it is in Jordan's interest to make sure that its medical facilities feature the latest in technologies. Towards this end, it would stand to benefit from 3D printing technologies.

Some features of Jordan's medical industry make certain adaptations of this 3D technology ineffective. In countries where technical labour is high, producing casts and moulds becomes cheaper through automation. In Jordan, however, it is often more cost effective to pay technicians' salaries (300-400 JOD) than to invest in new machinery. This is especially the case when the quality of 3D printed products is comparable to their conventionally-made counterparts. Low labour cost is thus one of the major reasons for the slow embrace of 3D printers in the Jordanian dentistry sector, which hosts only one company that 3D prints aligners.

A multinational distributor, Eon Aligner employs some 28 people in Jordan and generates revenues totalling some JOD 3.55 million.<sup>12</sup> On smaller scales, it becomes impractical for dentist and orthodontist clinics to purchase 3D printers for in-house use, ranging as they do from JOD3,000 to 18,000 before customs and taxes. This base price also does not include licensing fees for scanning software, which can reach scales similar to the hardware itself. In high-labour cost countries, clinics consider these investments cost-saving in the long-run.

Nonetheless, recent studies have shown that 3D printing has an overall edge in more specialised fields of medicine. This is the case with cardiology and amputee prosthetics, two of the most promising fields in which 3D printers can be applied to the Jordanian context.

3D printing has proven extremely effective in the diagnosis and planning phase for open-heart surgery. According to some studies, scans can produce 3D models of the heart with 95 per cent accuracy.<sup>13</sup> In pre-surgery, this helps doctors identify coronary abnormalities, the exactness of which helps determine the most suitable course of action. According to one study, in 98 per cent of cases (126/130), 3D printed models enhanced cardiovascular researchers' and clinicians' awareness of the coronary anatomy and abnormality.<sup>14</sup> In 89 per cent of all cases, they agreed that studying the 3D model was more effective for their understanding of the abnormality than just the

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<sup>12</sup> RocketReach, "Eon Aligner: RocketReach," RocketReach, n.d., [https://rocketreach.co/eon-aligner-profile\\_b58c47d0f621cd69](https://rocketreach.co/eon-aligner-profile_b58c47d0f621cd69).

<sup>13</sup> Anurup Ganguli et al., "3D Printing for Preoperative Planning and Surgical Training: A Review," *Biomedical Microdevices* 20, no. 3 (August 4, 2018), <https://doi.org/10.1007/s10544-018-0301-9>.

<sup>14</sup> Matthew Lee et al., "Evaluating 3D-Printed Models of Coronary Anomalies: A Survey among Clinicians and Researchers at a University Hospital in the UK," *BMJ Open* 9, no. 3 (March 1, 2019): e025227, <https://doi.org/10.1136/bmjopen-2018-025227>.

CT scan, with 74 per cent strongly agreeing.<sup>15</sup> Despite evidence pointing to 3D printers' benefits, no hospitals or clinics in Jordan have yet to adopt them in cardiology.

3D printers have revolutionised the field of prosthetics because of their accuracy, speed, and cost-efficiency. For developing countries like Jordan, they are considered far more affordable than conventionally produced prosthetics.<sup>16</sup> Standard Stereolithography (SLA) printers can translate any MRI, CT scan, or x-ray into digital 3D printed files. Using this method, 3D printers can produce complex and customised prosthetic limbs within 24 hours, cutting down labour costs. The greatest cost savings come from the raw materials of the 3D printed prosthesis, which cost between JOD 15 and 70.<sup>17</sup> In the Jordanian context, the final cost of a 3D printed prosthetic – including case estimation, assessment of the patient's needs, and printing time – can be as low as JOD180.<sup>18</sup> Still, most Jordanian medical providers continue to fit amputee patients with conventionally produced prosthetics, the prices of which range from JOD 800–3,000. This is in part because of patient preference for the more natural appearance of conventionally produced prosthetics, and also because of manufacturer's lack of access to the technology. This concern over preferences, however, is likely to diminish as materials techniques in the field develop. The mainstreaming of 3D printing technology would greatly stimulate Jordan's healthcare sector, lowering costs and improving the speed at which patients can access new limbs.

#### **4.1.1.1 Congenital Heart Disease**

In recent years, 3D printing technology has enabled cardiologists to print exact replicas of the heart to better understand its defects and approaches to treating it. Common imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and echocardiography images are limited in the sense that – even when produced as 3D models – they only appear on 2D screens. Rather, 3D printing technology presents a breakthrough for providing tactile 3D imaging. Specifically, for cardiovascular surgery, “3D printing can provide improved visuali[s]ation of the anatomical details and guide precision operations.”<sup>19</sup> As such, the most widely reported applications have been for congenital heart diseases (CHD).<sup>20</sup>

This application can be especially important to Jordan, where 12.3 out of every 1,000 children are born with CHD. Nearly one-fourth of such cases are considered for surgical intervention, where there is a range of anomalies targeted for correction.<sup>21</sup> However, 3D printers have added case-

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<sup>15</sup> Ibid.

<sup>16</sup> Fredrick Ishengoma and Adam Mtaho, “3D Printing: Developing Countries Perspectives General Terms 3D Printing and Developing Countries Keywords Additive Manufacturing and Rapid Prototyping,” *International Journal of Computer Applications* 104, no. 11 (2014): 975–8887, pg. 31, <https://arxiv.org/pdf/1410.5349.pdf>

<sup>17</sup> Benesch, “Developments in 3D Printing: A Sector by Sector Overview” (Benesch, 2018), pg. 17, <https://documents.jdsupra.com/d8b081b7-e3e2-49fe-8dd4-d747e5491a2c.pdf>

<sup>18</sup> Ibid.

<sup>19</sup> Daniel Cernica et al., “3D Printing—a Cutting Edge Technology for Treating Post-Infarction Patients,” *Life* 11, no. 9 (September 1, 2021): 910, <https://doi.org/10.3390/life11090910>.

<sup>20</sup> Daniel Cernica et al., “3D Printing—a Cutting Edge Technology for Treating Post-Infarction Patients,” *Life* 11, no. 9 (September 1, 2021): 910, <https://doi.org/10.3390/life11090910>.

<sup>21</sup> Laila Tutunji, Iyad Al Ammouri, and Fares Ayoub, “(PDF) Incidence of Congenital Heart Disease in Jordanian Children Born at Jordan University Hospital; a Seven-Year Retrospective Study,” ResearchGate, June 2017, [https://www.researchgate.net/publication/321136989\\_Incidence\\_of\\_Congenital\\_Heart\\_Disease\\_in\\_Jordanian\\_Children\\_Born\\_at\\_Jordan\\_University\\_Hospital\\_a\\_Seven-Year\\_Retrospective\\_Study](https://www.researchgate.net/publication/321136989_Incidence_of_Congenital_Heart_Disease_in_Jordanian_Children_Born_at_Jordan_University_Hospital_a_Seven-Year_Retrospective_Study).

specific accuracy to the intervention planning process. According to a 2019 experiment in which 3D printers were used in the planning stage of surgery, results showed that 3D printing had a significant clinical impact on redefining the surgical approach 47.5 per cent of the time. Most critically, in 25 per cent of cases, the 3D printed models helped change the plan from conservative management (non-surgical) to invasive surgery.<sup>22</sup>

The use of 3D printers could thus have a critical impact on the state of the surgical industry in Jordan. Specifically, it could increase the number of CHD surgeries per year. According to an upper-end professional estimation, 3,000 open-heart surgeries happen in Jordan every year. While funding sources differ for the approximately 1,000 carried out in private hospitals and clinics and 2,000 in public hospitals, each surgery costs approximately JOD8,500 – at an annual total of JOD 25.5 million. Roughly 900 or 30 per cent of these surgeries are for CHD, for a total of JOD 7.65 million. As per the 2019 study, the use of 3D printers might lead to 25 per cent or 225 more of these surgeries being carried out.<sup>23</sup> For patients, such 3D models could thus help prevent hardships induced from not undergoing invasive surgery – including death and worsening symptoms. For the medical sector at large, this could contribute JOD 1.913 million annually in new surgeries. 3D printed heart models for surgical use began to take off in 2014, the same year in which 3D printers were fully banned in Jordan.<sup>24</sup> Had they been allowed into Jordan for medical use, the health sector could have gained some JOD 13.4 million over the past seven years for CHD surgeries alone.

