

A Work Project, presented as part of the requirements for the Award of a Master Degree in Management from the NOVA –
School of Business and Economics.

3DWAYS INTERNATIONALIZATION PROJECT - SME COMPETITIVENESS FIELD LAB 2019/2020

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A Project carried out on the Master in Management Program, under the supervision of:

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3DWays is a 3D printing service-providing company. Currently, the company wants to internationalize its remotely managed network of 3D printing factories, specifically targeting at the healthcare sector. Therefore, this project analyses the current and future state of the 3D Printing industry, before assessing potential target markets. Subsequently, five countries, headlined by the United Kingdom, were determined to be the most suitable for the company's internationalization that will rely on direct exporting as an entry strategy because of the unique nature of the network. Complementary, a marketing plan and a financial evaluation were developed for 3DWays in the UK.

3DWays, Internationalization, 3DPrinting, Competitiveness

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Agenda

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 - End-user Product
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 - Global Overview
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Company Overview & Background

Profile and Management

COMPANY PROFILE

- > **Foundation:** 2016.
- > **Founders:** Francisco Tenente, João Rosa.
- > **Headquarters:** Lisbon, Portugal.
- > **Status:** 3DWAYS is a start-up originally designed to create a fan for camping tents, that quickly turned into buying two 3D printers to test how to develop, produce and sell in the airsoft industry. After just one year they had 800+ products developed and were selling to the world via Facebook alone.
- > **Mission:** a solution that allows clients to reduce production costs, lead-time, adequately utilizes human resources while simultaneously increase productive capacity, thus raising their potential. Their solution is to utilize their adaptable manufacturing methods to allow companies to keep up with innovation growing rates, and a user-friendly system that manufactures custom products locally is essential for their mass customization of products.
- > **Employees:** <10. 3DWAYS was founded by Francisco Tenente and João Rosa, and today they have an extremely experienced team of five members who are experts in 3D printing and industrial maintenance. The team has developed, operated and market-tested a system to remotely control 3D Printer Factories.
- > **Reach:** completed projects in more than 20 countries (e.g.: Sweden, UK, Spain and Italy).

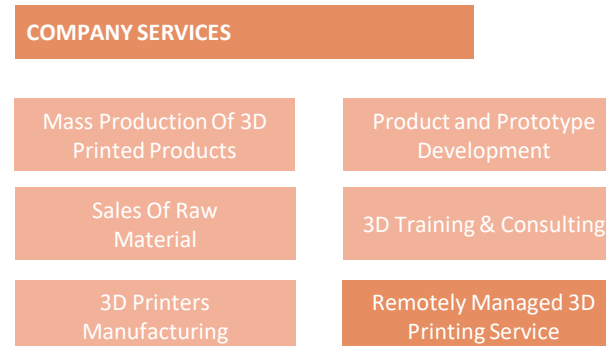
MANAGEMENT

- | | |
|---|---|
| > Francisco Tenente
CEO & Founder | > Telmo Pereira
Project Manager |
| > Alberto Silva
Financial Management | > João Rosa
Founder |
| > Tiago Elias
Remote Factory Manager | |

BUSINESS OBJECTIVE

Right now the company's Core Business is the **Production of 3D Products** according to customer orders. In the immediate future, the goal of the company is to **change its core business** to the **Remotely Managed 3D Printing Network**. This is a service that remotely controls professional 3D printers through **automated software**, which manufacture 24 hours a day. 3DWAYS' software is developed for **customers without 3DPrinting know-how**. Essentially, the objective of this service is to **empower companies with this technology** without having to possess the necessary know-how nor the need to have an engineer present in their facilities to operate 3D Printers and at a lower cost. Ultimately the goal of the company is to enable a circular economy and global decentralized production.

COMPANY SERVICES



PRICING SCHEME

- > **Core Business:**
 - Contracts are established directly with clients and price for the service and manufacturing is decided case by case
- > **Remotely Managed 3D Printing Service:**
 - Service Subscription:
 - Fixed Fee per priority printer: 50€/month/printer
 - 3D Printer Production File Ownership: 12,5€/print-file
 - 3D Printer Print-Job: 5-10€/print-job
 - Remote Assistance: 50€/hour

Company Overview & Background

Process and Operations, Positioning and Strategy

3D PRINTING PROCESS AND MATERIALS USED

3D printing is a process of making **three dimensional solid objects** from a digital file. The technique of 3D printing includes a variety of manufacturing approaches, which may be referred to as rapid prototyping, desktop-manufacturing, additive-manufacturing, or rapid-manufacturing. Initiating with stereolithography using a precise photosensitive polymer, the technology currently allows **printing with a variation of materials** that have varied properties, including soft and flexible materials. 3D printing allows for the creation of objects in a way that is more **organic** than traditional manufacturing. Products are created by **laying down successive layers of material** until the objective is completed. Every layer is a **thinly sliced horizontal cross-section** of the final product.

3DWAYS **manufactures** products using **more than 30 different polymers**, as well as, the use of **resins** (castable, transparent, flexible, dental and engineering resins) and **metals** (steel, Titanium, aluminum, Cooper, cromo-cobalt, silver, gold, platinum). Their printers also allow a variety of marketing materials, ranging from **polycarbonate and nylon to PLA, through the PVA and elastic materials**.

The **main benefits** for companies adopting **additive manufacturing** are the following: reduce the waste of raw material that is greatly affected by mass production; reduce pollution in transport due to products being produced where they are needed; decentralize innovation and production by mitigating monopolies; reduce corruption in developing countries by cutting costs; and helping with real products that are produced on-site by the people who will use them.

MARKET POSITIONING

Companies are now considering adopting 3D printing because of the benefits that it can enable across the whole value chain. Even though the price of this technology has been going down, it requires a certain technical know-how which the majority of the companies do not possess or find it to expensive to hire an engineer. 3DWAYS offers a substantially cheaper service that does not required the know-how, helping companies to realize the potential of this technology across their organization. The company **differentiates itself from the competition**, mainly in three ways: **Empowering companies** - instead of producing for clients, 3DWAYS helps companies get the most out of their printers by decentralizing the manufacturing know-how; **Simplifying**: software with a user-friendly interface that automates the manufacturing process; **Market focus**: 3DWAYS focuses on companies with mass customization needs, which are mainly companies that operate in healthcare and automotive sectors.

INTERNATIONALIZATION: GO TO MARKET STRATEGY

When internationalizing its Remotely Managed 3D Printing Network, 3DWAYS has outlined the following strategy:

- > **Focus on the healthcare segment.**
- > **Target big healthcare and industrial companies**, both in Portugal and abroad. Each **client** can have in average **five to twenty 3D printers**, thus by targeting big companies, **lowers the client acquisition cost** and augments the scalability of the business.
- > **Partner with renowned 3D Printer manufacturers and with certification groups** (Ex: ISQ) to increase the value and attractiveness of the service.
- > **Grow the addressable market by adding 3D Printers** (brands and technologies).
- > **Target countries with greater purchasing power and high labour costs.**

FUTURE PLANS

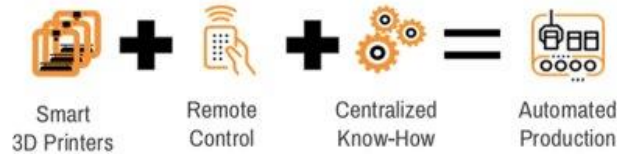
3DWAYS aims to grow its business until it becomes an attractive takeover target. The company has identified potential acquirers in the Paper Printing and Manufacturing & 3D printing segments. The main reasons for an acquisition are:

- > **Data Collection**: the company is able to collect a lot of data on 3D printing profiles, product design, 3D printing materials, 3D printing factories and 3D printing processes from clients in its network, being extremely valuable for manufacturing companies as they are always researching for new use-cases and applications.
- > **Technology**: in-house developed software can be monetizable by any acquirer (as long as 3DWAYS is able to protect it through IP rights);
- > **Certification** (if 3DWAYS is able to partner with ISQ): in-house processes that enable automatic certification of every part produced in any of the printing units is particularly valuable for any potential acquirer.

Company Overview & Background

Product Overview

REMOTE-PRINTING PROCESS



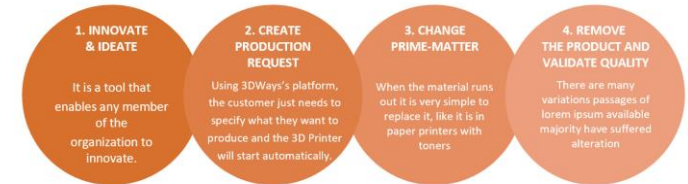
With the programmed and simplified **3D printers** in combination with **the know-how** and **experience** necessary to materialize the desired product, 3D Ways' service allows for **implementation** of the clients ideas to come to life with its in-house software where they can **define a project**. If needed, designers can help them develop the products, define the materials and the machines necessary to implement the product. The production starts **automatically**, and the clients only need to take the parts out of the machine and validate their quality to continue production. All the assistance, maintenance, updates, production management, and machine preparation are performed **remotely**. Moreover, 3D Ways' software can **optimize their production by using dynamic variables** that allow the company to guarantee **faster** and **superior** production. Additionally, 3D Ways remote control system allows the company to detect errors before they occur which, in turn, allows for adequate maintenance and an adequate final product.

INTERNAL ENVIRONMENT



The process works by developing and harboring new products. 3D Ways has already developed **+5,000 products** for various sectors. With more than **+300,000 hours** of 3D printing in a variety of materials and purposes, 3D Ways can optimize more than 50 parameters; this includes speed, temperatures, and supports to ensure efficient and effective production.

EXTERNAL ENVIRONMENT



3D Ways' service empowers customers with this innovative technology, without having the need to acquire technical know-how, nor the need to have an engineer present. Customers just need to specify what they want to produce, introduce the parameters and 3D Ways takes care of the rest. The production starts automatically and when finished, the employee in charge of the machine will receive a notification by email and mobile phone. The employee removes the product and must indicate that the product is complete.

3D Ways' goal is to spread its factories around the world, through its standardized software, enabling circular economy and global decentralized production.

- **Each print factory can sell its down-time to other print factories in the network**, through 3D Ways' platform, monetizing their printers idle time, benefiting from network externalities.
- The **security of the information and quality assurance** is provided by the system since 3D Ways controls all the nodes with standardized and certified processes.
- Since **processes and know-how is centralized**, the production is the same in every factory.
- The platform allows companies to **reduce logistics and shipping costs**.
- **Manufacturing risk is low**, as the risk of the production can be diluted by many nodes.
- **Data will be automatically gathered from the factories**, aggregating value to the service.

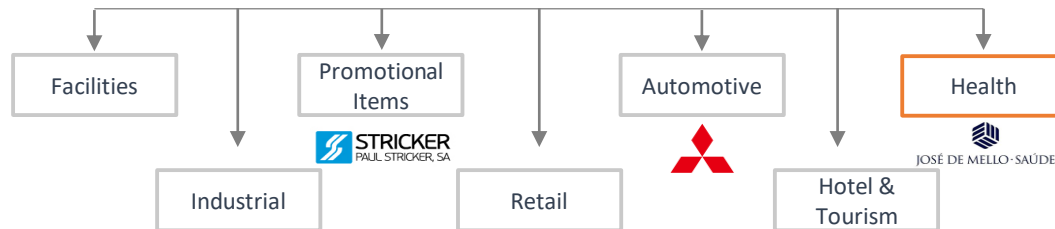
Company Overview & Background

End-user Product

SECTORS WHERE 3DWAYS OPERATES

3D Ways currently operates on a B2B level. The end users are innovative companies in a vast range of sectors that have in common the need for high mass customization, fast and cheap products, a seamless way to manufacture in-house, the most cost-effective products for their business, and sustainable manufacturing methods with waste reduction strategies in place.

3D Ways has had several projects across various sectors that include **facilities**, **industrial**, **promotional items** (e.g., *Paul Stricker*), **retail**, **automotive** (e.g., *Mitsubishi Motors*), **hotel and tourism**, and **healthcare** (e.g., *José De Mello-Saúde*). Previous projects' cases include operations jig, assembly jig, titanium prototyping, glove cast, arm cast, prosthetics, physiotherapy and mobility, vital sign screen maintenance, product maintenance, tac scan 3D printer, door jamb, and teaching and briefing sessions.



TRACTION

The company managed to validate their network business model, with very limited marketing, by implementing the following projects:

- > **Paul Stricker:** 9 remotely managed printers installed; 9 more printers already installed but are yet to be activated.
 - Use-case: 3D printed moulds and customized merchandising.
- > **José de Mello Saúde:** Entered GROW acceleration program, feasibility study proved to be valuable. Currently, one printer is being controlled in the Pilot Program. However, more printers are already ordered.
 - Use-case: 3D printed TC-Scan models to prepare operations, maintenance parts and custom physiotherapy devices.
- > **Mitsubishi Fuso:** feasibility study proved to be valuable, so the first printer ordered.
 - Use-case: 3D printed operation support jigs and fixtures.
- > **Mozambican Government:** feasibility study proved the value and project submitted for financing.
 - Use-case: 3D printed health and maintenance parts.

Currently, 3D Ways is focusing on improving the system's automation and marketing strategy to increase its customer base and begin its internationalization process

The **end users are innovative companies** in a vast range of sectors, from health to automotive, that have in common the **need for high mass customization and for the know-how to operate 3D printers.**

Company Overview & Background

Financial Analysis

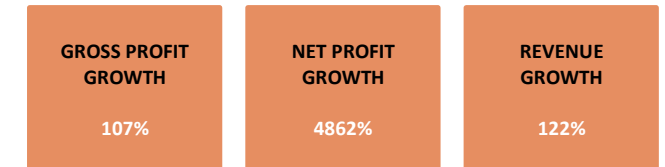
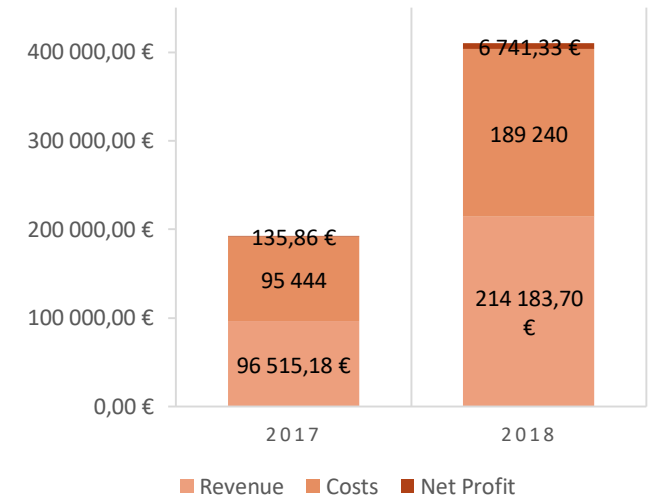
P&L STATEMENT

	2017	2018
Net Product Sales	€ 60,633	€ 175,883
Services Provided	-	€ 6,300
Grants & Subsidies	-	€ 182,183
Self Constructed Assets	€ 32,354	€ 31,508
Other Operating Income	€ 3,527	€ 493
Revenue	€ 96,515	€ 214,184
COGS	-€ 9,381	-€ 33,806
Fixed Costs	-€ 86,063	-€ 155,434
Costs	€ 95,444	€ 189,240
EBITDA	€ 1,072	€ 24,943
Depreciation & Amortizations	-€ 670	-€ 13,162
EBIT	€ 402	€ 11,781
Interest	€ 0.00	-€ 1,318
EBT	€ 402	€ 10,463
Taxes	-€ 266	-€ 3,722
Net Profit	€ 136	€ 6,741

FINANCIAL RATIOS

2017	2018
RETURN ON SALES	
1%	6%
RETURN ON ASSETS	
1%	21%
RETURN ON EQUITY	
5%	70%
DEGREE OF FINANCIAL LEVERAGE	
1	1.13
DEGREE OF OP. LEVERAGE	
217	15
DEGREE OF COMBINED LEVERAGE	
216	17

FINANCIAL HIGHLIGHTS



The company was founded in 2016, making it difficult to develop a solid financial analysis. In the last year it is worth highlighting that revenue grew over 122%. However, the company is not yet financially sustainable. Even though the net profit increased in the last year, it is only positive since the firm relies on grants and subsidies for being a start-up. The ROS increased meaning that the **company is becoming more operationally efficient**. The ROA increased by 20% in the last year, meaning that 3D Ways is **managing better the use of its assets to generate profit**. The huge change in the ROE is explained by the significant increase in the Net Profit. However, this does not reflect the reality since the company still relies on grants and subsidies, as previously explained. Finally, the Degree of Operating Leverage has decreased significantly. Thus, the company is less susceptible to changes in sales.