#### **4.1.1.2 Cardiology at Large**

Currently, no cardiology departments or clinics in Jordan use 3D printers. This is problematic because current lost opportunity costs will likely multiply exponentially in the future, as more and more applications for 3D printers are discovered. For example, prenatal care researchers in the UK have been able to produce 3D models of foetus' hearts while still in the womb.<sup>25</sup> Such pre-emptive measures could be critical for detecting anomalies and determining the best possible treatment plans – including surgical – for children before they are born.<sup>26</sup> This could be very beneficial for Jordan, where the number of neonatal mortalities in 2019 was 9.2 deaths per 1,000 children.<sup>27</sup> Moreover, neonatal disorders ranked sixth in non-communicable causes of death amongst the general Jordanian population,<sup>28</sup> with CHD a leading cause due to the lack of

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<sup>22</sup> Zhonghua Sun et al., "Personalized Three-Dimensional Printed Models in Congenital Heart Disease," *Journal of Clinical Medicine* 8, no. 4 (April 1, 2019): 522, <https://doi.org/10.3390/jcm8040522>.

<sup>23</sup> Zhonghua Sun et al., "Personalized Three-Dimensional Printed Models in Congenital Heart Disease," *Journal of Clinical Medicine* 8, no. 4 (April 1, 2019): 522, <https://doi.org/10.3390/jcm8040522>.

<sup>24</sup> T. J. McCue, "About a Boy: 3D Printed Heart Model Saves Young Life," *Forbes*, February 26, 2014, <https://www.forbes.com/sites/tjmccue/2014/02/26/about-a-boy-3d-printed-heart-model-saves-young-life/?sh=757fd05d10a1>.

<sup>25</sup> David F A Lloyd et al., "Three-Dimensional Visualisation of the Fetal Heart Using Prenatal MRI with Motion-Corrected Slice-Volume Registration: A Prospective, Single-Centre Cohort Study," *The Lancet* 393, no. 10181 (April 2019): 1619–27, [https://doi.org/10.1016/s0140-6736\(18\)32490-5](https://doi.org/10.1016/s0140-6736(18)32490-5).

<sup>26</sup> Hanna Watkin, "3D Printing Hearts of Babies with Congenital Heart Disease to Improve Care," *All3DP*, March 25, 2019, <https://all3dp.com/4/3d-printing-hearts-babies-congenital-heart-disease-improve-care/>.

<sup>27</sup> "Jordan Neonatal Mortality Rate, 1960-2020 – Knoema.com," *Knoema.com*, accessed September 9, 2021, <https://knoema.com/atlas/Jordan/Neonatal-mortality-rate>.

<sup>28</sup> "Jordan," *Institute for Health Metrics and Evaluation*, September 9, 2015, <http://www.healthdata.org/jordan>.

understanding of its exact anomalies, and there being a limited time frame to act. Such preventative scans could both diagnose anomalies and prevent chances of incorrect surgeries.

These rapid advancements have led one Jordanian cardiac surgeon to state, “Without doubt, [3D printing] is going to be the future in the diagnosis of disease and planning of the procedure required.” But beyond modelling uses, 3D printing technology promises even greater medical breakthroughs. The surgeon added, “In the somewhat distant future, portions of the heart or even a whole heart can be printed using flexible meshes of man-made fibre which is then placed in a culture of the patient’s stem cells to make a functioning copy of his heart.” Therefore, mastering 3D printers at the diagnosis stage is a critical step to mastering this technology for its future stem-cell uses. If not embraced by cardiologists and technicians now, there will be knowledge gaps in more advanced applications.

#### **4.1.1.3 Prosthetic Limbs**

Aside from those with congenital cases, Jordanians who need prosthetic limbs have often undergone trauma or diabetes-related amputations. Since 2003, Jordan has seen a sharp increase in patients from neighbouring countries seeking treatment for war-related injuries. One of the most common injuries are missing limbs, prosthetic solutions for which tend to be costly and require prosthetic technicians and special manufacturing facilities. A highly customised process, prosthesis manufacturing and fitting begins once stump incisions have healed, which can take from two to six months after surgery. Measurements are harder to obtain in the absence of the original limb before amputation, which characterises the case for refugees in Jordan who lost their limbs in their countries of origin. In that case, prosthetists seeking to make stump casts and socket designs would rely more heavily on impressions and digital readings of the remaining limb.<sup>29</sup> For decades, prosthetists have used digital readings, i.e. computer-aided design (CAD). This computerised process is discontinued in the conventional prosthetic manufacturing phase (including prototyping), which then applies these measurements to a hand-made process.

3D printers thus mark a great intervention in prosthetic design and manufacturing. Through a 3D laser scanner, their use could synchronise CAD phases and computer-aided manufacturing (CAM) phases, which would mean fewer design specifications lost in application. This is especially critical when it comes to socket accuracy in terms of stump bone shapes and sizes.<sup>30</sup> Both the measurement data and accuracy in application are critical, as they have a strong bearing on user comfort, as well as the wear and tear of the prosthetic, which needs to be replaced as often as three to five years – even more often for children still growing.<sup>31</sup> While much more can be said on the

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<sup>29</sup> Scheck & Siress, “How to Make Prosthetics (Step-By-Step Process),” Scheck & Siress, October 6, 2020, <https://www.scheckandsiress.com/blog/how-to-make-prosthetics/>.

<sup>30</sup> Chitresh Nayak, Amit Singh, and Himanshu Chaudhary, “Customised Prosthetic Socket Fabrication Using 3D Scanning and Printing Customised Prosthetic Socket Fabrication Using 3D Scanning and Printing,” September 2014, [https://www.researchgate.net/publication/274386505\\_Customised\\_prosthetic\\_socket\\_fabrication\\_using\\_3D\\_scanning\\_and\\_printing](https://www.researchgate.net/publication/274386505_Customised_prosthetic_socket_fabrication_using_3D_scanning_and_printing).

<sup>31</sup> ABCNews, “The Cost of a New Limb Can Add up over a Lifetime,” Hospital for Special Surgery, April 25, 2013, [https://www.hss.edu/newsroom\\_prosthetic-leg-cost-over-lifetime.asp](https://www.hss.edu/newsroom_prosthetic-leg-cost-over-lifetime.asp).

qualitative benefits of 3D printed prosthesis, this section focuses on the savings the technology can offer owing to its reduced labour processes and cheaper materials.

With refugee injuries adding to the local demand for prostheses, Jordan's patients at large could stand to benefit from the wider availability of 3D printing prosthetics. In Jordan's prosthetic industry, the technology is currently limited to a handful of INGOs focusing on refugees. To estimate market size, it is illustrative to look at annual volumes of prosthetic sales by three major providers, serving both local and refugee clients. Institute for Family Health/Noor Al Hussein Foundation (IFH/NHF) (local and refugee) provides roughly 1,500; Kamal al-Sa'adi (KAS) (local) provides roughly 29; Médecins Sans Frontières (MSF) (refugee) provides roughly 37. While some 1,566 may have been sold in 2020, IFH/NHF estimates indicate that the demand that year might have been 25 per cent higher, an indication of bottlenecks within Jordan's prosthesis service. With patients expected to replace prosthetics multiple times over a lifetime – especially if they are fitted with prosthesis at a growing age – the industry can moreover expect to see consistent demand.

As it currently stands, Jordan's healthcare services offer a range of prosthetic limbs. However, due to their relative complexity, they are still lacking in the field of upper limbs, especially when beginning at the shoulder. These cases are often referred to hospitals overseas. The 1,566 prostheses can thus be broken down into three types: 330 above the knee (21.05 per cent); 1,222 below the knee (78.07 per cent); 14 below the elbow (0.88 per cent). Either absorbed by patients or sponsors, each conventionally produced prosthetic has its average price in the Jordanian market: above the knee at JOD 2,250; below the knee at JOD 1,075; below the elbow at JOD 5,425. Individually, these interventions can be quite expensive, especially for refugees and those outside of the Jordanian social security network. In 2020, some JOD 2 million were spent in Jordan on just these three types of prosthesis.

However, 3D printed prosthetics can provide a far more affordable alternative. To estimate how much 3D printed prosthetic limbs could save in costs, one can compare the prices between IFH/NHF, Jordan's main conventional prosthetic producer, and three organisations that provide 3D printing prosthetics: Mand.ro, MSF, and Refugee Open Ware, all of which have or continue to operate in Jordan. Mand.ro is for-profit while MSF and Refugee Open Ware are non-profit, with refugees their main beneficiaries in Jordan. Compared to IFH/NHF, non-profit services savings average 94.7 per cent of the costs of conventional prosthetics. Even for-profit savings are a considerable 61.7 per cent of the cost of conventional prosthetics. This means that across the industry, 3D printed prosthetics can be 83.7 per cent cheaper than their conventionally produced counterparts. Based on this industry average, annual prosthetics costs in Jordan from these three major providers could be cut by as much as JOD 1.7 million.

Despite hesitancy surrounding capital investments in 3D printers, their application in both cardiology and prosthesis show how they can greatly cut costs. They can also help Jordan maintain its edge in medical tourism, which competes closely with the UAE and Turkey.



Especially when considering its lower labour costs, Jordan's medical services could offer greater savings than its competitors. By comparison, in Dubai, 3D printed savings are about 77 per cent of the cost of conventional prosthetics, more than five per cent below Jordan's industry average.<sup>32</sup> This could boost the country's regional profile as a supplier of prostheses. It is also imperative for Jordan's industrial culture to adopt 3D printing technology because its medical applications are expanding at a rapid rate. This can be seen in the prospect of 3D-printed bodily tissue, which would have critical implications in both cardiology and prosthesis. Overall, failure to master this technology at each stage could lead to incalculable missed opportunities in savings and quality improvement.

#### 4.1.2 Aerospace

Royal Jordanian (RJ) represents a critical share of Jordan's transportation sector. Its value accounts for 3 per cent of Jordan's GDP.<sup>33</sup> However, for roughly the past five years, RJ has been suffering financial losses, both from operational costs and COVID. The company's net losses reached JOD 5.9 million by the end of 2018.<sup>34</sup> In the wake of COVID, losses reached around JOD 36.4 million in the first quarter of 2021. The critical state of one of Jordan's largest companies compelled the government to raise JOD 50 million for the company's capital.<sup>35</sup> However, RJ cannot expect such subsidies on a regular basis. As this section will show, as much as JOD 15 million – 30 per cent of those JOD 50 million – could be recovered on an annual basis when RJ operates planes with 3D printed parts.

Since 2017, RJ has had seven 787-8 Dreamliners operating in its 25-strong fleet. Rolled out by Boeing in 2004, these planes are prized in the industry for consuming 25 per cent less fuel than similarly sized airplanes.<sup>36</sup> However, fluctuations in global oil prices have limited the impact of such fuel-saving technology. In recent years, RJ has thus suffered rises in fuel consumption relative to its total operational costs, from 19 per cent in 2016<sup>37</sup> to 22 per cent in 2017<sup>38</sup> to 31 per cent<sup>39</sup> in 2018 to 27 per cent in 2019 – for a four-year average of 24.75 per cent. According to Said Darwazeh, the Chairman of RJ's Board of Directors, the “unprecedentedly high rate” at which fuel prices have grown over the past few years has been eating into RJ's profits.<sup>40</sup> This means that going forward, RJ has to employ more cutting-edge aircraft infrastructure in order to keep its planes lighter, its fuel costs lower, and its competitive edge in the regional transportation industry.

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<sup>32</sup> Sarah Saunders, “The UAE's First Fully 3D Printed Prosthetic Leg Fitted: Recipient ‘Really Impressed’ with Technology That Made It Possible,” 3DPrint.com | The Voice of 3D Printing / Additive Manufacturing, May 31, 2017, <https://3dprint.com/176392/3d-printed-prosthetic-leg-dubai/>.

<sup>33</sup> Al-Mamlaka, 653 2018 مليون دينار إيرادات الملكية الأردنية لعام [653 million dinars revenues of Royal Jordanian for the year 2018], Al Mamlaka Channel, April 28, 2019, <https://www.almamlakatv.com/news/18391-653->.

<sup>34</sup> Ibid.

<sup>35</sup> “RJ Reports 70% in Capital Loss,” Jordan News Agency (Petra) (Jordan News Agency (Petra), November 3, 2020), [https://petra.gov.jo/Include/InnerPage.jsp?ID=29652&lang=en&name=en\\_news](https://petra.gov.jo/Include/InnerPage.jsp?ID=29652&lang=en&name=en_news).

<sup>36</sup> Royal Jordanian, “Royal Jordanian Preparing to Receive First Boeing 787 in August,” *rj.com* (Royal Jordanian, April 27, 2017), <https://rj.com/en/meet-rj/our-media-center/news/2014/04/28/royal-jordanian-preparing-to-receive-first-boeing-787-in-august>.

<sup>37</sup> Royal Jordanian, “Annual Report 2016” (Royal Jordanian, 2017).

<sup>38</sup> Royal Jordanian, “Annual Report 2017” (Royal Jordanian, 2018).

<sup>39</sup> Royal Jordanian, “Annual Report 2016” (Royal Jordanian, 2017).

<sup>40</sup> Ibid.

Responding to an awareness shared across the industry, aerospace manufacturers have recognized that fuel-efficient but conventionally manufactured planes are still in need of lighter parts. This has promoted designers and manufacturers to develop 3D printed aircraft parts, the materials of which makes them much lighter. These have included replacement components such as tray tables, windows, in-flight entertainment displays, and flight deck controls.<sup>41</sup> Exploration in the field of 3D printed metal engine parts promises even greater breakthroughs. In 2018, General Electric (GE) was able to reduce a civilian turboprop engine's component from 855 down to 12 via 3D printed parts, cutting its weight by 45 kilos, improving fuel efficiency by 20 per cent, and increasing its power by 10 per cent.<sup>42</sup> In 2021, GE Aviation and GE Additive began 3D printing four new gas turbine engine parts for the very first time. The firm's engineering team said that the move cut manufacturing costs by around 35 per cent.<sup>43</sup> That same year, Boeing released a new generation of Dreamliners featuring 3D printed titanium parts for its engines. These parts not only reduce the Dreamliner's price by USD 2-3 million, but also have long-term fuel saving benefits.<sup>44</sup>

Owing to its release date, there was no way RJ could have benefitted from the 3D printed technology when it purchased its batch of Dreamliners between 2014-2017. However, in considering future purchases, RJ might benefit from studying the fuel-saving qualities of this kind of technology. While there have yet to be any comprehensive studies on how much fuel the 2021 Dreamliner planes save compared to the previous generations, there have been on Boeing's 777X series, a plane comparable to the 787 series but at least 12 per cent larger.<sup>45</sup> The 777X planes have been known to reduce fuel use by at least 10 per cent per flight.<sup>46</sup> In what will raise the bar in regional standards, Emirates Airlines has ordered 115 of these planes, which are expected to arrive in 2024. Owing to the fact that the Emirates' fleet is currently ten-fold that of RJ's, the impact of the new technology cannot be compared.

Nonetheless, for RJ to remain competitive within its own scope of operations, it would stand to benefit from adding to or renewing its fleet with planes containing 3D printed inputs. Based on RJ's fuel expenses from 2016-2019, if its 25-strong fleet were to feature just the 3D-printed inputs currently used in Boeing's 777X series, it could expect to save JOD 58.68 million in fuel costs

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<sup>41</sup> IDTechEx, "Windows, Tray Tables and Planes – British Airways Trials 3d Printing," 3D Printing Progress (IDTechEx, December 19, 2019), <https://www.3dprintingprogress.com/articles/19216/windows-tray-tables-and-planes-british-airways-trials-3d-printing>.

<sup>42</sup> Adam Hodson, "The Future of the Aerospace Industry Is Additive Manufacturing," wevolver.com, April 5, 2021, <https://www.wevolver.com/article/the-future-of-the-aerospace-industry-is-additive-manufacturing>.

<sup>43</sup> Paul Hanaphy, Hayley Everett, and Kubi Sertoglu, "GE Cuts Costs by 35% in Move from Casting to 3D Printing Technology," 3D Printing Industry, May 7, 2021, <https://3dprintingindustry.com/news/ge-cuts-costs-by-35-in-move-from-casting-to-3d-printing-technology-189798/>.

<sup>44</sup> Kety S., "Leonardo Receives Boeing 787 Dreamliner 3D Printed Components Produced by Norsk Titanium," 3D ADEPT MEDIA, January 4, 2021, <https://3ddept.com/leonardo-receives-boeing-787-dreamliner-3d-printed-components-produced-by-norsk-titanium/>.

<sup>45</sup> Kevin Bullis, "Folding Wings Will Make Boeing's next Airplane More Efficient," MIT Technology Review (MIT Technology Review, April 2, 2020), <https://www.technologyreview.com/2013/11/18/175391/folding-wings-will-make-boeings-next-airplane-more-efficient/>.

<sup>46</sup> Carlota V., "Boeing 777X's First Flight with More than 300 3D Printed Parts," 3Dnatives, January 29, 2020, <https://www.3dnatives.com/en/boeing-777x-300-3d-printed-parts-290120205/#>.



alone. In order for RJ to capitalise on the benefits of the technology, it would need access to the latest in research and development, as outlined in the recommendations section.