Macro-Environment Overview

Porter's Five Forces Analysis of the entire 3D Printing Industry

Low Bargaining Power of Suppliers

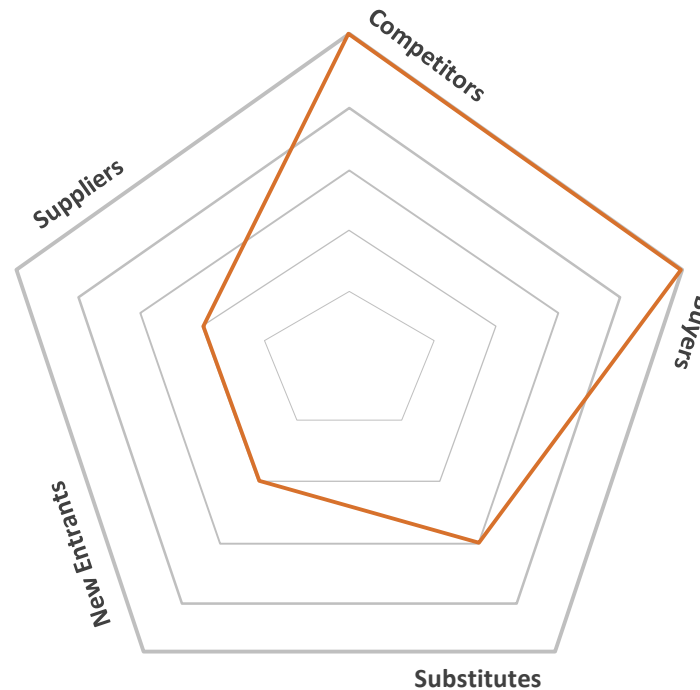
- > 3DP companies need two components or inputs to produce: materials or filaments and software. Although the prices of materials used in 3D printing are costlier compared to others used in traditional printing, prices are declining rapidly and can be expected to decline further as volumes increase (Chinese plastics suppliers have already started to sell plastic filaments at just five times the price of production-grade plastic). Also, large material suppliers are the reason for the steady and fast growth of 3D printing materials (Farrando, A., & Dhuru, R. D., 2018). As for software, the vast majority of 3DP companies rely on in-house developed versions. Furthermore, 3D printers are not relatively a very capital-intensive assets.

Low Entry Barriers for New Entrants

- > It is relatively easy for manufacturers to adopt this technology, transforming into 3DP companies. Printers are not relatively expensive assets, and there are a lot of software companies with different types of solutions;
- > The first barrier to overcome is the need for brand recognition when entering the industry. There is the possibility to overcome this by concentrating on the technological standpoint;
- > There is difficulty in acquiring intellectual property rights protection on software that may dissuade possible new entrants that focus their operations on the software segment of the 3DP industry. However, the majority of 3DP companies rely on in-house developed software or on standardized open-source software.



For the literature review, please check Appendix 1)



High Rivalry

- > Over the last three years (2015-2018), the number of AM players have significantly increased, going from 600 to 1,300, offering a wide range of both AM products and services. The increasing rivalry has been driven by the increasing number of start-ups entering the arena, especially in Europe, where the 40% of the total amount of AM companies (722) is represented by new AM players. On the contrary, in the Americas competition is played mainly by established AM or industrial players, accounting for 70% of the total of 421 AM companies (EY, 2019).
- > 3DP allows small companies to manufacture themselves, resulting in a higher concentration of companies, both small and large in the industry.
- > There are high exit costs (that result from high switching costs between different technologies) meaning companies are not exiting from the industry fast enough but are becoming more committed and competitive in the industry. In addition, each different 3DP production method and material has multiple companies specialized in it (Manuel, R., & Canas, S., 2014).

High Bargaining Power of Buyers

- > With the relative ease to be established as a manufacturer, service provider, 3D printer seller, etc., the number of competitors should increase and, subsequently, rivalry in the industry. Thus, giving more choice and bargaining power to customers;
- > Buyers are still few compared to volumes produced;
- > Buyers can source parts, products and services from a wide range of new competitors (Cohen, D., Sargeant, M., & Somers, K., 2014).

Threat of Substitutes is Medium

- > 3D printing is an alternative to traditional production methods proving to be a threat to the latter because of its benefits: cheaper production prices, higher customization and lower lead time. Once a company adopts this method of production, switching costs are high, as the different 3DP production methods require advanced technical capabilities (Manuel, R., & Canas, S., 2014);
- > At the actual pace of innovation, new applications, products and services are surfacing in the 3DP industry. However, it is hard to assess the viability due to their premature stage. Many companies still opt to choose traditional methods of production Cohen, D., Sargeant, M., & Somers, K. (2014).

Industry Overview

Global Overview

3D PRINTING VS TRADITIONAL MANUFACTURING

	Volume	Cost/Unit	Time to Market	Cost of Complexity
3D Printing	Small batch, Highly customized	High variable costs, No fixed costs	Very fast (≤ 1 day)	No added cost for complexity
Traditional Manufacturing	Large batch, Not customized	Low variable costs, High fixed costs	Very slow to moderately slow	Much higher than simple parts

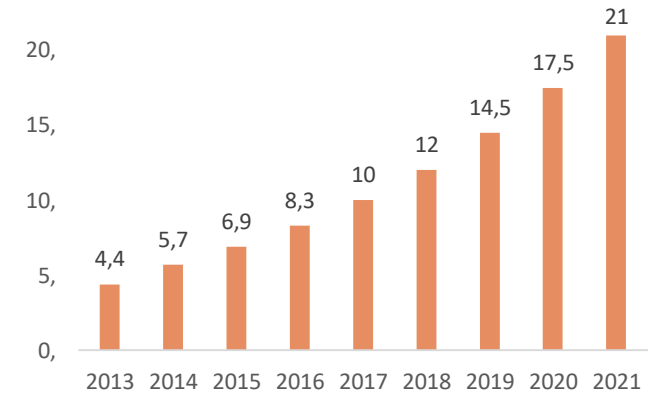
UPS

When comparing both methods, Additive Manufacturing or 3D Printing has a lot of advantages compared to traditional manufacturing, based on “metal extrusion, computer-controlled machining and manual modeling techniques for prototype development” (UPS, 2016). 3D printing can **speed progress** since the **cost of failure is lower**. Also, it allows **product customization**. Moreover, additive manufacturing allows **production costs to stay the same** independently from the produced units, **making production available to small businesses** that don’t have access to expansive funding. It also **reduces the time between conception and sale**, as well as **reduced lead times** for short production runs (Nadin.F, 2016). Additionally, it permits the **creation of very complex shapes without added costs**. Thus, this method can be rather **flexible** through the usage of enhanced inventory. Additionally, this method can **advance quality** through agiler fragments, superior ergonomics, and additional design autonomy. Finally, 3D Printing is incredibly **resource efficient** since the only material consumed is what passes under the laser, avoiding waste (MarlinWire, 2015).

GLOBAL 3DP INDUSTRY KEY FACTS

- > Market Size: \$21B by 2021 & \$44B market in 2025 (Citi Research, 2017);
- > 3DP Industry is expected to grow at a compound annual growth rate of 22.5 percent between 2020 and 2024 ((Forbes, 2019);
- > 67% manufacturers already use 3D printing and manufacturing accounts for 17% (\$10.2T of \$60T global economy) (PwC, 2016).;

Global 3DP market size forecast (in billion U.S. dollars)



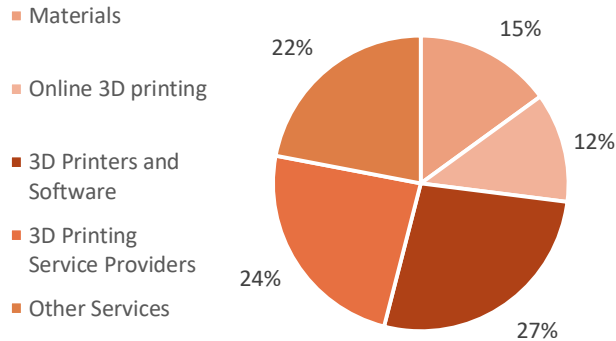
Statista

The global 3DP market will more than double in three years (from 2018 to 2021) and quadruple in 7 years (2018 to 2023) (Citi Research, 2017).

Industry Overview

Global Analysis

Shares of Global 3DP Market 2018, by segment



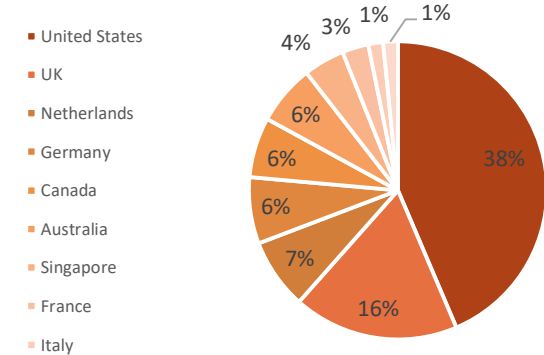
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Published 3DP Patents, 2018

USA	968
Germany	613
Japan	480
Italy	337
France	334
UK	325
Netherlands	322
Belgium	321
Switzerland	317
Austria	316

Statista

3DP Market Share 2018, by geographies



Statista

The **Global 3D Printing Market** is **highly fragmented** with no clear segment occupying a large portion of the market. The biggest segments are Materials, 3D Printers and Software and 3D Printing Service Providers (3DHubs, 2019). In fact, the sales of 3D printers represent the biggest expenditure in this industry, according to Statista. It is predicted that the in 2025 the spending will be ten times higher than in 2015 (IDC, 2019).

United States of America occupies a **big portion** of the **3D Printing market** compared to the remaining countries. They are clearly one step ahead when it comes to this technology, as mentioned by AT Kearney in its report “3D Printing: Disrupting the \$12 Trillion Manufacturing Sector” (A.T. Kearney, 2018). USA is followed by the United Kingdom with 16% share of the market. Lastly, follows a group of countries with similar shares like the Netherlands, Germany, Canada and Australia (3DHubs, 2018).

Global 3D Printing Market is highly fragmented, with the biggest segment being 3D Printers and Software (3DHubs, 2019). The **United States occupy the biggest portion of the 3DP market** with double the market share of Germany. Both countries are then followed by a group of countries with similar market shares (3DHubs, 2018). This trend is also illustrated by the number of 3DP patents published in 2018 (Cipher, 2019).

Industry Analysis

Global Analysis

3DP INDUSTRY KEY DRIVERS

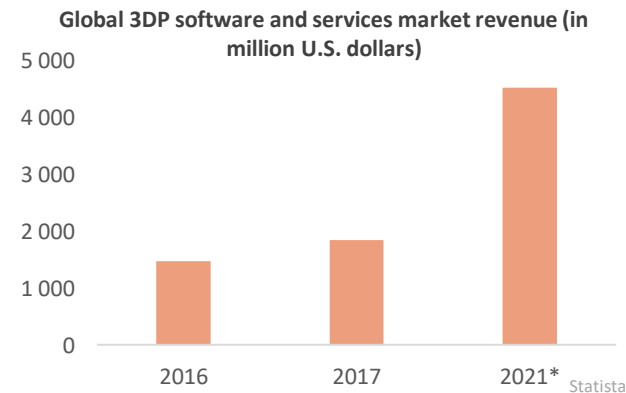
Key drivers supporting 3DP market growth (Clark & Deloitte, 2019):

1. Demand for **products' customization and democratization** across various industries; 3DP technologies facilitate the personalization of manufactured products, tailoring products according to customers' specific needs. Moreover, 3DP technologies support a reduction of the barriers to innovation, enabling both single individuals and collaborative teams to design and manufacture finished products easier.
2. Need for **cost-effective and rapid manufacturing**; 3DP technologies allow organizations to shorten their supply chains and reduce inventories by printing components prior to the assembly and/or close to the point of need. Thus, the logistical waiting-time becomes optimized, together with logistics costs (the costs of transports and stocks).
3. Global movement towards **environmental sustainability** and **circular economies**; 3DP technologies have a significant impact on the way companies efficiently manage their resources, especially in terms of raw materials. Particularly, additive manufacturing allows corporations to minimize the waste generation throughout their overall production operations.

3DP INDUSTRY KEY TRENDS

Key trends in the 3DP industry (Farrando & Dhuru, 2018):

- > Applications will drive the 3D printing industry forward;
- > Increase in polymer materials for 3D printing and decrease in prices;
- > Software will be the key to boosting productivity in 3D printing. It will also become increasingly valuable for managing and streamlining 3DP processes at all stages;
- > Technology-neutral interconnectivity, relying on IoT capabilities and software-based models;
- > Standardization of 3D Printing processes will help further the advancement, adoption and of 3D printing technologies and mainstream 3DP production.



SERVICE PROVIDERS

Based on a Sculpteo survey (2018), an **increasing number of businesses are purchasing 3D printers**, as a result of a growing **consideration of 3DP as a competitive advantage**: 66% of organizations surveyed across different industries own at least one 3D printer. However, **more the half of the respondents defined themselves as not "experts" in applying these technologies**. In fact, professional 3D printing services are often used to get access to those manufacturing technologies that are not in-house, favouring the networking business model promoted by 3DWAYS.

Additionally, 41% of the respondents affirm that, in order to increase their degree of expertise, they do all in house, with only 8% stating they use consulting services. However, only 17% of the interviewees answered positively in hiring candidates with profiles specifically linked to 3DP activities in the upcoming years. Combining these two insights, we can conclude that **corporations will necessarily move towards outsourcing their 3DP activities, relying on third-party service providers due to the lack of in-house resources**. In fact, current employees will increasingly not be able to keep up with the 3DP technological advancements.

Global 3D printing software and services market revenue already illustrates that trend, as shown on the graph on the left. The predicted CAGR from 2018 to 2024 is 21.68% (Forbes, 2019).

In a five-year period, the global **3DP software and services market revenue will grow almost five times**.

Country-specific Advantage

Home Country Business Environment: Porter's National Diamond

FACTOR CONDITIONS

According to Porter (1990), this set of variables represents the supply of specific factors in the home country. The resources can be distinguished between basic and advanced factors. The first is represented by conditions such as natural resources, demographic while the second one take in consideration elements such as investments or infrastructure. The actual economic and start-up ecosystem in Portugal has been growing 30% a year since the initial government investment in 2016, twice the average of the European Union countries (EY, 2018). The Portuguese government has launched numerous initiatives to support the national entrepreneurial ecosystem, with the goal of fostering start-ups, attract investment, both national and international, and accelerate the growth of Portuguese start-ups in foreign markets. Some examples are: National Strategy for Entrepreneurship Startup Portugal; Startup+ Portugal Program to incentivize growth and raise investment for start-ups established in the country; Startup Voucher which is a monetary grant to support the development of projects in its initial phase; Startup Visa to attract foreign entrepreneurs who want to establish their business in Europe; The Seed Program a tax relief for individual investors who purchase new shares in start-ups; and 200M a program to stimulate foreign start-ups to choose Portugal (Startup Portugal, 2019). Furthermore, Lisbon holds the "Web Summit", one of the biggest technology conferences in the world, which undoubtedly increased the country's visibility.

The Portuguese government has launched "Indústria 4.0", a strategy with the aim to develop the digital and innovative industry in its country. The funding for this strategy is both private and public, aiming at helping particularly Portuguese small and medium enterprises. Despite the small relevance that Additive Manufacturing has in the plan, the investments focus on research and development through partnerships between universities and third parties. Bosch is establishing a partnership with Minho University with an investment of 54.7€ million for labs in advanced additive manufacturing. Moreover, in early 2019 FCTUC (University of Coimbra) has developed, in partnership with a Norwegian research centre, a large-scale robotic metal 3D printing system with 6 axes of movement (Vialva, 2019).

Additionally, Portugal has made an effort to streamline processes and reduce bureaucracy when it comes to registering a company. Now, start-ups benefit from simplified licensing and special legislation designed to make life easier for technological and innovation business. According to the World Bank "Ease of doing Business Index" 2018, the time to set up a business in Portugal is less than 1 hour (World Bank, 2018). Portugal is highly connected and ranks 4th in the EU28 in "Broadband penetration" (EIS, 2017) and 7th in "Communications technology meets business requirements" (IMD 2016, 60 countries). Furthermore, start-ups in Portugal benefit from highly qualified professionals, like engineers, offering very competitive salaries. Also, Portugal is a very diplomatic country that has maintained excellent relationships with countries across the world and has access to the Schengen Zone. This facilitates processes when it comes to acquire materials from suppliers across the globe.

DEMAND CONDITIONS

The demand condition in the home country, represents a crucial element for the competitive advantage. If there is a high demand in the domestic market and the customer needs are exigent, the company has a competitive advantage based on the ability to fulfil the needs of their closer customers (Porter, 1990).

The adoption of 3D printing in Portugal is at a slow pace. According to AT Kearney, the country is still far from reaching the top of the industry. The report takes into consideration six different dimensions in order to assess the countries in three different segments: leaders, challengers and followers. The metrics regards 3D Printing capabilities (50% of the weight) and sub-metrics like macroeconomics factors. Among these, it is included demand, trade (impact of 3D printing in exports), people as level of workforce, governance and technology. Portugal lists itself as a follower with an overall score of 2.6, implying that there are not enough factors that push companies to embrace and adopt this technology. Portugal has a scarce demand (approximately 0.2 of the overall score) compared to others. This can be explained by the low manufacturing and labour costs which does not incentivize Portuguese companies to adopting alternative solutions that could be as cost-saving like 3D printing. Similar European countries, such as Italy and Spain, are labelled as challengers with a respective overall score of 3.8 and 3.3, meaning that they hold capabilities that are not yet being fully explored. However, they have a considerable potential to growth and explore this industry. In 2019 Portugal has become the 10th country for 3D printing patent application, as a result of the strong motivation to adopt this technology in the future (A.T. Kearney, 2018).