## 5 Drones

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### 5.1 Regulatory Framework of Drones

The commercial drone market is still nascent. In recent years, commercial drones have been used to enhance media production, irrigation techniques, infrastructure inspection, delivery, and land surveying. It is with these diverse uses in consideration that a Goldman Sachs report estimated the drone market size to reach USD 13 billion by 2020. Additionally, it has been forecasted that the global market for drones would grow to USD 58.4 billion by 2026.<sup>47</sup> However, adopting, developing, and selling drones has been a challenge in Jordan.

According to KIIs, the first person to introduce drone technology to Jordan was Dr Mohammed Amin Al-Jarrah in the late 1980s, when he assisted the Jordanian Armed Forces in establishing the first UAV programme in the region by 1992. Dr Al-Jarrah established Mars Robotics in 2013, the first drone-based company in Jordan. Following this trend, commercial drone services have been largely the preserve of entrepreneurs connected to Jordan's military establishment. Today, they lead Jordan's two registered companies providing commercial drone services, Mars Robotics and Sager Drone (founded in 2018). Most of their services consist of geothermal assessments, stockpile measurements for phosphate mines, and agricultural inspection. Far less of their services are dedicated to the more prolific yet smaller-scale services like event videography and construction monitoring. While Mars Robotics also manufactures drones, their sales are limited to clients outside of the country. As such, Jordanian clients must either import their own drones or rent them.

Before 2017, Jordan restricted the importation of drones by confiscating them at customs points. Some interviewees using drones for personal use mentioned bringing in parts over multiple commercial flights. But even when they were able to bring them in through roundabout ways, they would still face restrictions flying them in Jordanian airspace according to a 2007 law (see Appendix A). Then, in 2018, the government issued drone-related legislation that stated only juridical persons were allowed to own and operate drones and imposed deterrent laws on those who operated drones without the necessary licenses and permissions (see Appendix B).

It was the introduction of drone legislation that encouraged entrepreneurs to establish Sager Drone. However due to the nascent legislation and lack of government awareness of the industry specificities, it took Sager Drone a year to register their company. Sager Drone nonetheless

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<sup>47</sup> "\$58.4 Billion Unmanned Aerial Vehicle (UAV) Markets, 2026 by Point of Sale, Systems, Platform, Function, End Use, Application, Type, Mode of Operation, MTOW, Range – ResearchAndMarkets.com," [www.businesswire.com](https://www.businesswire.com/news/home/20210624005687/en/58.4-Billion-Unmanned-Aerial-Vehicle-UAV-Markets-2026-by-Point-of-Sale-Systems-Platform-Function-End-Use-Application-Type-Mode-of-Operation-MTOW-Range---ResearchAndMarkets.com), June 24, 2021, <https://www.businesswire.com/news/home/20210624005687/en/58.4-Billion-Unmanned-Aerial-Vehicle-UAV-Markets-2026-by-Point-of-Sale-Systems-Platform-Function-End-Use-Application-Type-Mode-of-Operation-MTOW-Range---ResearchAndMarkets.com>.

represents a success story, as leading up to 2017, many Jordanian technicians had been discouraged from pursuing drone technology, eventually channelling their talents abroad or locally in software. Then, in 2019, the Jordanian government required that – in addition to obtaining security clearance – all people wishing to fly drones must hire a Jordanian security escort to accompany them during their flights (See Appendix C). Interviewees mentioned that hiring these escorts cost around JOD 50 to 150 per session and that the entire approval process could take up to 14 days.

Interviewees generally expressed that commercial drone companies possessed a lack of legitimacy in the eyes of the government, and that the technology is still perceived as overwhelmingly military. A common assumption amongst non-experts is that Jordan's pre-2017 ban on drones was due to security concerns, namely, the country's sensitive geopolitical position. Another assumption – in light of Jordanian culture – is that drones might violate domicile privacy. However, some interviewees lamented what they saw as a lack of creativity amongst security apparatuses in devising regulations that would ensure the safe use of drones; indeed, the United Arab Emirates – which invests considerable resources into security and surveillance and has similar cultural mores – has had detailed drone legislation since 2014. Drones can be seen in Dubai's airspace, deployed in a number of everyday tasks such as media production and even food delivery.<sup>48</sup>

Economies differ and the range of input costs has meant that drones would not have the same value across sectors. For example, in places where scaffolding is heavily deployed in building inspection and maintenance, drones can save time and money by photographing exteriors that would have otherwise required a person's physical ascension. According to KIIs, owing to Jordan's architectural culture and inspection practices, drones might thus not benefit Jordan's construction sector. On the other hand, Jordan's agriculture sector in particular might stand to benefit from the use of drones, the absence of which could continue to spell missed opportunity.

## 5.2 Field Irrigation

Drones have proven incredibly useful in agriculture since they began to be used in earnest for surveying agricultural lands as early as 2006.<sup>49</sup> In their most advanced uses, they can directly irrigate crops and spray pesticides. Even for surveying uses, their thermal imaging capabilities can be incredibly useful for data collection on the state of farmlands. Processes such as counting livestock have become easier, with drones able to detect body heat – and even detect cases of illness owing to variations in temperature. Drones are also useful for understanding the state of fields themselves. They help farmers identify disease spreading amongst crops, nutrient deficiencies, pest infestations, and water stress or excess.<sup>50</sup>

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<sup>48</sup> Sarah Gamboni, "These Food Delivery Robots Are Set to Launch in Dubai This Year," *What's On*, February 10, 2021, <https://whatson.ae/2021/02/food-delivery-robots-are-coming-to-dubai-this-year/>.

<sup>49</sup> Ibrahim Naji, "The Drones' Impact on Precision Agriculture," January 1, 2019, 1–60. Pg. 15

<sup>50</sup> (Food and Agriculture Organization of the United Nations and International Telecommunication Union, "E Agriculture in Action: Drones for Agriculture," ed. Gerard Sylvester, 2018, 9–105. Pg., 16

This last function is critical for Jordan, a country that directs approximately 70 per cent of its water to agriculture, yet ranks as one of the top three most water-scarce countries in the world.<sup>51</sup> As such, any excess water irrigation as a result of misestimation or inefficient techniques can have harmful consequences on Jordan's overall water table. Jordan has made improvements in water efficiency owing to its speedy adoption of drip irrigation over the past 15 years, with this technology now dominating irrigation. Nevertheless, the high percentage of Jordan's water still needed for agriculture means that the sector continues to be targeted for strategic shrinking by some water experts, who read its 5 per cent GDP contribution<sup>52</sup> against the backdrop of a growing population.<sup>53,54</sup> While shrinking Jordan's agricultural sector would improve water security, it might also serve as a blow to some of Jordan's regional exports, or worse, its overall food security.

In order to minimise the long-term stakes of either maintaining or shrinking Jordan's agricultural sector, Jordan constantly needs to adopt suitable technologies that can reduce water waste. As recent studies have shown, drones fitted with special sensor modules can measure critical farming environment information such as soil temperature, soil humidity, soil fertilizer, sunlight intensity, CO<sub>2</sub>, soil PH value, and rain intensity.<sup>55</sup> A quad-rotor helicopter (which costs roughly JOD 850 – 1420) fitted with a 12MP 1/2.3" CMOS Sensor with a 24-48mm 2x Optical Zoom + Dolly Zoom (roughly JOD 1275) can carry out these functions. By supplying this environmental information, these drones can help farmers using conventional methods like surface and sprinkler irrigation on plots of land 405 dunams or more reduce irrigation water by as much as 67 per cent.<sup>56</sup> To a lesser extent, these drones can also reduce water use on plots where non-conventional irrigation is used.

Importing and flying regulations have meant that drones are almost absent in Jordan's routine agricultural practice. This is largely because of a lack of awareness, as many farmers in Jordan have never handled the technology. However, with 48.5 per cent of Jordan's farmlands 405 dunams or more, it could have wide application, and the investment in the technology could have speedy financial returns in terms of water saved. Smaller farmers (the median farmer in Jordan owns 71 dunams) could also benefit from this scale of water reductions when pooling together to commission a drone either by sharing its rent or purchase.<sup>57</sup>

There are certain types of cultivated area that would benefit immensely from the technology. Being covered, plastic tunnels and houses – approximately one-fifth of Jordan's cultivated area – would

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<sup>51</sup> Friends of the Middle East, "Water for Agriculture in Jordan: Policy Strategies for Reducing Water Consumption in the Agricultural Sector," n.d. pg., 6

<sup>52</sup> Aaron O'Neill, "Jordan – GDP Distribution across Economic Sectors 2020," Statista, July 21, 2021, <https://www.statista.com/statistics/385505/jordan-gdp-distribution-across-economic-sectors/>.

<sup>53</sup> Ursula Lindsey, "Land of No Rain: How Jordan Is Facing a Parched Future," Al-Fanar Media, August 6, 2020, <https://www.al-fanarmedia.org/2020/08/land-of-no-rain-how-jordan-is-facing-a-parched-future/>.

<sup>54</sup> Hana Namrouqa, "Jordan Can Reduce Agricultural Water Use by a Third, Research Finds," Jordan Times, March 7, 2017, <https://www.jordantimes.com/news/local/jordan-can-reduce-agricultural-water-use-third-research-finds>.

<sup>55</sup> (Food and Agriculture Organization of the United Nations and International Telecommunication Union, "E Agriculture in Action: Drones for Agriculture," ed. Gerard Sylvester, 2018, 9–105. Pg. 67

<sup>56</sup> (Food and Agriculture Organization of the United Nations and International Telecommunication Union, "E Agriculture in Action: Drones for Agriculture," ed. Gerard Sylvester, 2018, 9–105. Pg. 109

<sup>57</sup> Ministry of Agriculture, "al-zera'a bel arqam" (Agriculture in Numbers), Ministry of Agriculture, 2008-2018. Pg. 6

be unsuitable for conventional drone use. As such, drone technology would most specifically benefit farmers with irrigated (non-rain fed) open fields larger than 405 dunams that currently rely on surface and sprinkler irrigation.<sup>58</sup> Beyond Jordan's water network issues, these cultivation areas employ the least efficient irrigation systems and could stand to gain the most from the water reducing and money saving benefits of drone monitoring. By sector, *under the assumption* that these cultivation areas account for field crops at 68,968 DU (6.4 per cent of sector land use); fruit trees at 63,731 DU (~8 per cent of sector land use); and vegetables at 13,746 DU (4.1 per cent of sector land use). When looking at the average amount of water needed for the most prominent outputs in each of the three sectors, we can assume each sector's general water intensity. When relying on conventional irrigation methods, each sector's cultivation area roughly straddles between two water-consuming brackets: field crops (W3/W4) for an average of 50 m<sup>3</sup>/DU/month; fruit trees (W2/W3) for an average of 114 m<sup>3</sup>/DU/month; vegetables (W1/W2) for an average of 143 m<sup>3</sup>/DU/month. Each of these brackets carry their own tariffs: (W3/W4) for an average of JOD 0.0275/m<sup>3</sup>; (W2/W3) for an average of JOD 0.0175/m<sup>3</sup>; vegetables (W1/W2) for an average of JOD 0.0115/m<sup>3</sup>.

Based on these assumptions, it is possible to roughly estimate the share of the water and money wasted in Jordan's agricultural sector in the absence of drone technology. Specifically, this lost opportunity is on irrigated open fields that currently rely on surface and sprinkler irrigation. Multiplying the cultivation areas by the average water consumption in each of the three tariff brackets, field crops consume 41,380,800 m<sup>3</sup> of water/year; fruit trees 87,183,406 m<sup>3</sup>/year; and vegetables 23,588,136 m<sup>3</sup>/year; for a grand total of 152,151,342 m<sup>3</sup>/year. If the drone technology that reduces water use by 67 per cent were applied to these areas, it is assumed that water use could be reduced by 101,942,069 m<sup>3</sup> per year.

This water reduction translates to cost savings, which could be read as a significant missed opportunity for Jordan when multiplied by the number of years Jordan has not been using this technology. As it stands, the grand total of 152.2 m<sup>3</sup> of water/year currently used for irrigated open fields that currently rely on surface and sprinkler irrigation is valued at a total of JOD 2,934,945. On the other hand, the approximately 102 million m<sup>3</sup> of possible water saved per year through drone technology is valued at JOD 1,966,413 per year.

In light of the fact that drones began to be used in earnest for surveying agricultural lands 15 years ago,<sup>59</sup> this translates to an assumed JOD 29,496,197 in missed opportunity cost for Jordan over those years. While the figure is considerable, it still does not account for the missed opportunity cost of conventionally irrigated open fields smaller than 405 dunams, nor does it account for the potentially greater missed opportunity costs in the absence of drones' watering, spraying, and non-water surveying uses.

Although considered a breakthrough technology less than ten years ago, drones have now become a standard technology in some parts of the world. In the United States, for example, they are

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<sup>58</sup> Department of Statistics, "Agriculture Statistics" (Jordan: Department of Statistics, 2019). Pg. 26.

<sup>59</sup> Ibrahim Naji, "The Drones' Impact on Precision Agriculture," January 1, 2019, 1–60. Pg. 15

gradually inhabiting the place of remote-controlled cars as children's toys. In other words, an emerging generation is mastering this once specialised technology, giving them a solid basis for discovering its future uses. In Jordan, however, its access remains limited to the military and a handful of licensed technicians. In order for the technology to benefit not only Jordan's agricultural sector but its economy at large, drone use has to be mainstreamed at the early stages of Jordanian scientific learning. In order to do this, Jordan's regulatory framework has to facilitate this technology at the research and development level as well as the technical skills level, recommendations for which follow.

## 6. Recommendations

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### 6.1 General

While 3D printers promise manufacturing efficiency relative to conventional methods, it is important to reiterate that some uses of 3D printers are not applicable in all economic contexts. However, perhaps more critical to Jordan's economy in the long-run is not just the number of 3D printed products it can churn out, but the economic culture that fosters this technology and the experts who use them. Thus, while the UAE's projected 3D printed market largely depends on the technology's developments in construction and medicine in the coming years, the key element is that the UAE's in-time adoption of the technology is allowing for its incremental technical mastery. This means a generation of experts will be raised on this technology, not having to seek opportunities outside of the UAE to experiment with these technologies.

In terms of talent retention, this is undoubtedly a reason why some 75 per cent of graduates in the UAE remain in the country and are employed in the business management, computer science, and civil engineering fields. This retention is strikingly contrasted to Jordan's potential for brain drain in which 70 per cent of Jordanian graduates seek opportunities outside of Jordan.<sup>60</sup> Indeed, the combination of Jordan's readily available supply of technical talents and its restrictive technology regulations have made migration imperative for scientists whose careers depend on mastering the latest technologies of their fields. Some of the biggest names in Jordanian social media have located their studios abroad. Some of them, like 'Ibn Hattuta' – who makes travel videos – mentioned specifically being unable to keep his filming drones in Jordan.<sup>61</sup>

### 6.2 3D Printing

#### 6.2.1 Aerospace Industry

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<sup>60</sup> Konrad Adenauer Stiftung, "Migration in the Middle East and North Africa What Are the Public Perceptions in the Region? Executive Summary" (2021), <https://www.kas.de/documents/282499/282548/Migration+in+the+Middle+East+and+North+Africa+Report+KAS+PoDiMe+d+Survey.pdf/aec38c1f-bcf4-a58d-fe93-ae33db2d9228?version=1.0&t=1616675653756>.

<sup>61</sup> Ibn Hattuta Travels, دخلي الحقيقي من يوتيوب؟ ليش بقلد جو حطاب؟ شو عدة التصوير؟ سؤال وجواب مع سعد, [My real income from YouTube? Why imitate Joe Hattab? Video Production Equipment? Q&A with Saad] YouTube Video, 2:40. August 3, 2021. <https://www.youtube.com/watch?v=TTQAmzu1Va8&t=899s>.

In order for Jordanian aviation companies like RJ to optimise aircraft weight reduction, they would need to benefit from the possibilities of 3D, even if through prototypes and at a consultative level. RJ's prospects of benefiting from this technology through its existing maintenance, repair, and overhaul (MRO) relationships are significant. In 2016, Dubai Aerospace Enterprise (DAE) acquired Jordanian-based Joramco, RJ's local MRO provider.<sup>62</sup> Having been the first independently certified MRO in the region,<sup>63</sup> Joramco has been certified by a number of international bodies such as the Jordanian Civil Aviation Regulatory Authority (JCARC), the European Aviation Safety Agency (EASA), the US Federal Aviation Administration (FAA), and UAE General Civil Aviation Authority (GCAA).<sup>64</sup> Joramco serves over 30 commercial and cargo airlines from Europe, the Middle East, and Africa. The company now has 300 employees and a current revenue of around JOD 31.2 million per year.<sup>65</sup>

The same year that DAE purchased Joramco, Dubai's government released its "Dubai 3D Printing Strategy", with the goal of making Dubai a top consumer, manufacturer, and exporter of worldwide 3D printing processes, technologies, and services.<sup>66</sup> This coincides with the UAE's MRO market, which is anticipated to grow from USD 9 billion in 2019 to USD 13.2 billion in 2029, in no small part due to additive manufacturing from 3D printers.<sup>67</sup> Under the DAE, Joramco is thus well-posed to adopt this technology into its research and development, towards producing lighter parts for its customer base, especially RJ and other regional carriers.