Considering the recent progress, it is likely that the industry will experience a boost in the demand in the next years, but it is not yet constant nor stable for companies operating in it. It does not hold favourable circumstances for firms which seek a rapid growth and an international exposure.



For the literature review,
please check Appendix 2)

Country-specific Advantage

Home Country Business Environment: Porter's National Diamond



For the literature review,
please check Appendix 2)

RELATING AND SUPPORTING INDUSTRIES

The Portuguese technology sector is characterized by districts which represent significant incubators of innovative entrepreneurship, and where synergies among companies and related supporting industries are promoted Entrepreneur (2018). 3DWays is currently involved with an incubator that is helping the company to grow. In fact, 3DWays' headquarters are in the incubator. Also, this incubator is in one of the technological clusters in Lisbon. This allows the company to not only benefit from the incubator program, but also from the knowledge that is shared inside these types of clusters.

Large material suppliers are the reason for the steady and fast growth of 3D printing materials. Although the prices of materials used in 3D printing are 50 to 100 times more expensive than materials used for injection molding, prices are declining rapidly and can be expected to decline further as volumes increase. For example, Chinese plastics suppliers have already started to sell plastic filaments at just five times the price of production-grade plastic. Every year, new extruders have been developed that can turn production-grade plastics into filaments. Also, new types of materials are being adapted for additive manufacturing, some polymer types even offer flexibility, electrical conductivity, and biocompatibility (e.g., for implants). An important step that could push this subject even further is the possible development of standardized materials that can be used by 3D printing systems from different vendors (today, each manufacturer requires its own certified materials) (Farrando, A., & Dhuru, R. D., 2018).

COUNTRY-SPECIFIC ADVANTAGE ASSESSMENT

Portugal has been pushing for investment in the technology sector for the past three years, creating programs, public grants and supporting innovation. Several clusters, incorporating incubators and start-ups, have been emerging in the country. However, the factor conditions are not enough developed to represent a competitive advantage in the 3DP Industry. Regarding demand conditions (Porter, 1990) assert that they represent an advantage when the company can rely on "*sophisticated and demanding buyers*" (p.82). A complex demand from the customers is translated as push factors to improve and innovate companies' products and services in order to meet customers' high standards.

As a result, **Portugal does not provide a country advantage for companies in the 3DP industry**. Even though Portugal has made an effort to support start-ups in the past years, the 3DP industry is still on a premature stage. As mentioned previously, the **market is not yet developed, being the demand and the adoption rate low**. Consequently, **3DWays can not rely on a country-competitive advantage. The only advantage for 3DWays is the fact the labour cost is cheap when compared to most European countries**. Thus, 3DWays can produce at a lower cost compared to international competitors. 3DWays can take advantage of that by maintaining the operational base of the remotely managed printing factory in Portugal while the printers are spread across different geographical locations.

STRATEGY, STRUCTURE & RIVALRY

The national environment of how are created, managed and organized firms in similar industries affects the overall management and organizational structures of non-related industries. According to the OECD, Portugal has one of the lowest average salaries in Europe; behind Latvia, Lithuania, Greece and Estonia. This is good for companies operating in Portugal since they can find highly qualified professionals for lower labour costs when compared to other countries. This enables 3DWays to provide lower prices to customers when compared to international competitors. The 3D printing industry in Portugal is composed of small firms. There isn't a clear major player that owns a large portion of market share. Most of the firms operating in Portugal are 3D Printing Service Bureaus, like 3DFactory, Impressão3D, 3DMaker, 3DHubs, 3D Life, Codi and Xpim3D. They model and produce 3D objects according to customer orders. There are also some big players from the traditional printing industry like HP that are trying to enter in the global 3D printing industry. In Portugal, HP is trying to establish a network of official dealers, being the first one 3D Ever, which belongs to the above mentioned. Additionally, there are firms that sell 3D printers and printing filaments, such as RepRap, ElectroFun and 3DSystems. Finally, there are some companies that do serve both markets, like BEVERYCREATIVE.

To conclude, there isn't any company in Portugal that offers a remotely managed network of 3D printing factories like 3DWays offers. Only the company's current core business is matched by competitors in Portugal systems from different vendors (today, each manufacturer requires its own certified materials).

Firm-specific Advantages

Resources and Capabilities



For the framework, please check Appendix 3)

TYPES OF RESOURCES

Resources can be broadly divided into tangible, intangible and human assets. Furthermore, they can be separated into different types of resources:

- > Physical resources, such as buildings, equipment, tools, etc.
- > Financial resources, like cash, budget obligations, and other types of liquid instruments.
- > Technological resources, such as computers, software, networks, databases, communication systems, etc.
- > Human resources, for example, physical, intellectual (know-how), and emotional.
- > Social resources, such as relationships, trust, norms, friendships, and firm and employee reputation.
- > Organizational resources, like information systems (formal and informal), structures and procedures, firm culture, organizational relationships, etc.

PHYSICAL RESOURCES

- > Set of owned “smart” 3D printers;
- > National network of 3D printers;
- > Headquarter in TagusPark.

FINANCIAL RESOURCES

- > Institutional financial incentives (Lisboa2020).

TECHNOLOGICAL RESOURCES

- > In-house developed remote-control software;
- > User-centered communication processes;
- > Information database.

HUMAN RESOURCES

- > Extent 3DP know-how across every technical dimension;
- > 3D printing experience applied to a wide range of sectors;
- > Team of 4 professionals (CEO, CFO, Remote Control Manager & Designer).

SOCIAL RESOURCES

- > Relationships with certification entities for certified additive manufacturing;
- > Relationships with 3D printers and materials suppliers.

ORGANIZATIONAL RESOURCES

- > Startup culture;
- > Agile organizational processes;
- > Business model centered around value network

The most relevant asset that 3D Ways possesses in terms of differentiation is its value network-based business model. Based on a critical evaluation, 3D Ways stands out for **highly specialized technological and human assets**, along with its **social and organizational resources**. In particular, the last two mentioned aspects are those allowing 3D Ways to build its intended manufacturing network:

- Partnerships with certifiers and suppliers enable 3D Ways not only to easier establish and expand contacts with future potential clients but also to be considered as a trustful partner.
- 3D Ways’ startup culture and agile organizational structure facilitates the company in its process constantly innovating its offering, starting as a 3DP factory and moving to remote-control manufacturing service, thus delivering higher value to its clients.

Firm-specific Advantages

Resources and Capabilities



For the framework, please check Appendix 3)

Capabilities can be defined as the capacity to deploy a combination of resources through collective organizational routines to achieve goals. The capabilities that can be identified for 3DWays are:

ABILITY TO MANAGE STAKEHOLDERS.

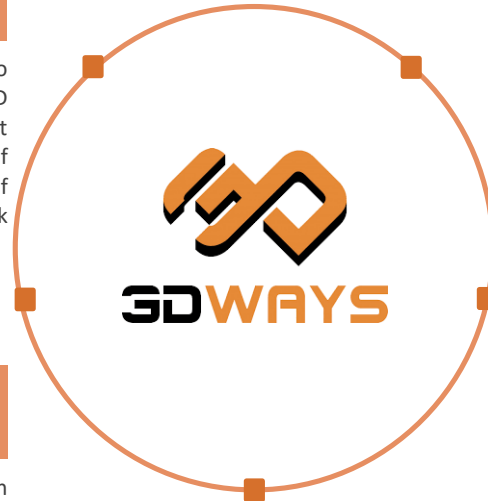
With their user-centered communication processes, 3DWays is able to share information and communicate clearly with all stakeholders. The 3D manufacturing process is remotely controlled by 3DWays, but it is a joint effort with the client, where both companies are partners in the creation of a product. Therefore, 3DWays will consult its stakeholders in each step of the process. The firm is also able to manage relationships and risk effectively.

Resources Utilized: Communication Processes; Information database; Know-how and experience; Partnerships and relations with suppliers;

ABILITY TO INTERMEDIATE WITHIN PARTIES IN THE ADDITIVE MANUFACTURING VALUE NETWORK, THUS REPRESENTING A TRUSTFUL PARTNER.

Using their national network of clients and their supplier relationships in various sectors, the firm can connect all entities involved in the manufacturing process, having a business model centered around network value creation. As the firm grows and internationalizes, this network will scale and enable clients to be part of a global ecosystem that can provide advantages such as manufacturing your products using other players machines.

Resources Utilized: National network of 3D printers; Communication Processes; Experience; Partnerships and relations with suppliers; Business Model



ABILITY TO PROVIDE OPERATIONAL FLEXIBILITY.

The software allows for an adaptable production process, from resources, to fast prototyping and refining product design in real time. Since 3DWays' business model revolves around building a value network, the firm can also offer value chain flexibility through partnerships and relations.