In order for Joramco to adopt and explore 3D printing technologies in Jordan, it needs incentivisation from the Jordanian government. Specifically, the government could allow the entry of industrial-sized 3D printers for Joramco and waive customs fees. The following table shows the prices of a range of industrial aerospace 3D printers by printing volume.

| Table 3: The Prices of 3D Printers – Original Prices and Gross Prices |                      |                                  |        |             |
|---|----------------------|----------------------------------|--------|-------------|
| Name  | Original Price (JOD) | 30 % (16 % Sales + 14 % Customs) |        | Gross (JOD) |
| Modix BIG-180x  | 8,408                | 1361                             | 1191   | 11,060      |
| Stratasys Fortus 450mc  | 131,165              | 20,986                           | 18,363 | 170,514     |

<sup>62</sup> "DAE to Acquire 80% Of Joramco," Dubai Aerospace Enterprise (Dubai Aerospace Enterprise, September 20, 2016), <https://dubaiaerospace.com/2016/09/20/dae-to-acquire-80-of-joramco/>.

<sup>63</sup> "Press Release: Joramco Is the FIRST EN9110:2018 Certified INDEPENDENT MRO in the Mena Region," Joramco (Joramco, October 9, 2019), <https://www.joramco.com.jo/media/events->

<sup>64</sup> Joramco, "Approvals & Certificates | Joramco," [www.joramco.com.jo](http://www.joramco.com.jo), accessed October 4, 2021, <https://www.joramco.com.jo/about-us/approvals-certificates>.

<sup>65</sup> "JorAMCo Information," RocketReach, accessed September 8, 2021, [https://rocketreach.co/joramco-profile\\_b5c75a17f42e0d0e](https://rocketreach.co/joramco-profile_b5c75a17f42e0d0e).

<sup>66</sup> Tess Boissonneault, "Dubai Launches 3d PRINTING Strategic Alliance," 3D Printing Media Network – The Pulse of the AM Industry, July 6, 2020, <https://www.3dprintingmedia.network/dubai-launches-3d-printing-strategic-alliance/>.

<sup>67</sup> "UAE Adopts 3D Printing in Aerospace Activities," International Trade Administration | Trade.gov, September 6, 2020, <https://www.trade.gov/market-intelligence/uae-adopts-3d-printing-aerospace-activities>.

|                     |                    |                   |        |                    |
|---------------------|--------------------|-------------------|--------|--------------------|
| Arcam EBM Spectra L | 177,250            | 28,360            | 24,815 | 230,425            |
|                     | <b>JOD 316,823</b> | <b>JOD 95,076</b> |        | <b>JOD 411,899</b> |

If Joramco were to acquire these or similarly-sized printers, the company could experiment in printing the range of tried engine and replacement parts. It could begin by printing prototypes according to RJ fuel reduction targets and aircraft specifications. Internationally certified, Joramco could then expand this service to regional carriers. To incentivise them to adopt 3D printers into their research and development, the Jordanian government could wave the 30 per cent sales and customs taxes. While this is an exceptional case for one company, the following section outlines how the Jordanian government could more broadly incentivise Jordan’s research and development.

### 6.3 Drones

Countries have devised numerous ways to ensure the safe use of drones. Some countries in the region, such as Saudi Arabia, have made agreements with drone manufacturers to programme drones so that they cannot fly above military or other sensitive installations. The United Arab Emirates has developed quite elaborate but accessible instructions for those wishing to fly drones in its airspace (see Appendix D). However, as a first step, Jordan might consider an even more conservative approach. Rather than designating no-fly zones, Jordan can designate a single fly zone. This zone – approximately five square kilometres – could be in an open area of southern Jordan, far from any border. There, technicians could practice flying their drones in a monitored area. It could develop in a technology research hub, where schools take their students for field trips, gradually exposing Jordan’s scientific community to the dynamics of the technology in a controlled environment.

## 7. Economic incentives to support scientific research and development

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### 7.1 Reasons for offering incentives

Stimulating investment in scientific research and product innovation development will contribute to Jordan’s economic growth by leading – at the macroeconomic level – to job creation and increased demand, thereby increasing treasury revenues in the medium and long term.

### 7.2 Possible forms of tax incentives

- Granting exemptions and facilities to information technology sector start-ups and venture capitalists developing new products and innovations.
- Providing exemptions for companies that are jointly established by scientific research centres (universities and institutes) and investors in the industrial, agricultural, and other fields. This would stimulate investment and scientific research on the one hand, and



promote the continuity of efforts expended in the fields of scientific research, development, and new innovations.

### 5.3 These exemptions and facilities can be summarised as follows:

The government should:

**First:** Exempt goods and services necessary for economic activities that contribute to the development of scientific research and new innovations, emerging venture capital companies, companies that are jointly established by scientific and research centres (universities and institutes) and investors in the industrial, agricultural, and other fields with the aim of developing scientific research and developing new products and innovations. The government could exempt them from customs duties in the event of importation and subject them to the general tax at the zero rate if purchased locally.

**Second:** Reduce the income tax due on the activities of companies determined as start-ups – to which the concept of venture capital applies – or on companies working in the fields of scientific research, product development, and innovation, or that are jointly established by research centres and investors, to 5 per cent of the taxable income.

**Third:** Exempt capital gains arising from the sale of shares in those types of companies from income tax for the first time for a period not exceeding fifteen years from the date of their registration.

Once Jordan's information technology sector can foster vibrant research and development activities – and the investor confidence to sustain it – investors can then look towards the domestic manufacturing of information technology. While this might reduce government revenue from taxes, it will stimulate private sector employment. This would be a welcome development in light of government ambitions to reduce the employment burden on its public sector.<sup>68</sup>

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<sup>68</sup> The Economic Policy Council (EPC) (2018, November). Jordan Economic Growth Plan: 2018-2022 (Rep.). Retrieved February 15, 2021, from The Economic Policy Council website: <https://www.ssif.gov.jo/UploadFiles/JEGProgramEnglish.pdf>



## I. Appendices

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### I.I Appendix A

#### **Law No. (41) of 2007 – Civil Aviation Law Chapter Five: General Regulatory Provisions**

##### **Article 27**

**A-** No aircraft may fly in the airspace of the Kingdom unless it holds a valid airworthiness certificate issued by or approved by the competent authority in the country of registration, with the exception of aircraft registered in the national registry that flying in the airspace of the Kingdom with the intention of testing or in specific cases according to instructions issued by the President

**B –** The Chief Commissioner of the Commission and Chief Executive Officer of the Commission has the right to withdraw or suspend the airworthiness certificate of the aircraft registered in the National Register if it becomes clear to him that they are not airworthy, and he has the right to subject these aircraft or any other aircraft not registered in the Register to a technical inspection, and that it is not allowed to fly except after taking measures to ensure its safety.

**C –** It is not permissible for any aircraft flying in the airspace of the Kingdom to be equipped with any radio equipment without a license from the competent authorities in the country of registration.

**D –** It is not permissible for any aircraft flying in the airspace of the Kingdom to carry aerial cameras or use these machines without a prior license from the President, according to the conditions set by the Council.

**E –** Every person who intends to build a facility or install a fixed or mobile equipment or machine for a temporary or permanent period, or to send a toy plane, the height of any of these objects is more than 15 meters above the surface of the earth within a circle of 5 kilometres in diameter around any airport, or The height of any of them exceeds (40) meters outside this circle, or to use laser beams or any high lighting within (15) kilometres from any airport, to submit a written request to the authority to obtain its approval, and to comply with the authority's instructions in this regard.<sup>69</sup>

### I.II Appendix B

#### **Law No. (8) of 2018 Law Amending the Civil Aviation Law (Unofficial Translation)**

##### **Article 1**

This law is called (Law amending the Civil Aviation Law of 2018) and it is read with Law No. (11) of 2007 referred to below in the original law as a single law and comes into force thirty days after the date of its publication in the Official Gazette

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<sup>69</sup> "Civil Aviation Law," 41 (2007), <https://www.carc.jo/images/Regulations/Law412007.pdf>.

## Article 2

Paragraph (a) of Article 2 of the original law shall be amended as follows:

**First:** By adding the phrase (and unmanned or remotely piloted aircraft) to the end of the meaning assigned to the definition of the aircraft) contained therein.

**Second:** By deleting the phrase (unmanned aircraft) and replacing it with the phrase (unmanned aircraft) wherever it appears in this law.

**Third:** By deleting the phrase (set by the Ministry of Transport and which is in the meaning assigned to the definition of (the National Program for Aviation Security) contained therein.

## Article 5

Amending Article 12 of the original law as follows:

**First:** cancel the phrase (including) in Article 12.

**Second:** Deleting the word (prices) mentioned in paragraph (o) and paragraph (f) thereof and replacing it with the word (cost).

**Third:** by adding clause (3) and clause (4) to paragraph (t) which includes the following text:

3- Develop instructions for the conditions for maintaining unmanned or remotely piloted aircraft and training related thereto.

## Article 7

Article 12 of the original law shall be amended as follows: -

**First:** by deleting the text of Paragraph (F) thereof and replacing it with the following:

**Q-** Determining the prices and wages of civil aviation services in the absence of competition due to the control or monopoly of one of the investors or operators.

**Second:** By deleting the text of paragraph (t) and replacing it with the following text:

**R-1-** Establishing instructions that include air rules for regulating the flight of aircraft and air navigation in order to achieve the optimal use of the Kingdom's airspace.

**2-** Develop instructions to specify the conditions for manufacturing, importing and exporting unmanned or remotely piloted aircraft, and regulating their use in a manner that ensures the protection of people and property, in coordination with the competent authorities.

## Article 13

Article 27 of the original law is amended as follows: -

**First:** by deleting the phrase (in accordance with instructions issued by the president) contained in paragraph (a) thereof and replacing it with the phrase (issued by the Council).

**Second:** By deleting the text of Paragraph (C) thereof and replacing it with the following text:

**C-** It is not permissible to equip any aircraft flying in the airspace of the Kingdom with any wireless devices unless it has a license to do so from the relevant authorities in the airspace for special purposes only. In accordance with the provisions of this law and the conditions of the license.

**Third:** By deleting the text of paragraph (d) and replacing it with the following text:

**D-** It is not permissible for any aircraft flying in the airspace of the Kingdom to carry aerial cameras or use these machines except with the prior written approval of the Chairman in accordance with the conditions established by the Council.

#### **Article 26**

Article 60 of the original law is amended as follows: -

**First:** by adding the phrase (or moral) to the beginning of paragraph (a) of it.

**Second:** By adding clause (12) to Paragraph (A) thereof with the following text:

**12-** Possessed, imported, exported, manufactured or used an unmanned or remotely piloted aircraft without obtaining the licenses, approvals and permits established under this law and the regulations and instructions issued pursuant thereto.

**Third:** By adding paragraph (d) to it with the following text:

D - The unmanned or remotely piloted aircraft and its accessories that are seized are confiscated in violation of the provisions of item (12) of paragraph (a) of this article.

#### **Article 27**

Paragraph (a) of Article 61 of the original law is amended by deleting the phrase (five hundred thousand dinars for legal person) contained therein and replacing it with the phrase (five million dinars for natural or legal person).

### **I.III Appendix C**

#### **Ministry of Industry, Trade and Supply, Jordan**

**Number: 23/27/1947**

**Date: 24/06/2019**

**Letter to:**

**His Excellency the President of the Jordan Chamber of Commerce**

**His Excellency the President of the Jordan Chamber of Industry**

**Subject: Drones**

In reference to His Excellency the Minister of Interior's letter No. 119783/57/26 sent on 6/19/2019 regarding the meeting of the committee formed to re-examine the foundations and conditions for entry and the use of drones, where the Committee held a meeting on 17/6/2019 and agreed on the following:

1. Adding the goal of owning unmanned aerial vehicles (DRONES: UNMANNED AIRCRAFT) to the goals of the companies that own drones and are in the Directorate of Moral Guidance / the Jordanian Armed Forces, and give a deadline of one month from the date of adding the goal to the Ministry of Industry, Trade and Supply to correct the conditions of the existing aircraft at the

Jordanian Armed Forces / Directorate of Moral Guidance or the Directorate of Public Security in the Kingdom for the purpose of accepting applications from companies and not individuals.

2. The entity wishing to benefit from the services of unmanned aircraft shall submit a duly approved request to the Civil Aviation Regulatory Authority ten working days before the event. Accordingly, once the filled form is approved on the Civil Aviation Regulatory Authority website, the request is sent to the Ministry of Interior to obtain security approvals.

3. Obtaining the approval of the Media Commission and /or the Royal Film Commission of Jordan for the production work to be filmed, each according to its specialization, and then contacting the Ministry of Interior to obtain security approvals, in addition to obligating the beneficiaries to submit the filmed material and according to the competence of each of the above-mentioned parties.

4. Adoption of the technical security form that was agreed upon between the Civil Aviation Regulatory Authority and the security services, on the basis of which the necessary approvals are granted.

5. Adhering to the circular of His Excellency the Minister of Interior in his letter No. MD / 1251 / 22 dated 11/18/2018, which includes a security escort.

6. These bases and conditions shall be applied temporarily until the issuance of the security instructions for licensing and operating drones issued by the Civil Aviation Regulatory Authority.

Your Excellency, kindly informs and instructs those who are required to work on circulating to all your stakeholders to adhere to the above recommendations

With utmost respect,

Dr Tareq Hammouri  
Minister of Industry, Trade and Supply

**Response to: the Minister of Industry, Trade and Supply, Dr Tareq Hammouri;**  
**Number: 23/27/1947**  
**Subject: (Drones)**

**Number: 26/57/119783**  
**Date: Shawwal 10 1440**  
**Date: 19/06/2019**

Your Excellency.

Subsequent to the letter No. 26/57/112978 dated 06/12/2019, which is related to the re-examination of the foundations, conditions, entry and use of Drones/unmanned aircraft. The committee held its meeting in the Ministry of Interior building on 06/17/2019 and the following recommendations were made:

1. Addressing the Ministry of Industry, Trade and Supply to introduce the goal of owning unmanned aerial vehicles (DRONES: UNMANNED AIRCRAFT) to be added to the goal of

companies that own drones and exist for the purpose of moral guidance, the Jordanian Armed Forces, and to give a deadline of one month from the date of adding the goal with the Ministry of Industry, Trade and Supply to correct the conditions of the planes. The Jordanian Armed Forces currently have the Directorate of Moral Guidance or the Directorate of Public Security in the Kingdom, for the purpose of accepting applications from companies and not individuals.

2. The entity wishing to benefit from the services of unmanned aircraft shall duly submit an application for approval to the Civil Aviation Regulatory Authority ten working days before the event, and according to the form approved on the Civil Aviation Regulatory Authority's website, and then the request is sent to the Ministry of Interior to obtain security approvals.

3. Obtaining the approval of the Media Commission or the Royal Film Commission of Jordan for the production work to be filmed, each according to its specialization, and then addressing the Ministry of Interior to obtain security approvals, in addition to obligating the beneficiaries to submit the filmed material and according to the competence of each of the two aforementioned parties.

4. Adoption of the technical security form that was agreed upon between the Civil Aviation Regulatory Authority and the security services, on the basis of which the necessary approvals are granted.

5. Adhering to the circular of His Excellency the Minister of Interior in his letter No. MD / 1251 / 22 dated 11/18/2018, which includes a security escort.

6. These bases and conditions shall be applied temporarily until the issuance of the security instructions for licensing and operating drones issued by the Civil Aviation Regulatory Authority.

I hereby approve the recommendations of the committee set forth above and to instruct the implementation of their content, each within his competence.

With utmost respect.

Salama Hamad,  
Minister of Interior

A copy to be sent to:-

His Excellency, the Director General of the Media Authority.

His Excellency the Director General of the Royal Film Commission of Jordan

(For the same reason)

## I.IV Appendix D

### **Regulatory Framework for UAS/drone Operations in the UAE**

#### **1. INTRODUCTION**

The UAS/drone industry is diverse, innovative and international. It has an enormous potential for growth with the associated possibility to create jobs. To ensure a safe, secure and environmentally friendly development, and to respect the citizens' legitimate concerns for privacy and data protection, GCAA has developed a regulatory framework for UAS/drone operations in the UAE.