Resources Utilized: Owned "smart" 3D printers; Communication Processes; Information database; Startup Culture; Agile organizational processes

ABILITY TO KEEP CLOSE CONTACT WITH COMPANIES AND ACT AS A "VIRTUAL EMPLOYEE".

Since 3DWays is still a small company with limited resources, it cannot have a direct physical presence with its customer base, working instead as a "remote employee" or a long-term freelancer, that works on tasks assigned by the partner firms.

Resources Utilized: Communication Processes; Information database; Know-how and experience; Startup Culture; Agile organizational processes;

ABILITY TO PROVIDE A TURN-KEY SOLUTION, THUS EMPOWERING CUSTOMERS WITHOUT ANY TYPE OF MANUFACTURING OR ENGINEERING KNOWLEDGE.

With their owned software, developed with their know-how and experience, 3DWays is able to offer remote-controlled solutions for clients that want to manufacture their products through 3D Printing processes, but lack the technical knowledge to do so on their own.

Resources Utilized: National network of 3D printers; Software; Communication Processes; Information database; Technical know-how and experience; Startup Culture; Agile organizational processes

For 3DWays to internationalize its service and built a competitive advantage, the **most relevant capabilities are the value network intermediation**, that connects all parties of the additive manufacturing value chain, since it provides positive network externalities for companies, like the ability to monetize printers' idle time by manufacturing products for other firms in the network. Moreover, **the in-house solution for clients that lack expertise, as well as the ability to be a quick response**, reliable "virtual employee" will help 3DWays create a differentiated image from other 3DP service providers on a global scale.

Firm-specific Advantages

Competitive Advantage

STRATEGIC IMPORTANCE AND RELATIVE STRENGTH

✓ - Passes the test ✗ - Fails the test



For the framework, please check Appendix 3)

Capabilities	Relevance	Scarcity	Durability	Non-Transferability	Non-Replicability
Ability to provide a turn-key solution	✓	✓	✓	✓	✗
Ability to intermediate within parties in the 3DP value network	✓	✓	✓	✓	✗
Ability to provide operational flexibility	✓	✗	—	—	—
Ability to act as a “virtual employee”	✓	✗	—	—	—
Ability to manage stakeholders	✓	✗	—	—	—

Most of the 3DWays’ resources and capabilities are relevant, but not scarce. Its physical resources (such as printers), financial and human (such as know-how and experience), and its cultural and organizational processes are all relevant to the current business environment, but they are not scarce, since competitors possess them as well. The same is true for the capability to provide operational flexibility, since most 3DP services have this factor in common, and the abilities to manage stakeholders and act as a virtual employee. **Therefore, 3DWays’ differentiating aspects in terms of scarcity are their business model.** Even though it is still to be fully implemented, and consequently the ability to provide a turn-key solution, the ability to intermediate between parties of the value network, and its HQ, printer network and owned remote-control software are ready, despite this last one being under constant improvement and not being yet subject to any IP.

3DWays’ Business Model based on a value creation network (and its intermediation) can be a durable asset, as long as the relationship with its clients lasts. However, the network is transferable, since players can leave it and join another. It can also be replicated by competitors, if they choose to build their own networks. Nonetheless, **3DWays can gain from its first movers’ advantage, since the business model benefits from network effects, that can potentially deter players from leaving and others from replicating it, as it would be difficult to build their networks on a similar scale.**

Regarding the software’s durability, as it is a technological resource, it must be constantly updated and able to incorporate innovation, as technology keeps evolving at a rapid pace. However, this is something that the firm can accomplish with their technical know-how. It is not transferable, as it is owned and controlled by the firm. However, it is replicable, since they do not have a patent or any type of intellectual property protection yet (3DWays is currently looking to get an intellectual property rights protection).

Resources	Relevance	Scarcity	Durability	Non-Transferability	Non-Replicability
Owned Printers	✓	✗	—	—	—
Printer Network	✓	✓	✓	✗	✗
Headquarters	✓	✓	✓	✓	✗
Financial Incentives	✓	✗	—	—	—
Remote Control Software	✓	✓	✓	✓	✗
Communication processes	✓	✗	—	—	—
Information database	✓	✗	—	—	—
Know-how	✓	✗	—	—	—
Professional Team	✓	✗	—	—	—
Certifications	✓	✗	—	—	—
Relationships	✓	✓	✓	✗	✗
Culture	✓	✗	—	—	—
Organizational Processes	✓	✗	—	—	—
Business Model	✓	✓	✓	✓	✗

Intrinsically, the **strongest assets** that 3DWays possesses are its **innovative value creation network centered business model** and its **software**. However, both have issues that still need to be resolved. Nonetheless, they present a **potential source of competitive advantage** to the firm, as a form of differentiation. They are also considered to be of **high strategic importance** to the company and can be assessed as **key strengths** for 3DWays.

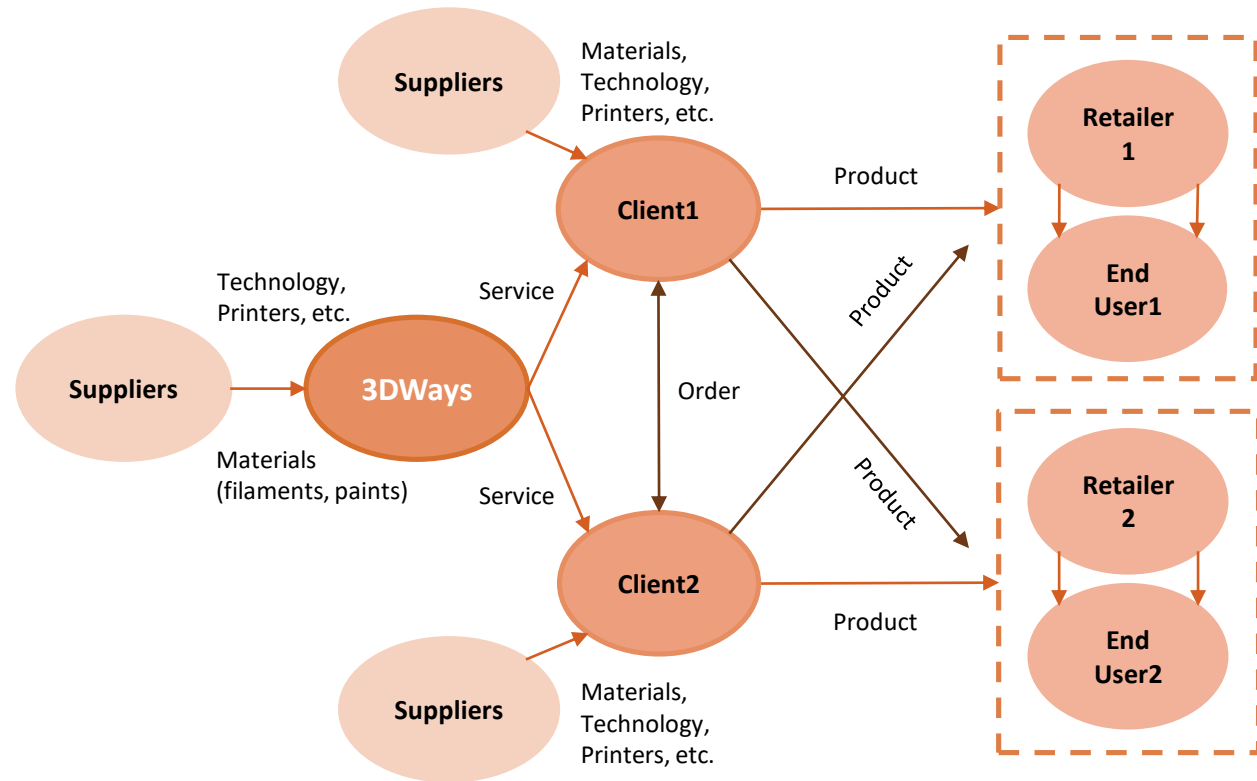
Firm-specific Advantages

Competitive Advantage

VALUE NETWORK BUSINESS MODEL

3D Ways' business model regarding the remote-control service is based on a value creation network of clients and suppliers. 3DWays has its own suppliers of materials, such as filaments and paints, technology, printers, etc. Using its resources and capabilities, the firm can offer a remote-control service to its clients, that enables automated production, which is controlled in every phase, from design to post-production. This allows for customers to maximize product quality, without necessarily having any 3D printing expertise, since 3DWays controls the whole process, from choosing the printer and materials that best fit their clients needs, to design and actual production. This means that 3DWays can connect their clients with the right suppliers, which creates a potential for expanding the current network by adding suppliers to it. Summarizing the process, the client has its suppliers deliver the materials, and its products manufactured in-house, which can then be sent directly to retailers or end-users.