#### **2. THE LAW**

##### **ARTICLE 69**

A term of imprisonment not exceeding one year and a fine not exceeding fifty thousand Dirhams, or either penalty, shall be imposed on the following persons:

1. An owner or operator of an aircraft who caused it to be flown without an authorization or permit from the Competent Authority or prior to obtaining a certificate of registration or a certificate of airworthiness or after the expiry or revocation of such certificates,
2. Any person who has unlawfully piloted an aircraft or who has taken command of an aircraft in flight without holding the required certificate, licences or authorizations require under the provisions of this Law,
3. Any person who has piloted an aircraft when drunk to such an extent as to impair his capacity to pilot the aircraft,
4. Any person who has caused damage to aeronautical communication facilities or navigation aids on the ground or who has not maintained such facilities in a good condition if required to do so, or
5. A pilot-in-command who has failed to enter the required information in the documents or records of the aircraft or who has altered such information.

##### **ARTICLE 70**

A term of imprisonment not exceeding three years and a fine not exceeding one hundred thousand Dirhams, or either penalty, shall be imposed on the following persons:

1. Any person who has piloted an aircraft or caused it to be flown without bearing the nationality and registration marks or displaying incorrect or ineligible marks,
2. Any person who has piloted an aircraft over prohibited area or has flown over any such area and has failed to comply with the instructions issued to him,
3. Any person who has not complied with an order to land his aircraft while in flight over the territory of the State,
4. Any person who has caused his aircraft to land at or take off from areas other than the designated airports or locations, or has flown the aircraft outside the designated areas,

- unless he has obtained a special authorization to do so from the Competent or Appropriate Authority,
5. Any pilot-in-command of an aircraft who flies without authorization over the territory of the State and carries on board such an aircraft:
    - a. Weapons, munitions of war or any other items the carriage of which is prohibited under national laws, or
    - b. Persons having the intention of committing an act of smuggling or felony, even if no such felony has actually been committed.
  6. Any person who has refrained unjustifiably from complying with a request from the Competent Authority to Participate, within the limits of the means available to him, in the rescue of an aircraft or in the rescue of a person facing imminent danger as a result of an aircraft accident.

### 3. DEFINITIONS

- **Aerial Work:** An UAS operation in which an UAS is used for specialized services such as agriculture, construction, photography, surveying, observation and patrol, search and rescue, aerial advertisement, etc.
- **Individual Registration:** All UAS/drones, regardless of their weight, which are used by individuals for recreational purposes, shall be registered with the GCAA.
- **Operator:** A person, organisation or enterprise engaged in or offering to engage in an aircraft operation.
- **Remote Pilot Station:** The component of the remotely-piloted UAS system containing the equipment used by a pilot for flying the UAS remotely.
- **Remotely Piloted UAS System (UASS):** A set of configurable elements consisting of a remotely- piloted UAS, its associated remotely-piloted station(s), the required command and control links and any other system elements, as may be required at any point during flight operation.
- **UAS Organisation (Commercial):** An organisation which is involved in all types of commercial operation and which receives reward/payment for its activities.
- **UAS Organisation (Non Commercial):** A government entity involved in non-commercial operations, which includes all types of activities for their own projects.
- **Unmanned Aerial Vehicle (UAV) Remote Piloted Aerial Vehicle (UASV) or Drone** is actual unmanned aerial vehicle, other than a balloon or kite which is intended to be operated with no pilot on board.
- **Visual Line of Sight:** The maximum distance between the UAS/drone and manned aircraft within which the position and the trajectory of the UAS/drone can be visually observed without the use of camera, binoculars or other visual aids, and the distance where the UAS/drone can be safely maneuvered and collisions with other UAS/drone or manned aircraft, persons or property on the ground can be avoided. Other visual aids are not spectacles or contact lenses used for correction of reduced vision.

#### **4. TYPE OF USERS**

##### **a. Individual/Private (Recreational)**

This category is for all individual/private users who would like to fly UAS/drones in the UAE for leisure (hobby).

##### **b. Organization/Operator (Commercial & Non Commercial)**

This category is for all organization/operators who would like to operate UAS/drones in the UAE for commercial purposes or for special operations e.g. photography, aerial survey, etc.

#### **5. REQUIREMENTS**

##### **a) Requirements for an Individual/Private User (Recreational)**

- The user and UAS/drone shall be registered with the GCAA before flying;
- All UAS/drones weighing 5kgs or less shall only be allowed to fly in the approved flying zone indicated in my drone hub mobile application (i.e the green zone);
- Camera usage is only allowed in the flying zones. Drone users must not violate relevant UAE laws while using the camera;
- No UAS/drones shall be equipped with drop or release devices;
- UAS/drones flying range shall be within line-of-sight and not more than 400 feet above ground level;
- UAS/drones shall fly only during day time and in good weather conditions;
- UAS/drones shall be used for fun and not for commercial purposes;
- The user shall be responsible to ensure the UAS/drones is used in accordance with the manufacturer's instructions and it is inspected before commencement of flight;
- No user shall fly the UAS/drones near public and/or private property;
- No user shall fly the UAS/drones within 5 km of UAE airports outer fence, Heliports, Helicopter landing Sites, and airfields or in controlled zones;
- Direct radio control link shall be maintained between the user and the UAS/drones;
- Frequency Band Restrictions (29.7-47.0 MHz max power 10 mW, or 2400-2500 MHz max power 100 mW) shall be maintained;
- UAS/drones user shall take into consideration the effects on radio communication, interference of the frequency used;
- UAS/drones user shall avoid collisions with people, objects, other manned and unmanned aircraft;
- UAS/drones user shall not harass or endanger people or threaten to damage property;
- UAS/drones owner shall be responsible to inform the GCAA through the GCAA website when he/she intends to resell the UAS/drones;
- If a UAS/drones accident or UAS/drones loss of control has occurred, the user shall immediately report the incident/accident to the GCAA on hotline: +971506414667 and E-mail: [aai@gcaa.gov.ae](mailto:aai@gcaa.gov.ae) ;
- All UAS/drones weighing above 5kgs and/or equipped with gas engine shall only operate within the GCAA approved flying clubs;
- The minimum age to fly UAS/drones weighing more than 25Kgs is 21 years.



## **b) Registration Requirements for an Organisation/Operator (Professional use)**

### **Step 1:** Register the organisation and obtain the Unmanned Aircraft Operator Authorisation (UOA)

- All Organisations/Operators who intend to operate UAS/drones in the UAE for professional use or special operations are required to submit the following documents:
- All organization/operator shall obtain Security clearance issued by GCAA ([click to apply](#))
  - o Note: (for further assistance regarding security clearance please contact AVSEC team on Tel: +97124054492 or E-Mail: [ITA@gcaa.gov.ae](mailto:ITA@gcaa.gov.ae) )
- All organization/operator shall fill “UA operator registration letter”, the letter should be printed on company letterhead and submit it to [drones@gcaa.gov.ae](mailto:drones@gcaa.gov.ae) ([Click to Apply](#))
- All organization/operator shall subscribe in GCAA E-Publications service and send the evidence of subscription to [drones@gcaa.gov.ae](mailto:drones@gcaa.gov.ae)(applicable fee= AED 1,200) ([click to apply](#))
- SLA: Times takes to obtain Unmanned Aircraft Operator Authorisation (UOA) is 3 weeks subject to meet GCAA requirement.
  - o Note: Obtaining UOA does not authorize the operator to fly the drone, please follow step 2 to obtain operational approval

### **Step 2:** apply for operational permission

- Once UOA is obtained from GCAA, organization/operator will need to apply for unmanned aircraft operation permission for each drone flying activity in red zone. ([click to apply](#))
  - o Note: regardless of the flying zone (red or green), organization/operator must apply for security clearance approval if their drone flying activity will involve the use of any capturing devices such as but not limited to (camera, video streaming, etc) ([click to apply](#))
- **SLA:** 14 working days
  - o Note: (for further clarification regarding operational approval please contact ANA team on
  - o Tel: +97124054257 or E-Mail: [ana.approval@gcaa.gov.ae](mailto:ana.approval@gcaa.gov.ae))

### **Example of Special Operations allowed for this category:**

- Aerial Work
- Agriculture
- Air Show
- Fire fighting
- Inspection
- Media
- Petroleum
- Protecting Wildlife
- Screening

- Surveillance
- Survey
- Weather forecasting

### **UAS/Drones Flying Zones**

To learn regarding allowable flying zones in the UAE airspace, you can download the Mobile App [“My Drone Hub”](#) for Android or iOS phones or download the [KMZ file here](#).

### **For UAS/drones enquiries please contact the following:**

For registration and requirements contact the GCAA Aircraft Registry Unit by email at [drones@gcaa.gov.ae](mailto:drones@gcaa.gov.ae) or by telephone at 8004466 (Sunday - Thursday, 8am - 2pm).