Besides the remote-control component, the other differentiation factor of this business model is the relationship network. For example, *Client1* can send a production order directly to *Client2* through 3DWays' software. After *Client2* finishes the production order, the firm sends it either to *Client1* or directly to its retailers/end-users. When the network grows global, this process will bring value to the firms, as they can manufacture directly in a country where they have operations, using another member's printers. Meaning that each client has the opportunity to monetize its printers' idle time, save on shipping costs or on the costs of having production infrastructures abroad. Therefore, benefiting from positive network externalities.



A value network centered business model will be key in differentiating 3DWays from its competitors. The ability to connect clients with the right suppliers and with each other will help to build business relations, form a value creation business environment where clients can optimize organizational processes by utilizing each others' assets and monetizing printers' idle time. Moreover, it benefits from network effects, and will become stronger and more attractive as the number of players involved grows.

Firm-specific Advantages

Competitive Advantage

Since **3DWAYS** is a service provider in the 3D printing industry, an analysis of **key success factors** was performed for both industries, **3DPrinting** and **Professional Service Providers**.

KSF for 3D Printing

Reliability of firm and product quality

For a 3D orienting firm to succeed, it needs to ensure the additive manufacturing process is feasible for production. The hardware and software the company uses need to be reliable in the sense that they guarantee total accuracy and repeatability. The end parts and products must be manufactured with the exact same parameters and properties. When a company can ensure these aspects, it will be considered to have quality and be reliable.

Accessibility in terms of price

For 3D printing to remain cost competitive, prices need to be kept reasonable. Traditional manufacturing processes are still more cost effective when it comes to mass production, and cost is a big part of this reality.

Printing speed

A 3D Printing company needs to maximize its service speed, because slow production can limit the scalability of the business and its potential to be applied in mass production.

Availability of raw materials and parts

Material availability is still a big challenge for this industry, since they can be expensive and lack standards and diversification.

Workforce Knowledge

Employee technical knowledge is one of the most elementary KSFs. Companies who work in the 3D printing industry need members of staff who are expert in the area, to better cater to clients' needs.

KSF for Service Providers

Explicit service quality

For a service providing firm to succeed in the market, it should be able to build a reputation of quality, and have quantitative prove of it, through certifications and accreditations. Prosperous service providers are application-driven and have cost-of-ownership oriented viewpoints.

Proactive total solution

This KSF refers to the ability to provide a one-stop-shopping offer, that ensures a high scale of customization towards different clients.

Timely, emphatic design of new services

Firms need to be fast to adjust to changes in the market and innovate. They should also be seen by customers as a "virtual employee" that can be given any task at any point and perform it quickly and reliably.

Firm-specific Advantages

Competitive Advantage

Suppliers of 3DP products can be classified according to the following segments:

SPECIALIZED 3D PRINTER VENDORS

> This segment is characterized by focusing on a specific technology of 3D printing. Inventory turnover is a slow process and very expensive to the firms, since technology becomes obsolete quickly. The main players in this segment are companies such as *Autodesk, EOS, EnvisionTec, Exone, Stratasys, 3D Systems, Reprap* and *Ultimaker*.

3DP SERVICE BUREAUS

> 3D bureaus are firms who produce manufactured goods through 3D printing. They also offer after-sale services and consulting. Some main players are *Advanced Manufacturing, Aspect, DiSanto Technology (a Unit of Arcam), Hyphen Services, i.materialise, Ponoko* and *Shapeways*.

MARKETPLACE PROVIDERS

> Players in this segment focus on online platforms and act as intermediaries between owners of 3D printers and users who want to produce objects. Their services are offered across a large network of printers located all around the world. Main players are *3D Hubs, Additer, Kraftwürz, Maker 6, Make XYZ, Materialise* and *Spark*.

“ **3D Hubs, for example, links a file to a printer in one of their 5,000 global hub locations that can provide 3D print in the selected material. This proximity factor to the consumer has made them successful and increased the accessibility of 3DP to anyone.** ”

SOFTWARE VENDORS

> Software firms' focus is on open-source platforms for both crowdsourcing ideas and supplying blueprints for spare parts. They can also provide exclusive software for managing 3D printing workflow. Examples of these firms are *3D Systems, 3DPrinterOS, EOS, HP Inc., LINK3D, Materialise, SAP, Siemens, Stratasys* and *Y Soft*.

“ **C, for example, is the first open 3DP software platform (not including the pioneer Reprap, as it was limited to hardware). C was created by Autodesk and runs with an Ember 3D printer.** ”

PROFESSIONAL SERVICE PROVIDERS

> These players offer consulting services, including strategy, supply chain, design and engineering, product development, IT etc. Moreover, they manage end-to-end processes related with additive manufacturing and guide firms on their adoption process. Some players include *3D Systems, Aleph Objects, Canon, FATHOM, GoPrint3D, Konica Minolta, Print IT 3* and *Ricoh*.

Firm-specific Advantages

Competitive Advantage

SPECIALIZED 3D PRINTER VENDORS

- > **3D Systems:** American provider of 3D printing solutions. Product segment ranging from digitization, design and simulation through manufacturing, inspection and management. Services offered include a wide range of hardware, software, materials and on-demand production, as well as client support from experts. It serves various industries, such as dental, teaching and training, aerospace and defense, automotive, healthcare, durable goods and entertainment (MarketLine). The firm is present in Europe, America (North and South), Middle East and Africa, and Asia-Pacific.
- > **ExOne:** US company that produces and sells 3D printing machines, 3D-printed products and related services to customers in a variety of industries, like aerospace, automotive, heavy equipment and research and development. It offers pre-production collaboration, material supplying, training and technical support to its clients, as well as cost-effective, customized parts using industrial-grade materials. The firm operates in the US, Germany and Japan.
- > **Stratasys:** Company with dual HQ in the US and Israel, that provides 3D printers, consumable materials and software solutions, as well as expert services and on-demand parts production. It is present in different sectors, such as aerospace, healthcare, automotive, education and consumer product industries. Its teams are grouped by vertical market, ensuring expertise not only in 3D printing but also in each industry. The firm has operations in North America, Latin America, Europe, the Middle-East, Africa and Asia-Pacific.

3D-Printing-Related Presale Service Offerings

- > 3D print production process simulation
- > Evaluation of potential impact on application design and engineering
- > Evaluation of potential impact on IT (le creation, sharing, networking and archiving)
- > Evaluation of potential impact on intellectual property protection
- > 3D printing of prospect's parts
- > Quality assurance testing of prospect's 3D- printed parts
- > Other consulting services

3D-Printing-Related Post sale Service Offerings

- > Operator training
- > Sales training
- > Marketing support (collateral materials, go-to-market advice, etc.)
- > Other consulting services

3D PRINTER SERVICE BUREAUS ANALYSIS

- > **Advanced Manufacturing Services:** Australian company that provides industrial additive manufacturing services through laser sintering technology. It produces products and spare parts using its five 3D printers and six powder materials, in small batches. It caters to industries like Aerospace, architecture, automotive, consumer products, education, defense, dental, engineering, healthcare, manufacturing, and medical devices. Its present geographically in the Asia/Pacific market.
- > **Aspect:** Japanese firms focused on manufacturing 3D printing equipment and power materials, as well as operating a service bureau with its power bed fusion system and providing basic post-processing services. The company currently operates 12 printers, which include a system capable of processing high-temperature plastics. It caters to industries such as Aerospace, architecture, engineering and construction (AEC), automotive, consumer products, dental, education, healthcare, manufacturing, and medical devices, and it operates in Japan.

3D PRINTER MARKETPLACE PROVIDERS ANALYSIS

- > **Materialise:** Belgium company that engages in 3D printing software and production, offering pre and postproduction services. It is one of the largest additive manufacturing facilities in the world, with more than 150 machines. The firm separates its operations in two markets: industrial and medical. The first segment serves manufacturers in automotive, aerospace, consumer goods, and hearing aid industries, while the second caters to medical device companies, hospitals, universities, and industrial companies. *Materialise* operates in Belgium, France, Germany, Japan, the US, the UK, Austria, Malaysia, Ukraine, Poland, Colombia, China, Australia and Italy.

It was decided to compare 3D Ways with players operating in different market segments, since the company provides an inclusive 3DP solution, which combines a wide range of services at the same time. Therefore, since the positioning of 3D Ways within a pre-defined unique segment was not clear, several competitors were selected, across different segments of the 3D Printing Industry.

Firm-specific Advantages

Competitive Advantage



For a breakdown of the KSFs, please check Appendix 4)

Key Success Factors	ExOne	Stratasys	3D Systems	Advanced Manufact.	Aspect	Materialise	3D Ways
Reliability	2	5	5	5	5	5	4
Price	4	4	4	4	4	4	5
Speed	5	5	5	5	5	5	5
Availability of parts & materials	5	2	5	2	5	5	4
Workforce Knowledge	5	5	5	5	5	5	5
Explicit Service Quality	5	5	4	4	4	5	1
Proactive Total Solution	4	4	5	3	3	5	5
Timely, emphatic design of new services	5	5	4	4	5	5	5

- > By possessing most of the key success factors for both industries, 3D Ways can successfully compete in both 3D Printing and Professional Service market, offering an overall comparative offering to the other international players in the industry.
- > The factor on which 3D Ways can mostly achieve a **competitive advantage** compared to its competitors is “**Price**”, since the cost of producing and maintaining the software is low enough to allow the firm to offer quality services for less charge than competitors. In fact, its **software-based offering can be highly attractive for manufacturing companies, for which can be very expensive investing in 3DP technologies and the related personnel dedicated to managing 3DP production processes**. Combining the relatively low fees charged for its professional services compared the other big companies and the cost-saving achieved by its costumers as a result of lower expenses in fixed assets (3D printers) and human resources (in-house engineers), 3D Ways turn-key solution represents the optimal alternative, both in terms of efficiency and effectiveness.
- > The only aspect in which 3D Ways is currently **critically underperforming** is represented by “**Explicit Service Quality**”, which is mainly caused by the seed stage faced by the company. In fact, due to the company’s limited customer base, 3D Ways more established competitors can benefit from higher brand recognition and reputation. Therefore, the firm needs to find ways to explicitly demonstrate its service quality, by obtaining formal certifications, which are necessary in order to objectively prove its trustworthiness. However, **the condition for 3D Ways to facilitate the implementation of this strategic plan is to secure professional accreditation and certifications and expand rapidly its network to benefit from the first-mover advantage, achieving business scalability. Also, during this process the company should protect its software through intellectual property rights.**

Global Readiness

Global Readiness Test

GLOBAL READINESS

The global readiness test aims at assessing if a company has the necessary resources and capabilities to expand internationally. Considering firms which operate only in a domestic market, it evaluates if a company can expand abroad with a specific kind of entry strategy.

Due to the slow pace of the industry in Portugal, currently there is not an opportunity for the company to grow and become sustainable. When referring to the demand conditions, the country's adoption rate is still low. Thus, **the result of the test when considering expanding to foreign markets is necessary**. 3DWAYS intends to expand to new foreign markets with its **remotely managed 3D printing service**, leveraging on their **operational flexibility**. Both factors combined allow the company to manage its operations from its home country while, at the same time, reaching foreign markets without the need to establish operations abroad.

CONFLICTIVE ANSWERS

- > *Is the foreign market similar to the domestic market? (The more similar the market the more favorable) 4*
- > *Is the product successful in the domestic market? (The more successful the more favorable) 5*

The **answers mentioned above provided by 3DWAYS' management express discrepancies** with the actual situation of the company in the domestic market, reflecting the misleading global readiness score of 85 (please check appendix 5). This in turn would suggest a very costly and risky FDI entry strategy, as a result of the unrealistic corporate perspective. In fact, 3DWAYS plans to expand with a business which is not successful in the domestic market (only 1 client in Portugal) and does not represent its core business. According to the answers provided, the domestic market is similar to the foreign markets. However, this is not the case, since the Portuguese market is undeveloped compared to similar Eurozone countries, where higher standards are required in order to satisfy the more complex needs of the industry (A.T. Kerney, 2018).

3DWAYS' ANSWERS

- > *What is the stage of the product's life cycle in the home market? (Early stage is more favorable) **Introduction - 3***
- > *What is the stage of the product's life cycle in the international market? (Early stages are more favorable) **Growth - 3***

These answers shows that it is possible to exploit an opportunity in foreign markets, where the product life cycle is already at a growth stage. A delay could comprise their ability to succeed in a market and encounter higher entry barriers.

Examining these conditions, according to the traditional models and process of internationalization, the company would not be ready to expand internationally because of its scarce resources and lack of a solid demand in their home domestic market. However, casuistry has demonstrated so far that companies have been able to internationalize through a **successful strategy**, which takes into consideration the **characteristics of the service** and the **early stage of the company**.

As a result, due to these factors and the domestic market conditions, the most suitable approach for 3DWAYS is to adopt the strategy of a **Born Global firm**.

Global Readiness

Born Global Firm: Theoretical Framework

DEFINITION

Cavusgil and Knight define *Born Global* firm as “*business organizations that, from or near their founding, seek superior international business performance from the application of knowledge-based resources to the sale of outputs in multiple countries*” (p.124). Even though some authors provide different definitions of a *Born Global* Firm, a common and distinctive characteristic is the adoption of an early and rapid internationalization process.

CHARACTERISTICS

Cavusgil and Knight in 2015 redefined the characteristics of Born Global firms. These can be classified into four dimensions: *organizational*, *product characteristics*, *environmental* and *network*. The **organizational features** are **embodied by the entrepreneurial spirit of the management team** which helps the company to develop and discover attractive opportunities faster than traditional companies (Cavusgil 2004). The **product characteristics** aim at internationalize an innovative product or service which is mostly suitable for self-developed technology goods. The **product strategy is mainly based on the ability to secure a competitive advantage on the product that must possess unique features**. Due to the scarcity of resources that characterizes most of these firms, the product portfolio of Born Global firms is limited for three main reasons according to Shrader (2000). Firstly, the scarcity of resources does not allow the firms to expand their products ranges. Secondly, this scarcity helps and facilitates companies to focus on a wider geographical market. Thirdly, it facilitates the management of this process of internationalization. The **environmental dimension** is represented by the **small size and lack of opportunities which distinguish the domestic market from the international market**. This can be considered the main driver for an early internationalization. Indeed, **Born Global firms are generally characterized by a larger portion of revenues derived from international markets**. It is important to stress out that *Born Global* firms attain a vast knowledge that is their main essential asset. Indeed, **these companies usually operate under the condition of *asset parsimony*, meaning that they have scarce resources compared to firms that follow a gradual approach to internationalization**, choosing to do so when are fully established in their domestic market. However, this allows **Born Global firms to leverage their unique capabilities and strengths (i.e. innovation and differentiated offering) and at the same time reinforce them**.

STRATEGIES AND ADVANTAGES

Up to the present days, the literature has presented several strategies for *Born Global* firms with the corresponding advantages. The main advantage is the possibility to act as a **first-mover** due to the **innovative nature of the services that usually distinguishes these firms**. Being able to internationalize before potential competitors represents an essential step to acquire significant market share. Most of the strategies adopted by these firms are represented by the **differentiation and focus strategies**. The **differentiation strategy** targets broad markets with a distinctive offering, which, in the case of Born Global firms, relies on the possibility of sharing data, enabling them to communicate instantly and efficiently with clients, cutting down costs and time. Hence, it is crucial for born global to leverage information and communications technology (ICT). The **focus strategy** occurs when firms concentrate their expertise on a specific market niche (e.g. specific customers' categories, customers' needs or geographies).

Despite of the limited academic research on this topic, the **concept of networking seems to be applicable to IT Born Global firms** as well as to 3D Ways' case, which intends to internationalize its service that is based on its IT characteristics. Literature demonstrates that the networking theory is extremely useful to build and nurture relationships, which could overcome typical constraints for these firms (i.e. scarce financial resources) and exploit market opportunities. Specifically, considering the nature and the characteristics of the service provided by 3D Ways, which needs to establish a network, where the value and success of the service itself is dependent on the result of the simultaneous participation of the agents in the network.

NETWORKING – TRADITIONAL SUPPLY CHAIN

Recent authors have introduced an additional dimension which highlights the importance of networking competencies. According to Cavusgil and Knight (2015) firms which seek an early and rapid internationalization discover a beneficial **networking** relationship. The main advantages are the ability to overcome constraints which usually characterize born global firms as a result of the relationship with distributors, clients and suppliers aimed at obtaining and sustaining a competitive advantage. *Born Global* firms can leverage networking capabilities to exploit market opportunities, mainly by facilitating and supporting the international performance of knowledge-intensive products (Cavusgil and Knight, 2015). In support of that, Oviatt & McDougall (2005) highlighted the **importance of the presence of technologies, knowledge and supportive network for a successful rapid internationalization**. This can be translated into opportunities for cross-country combinations in resources and markets, as Matthews and Zander (2007), argued about the importance of a global economy as evidence “*ability to draw competitive advantage from external network*” (P. 398)

VALUE NETWORK – DIGITAL VALUE CHAIN

The importance of the networking dimension has also affected the logic of the traditional value chain. Pepperd (2006) states that when a “*service or product fails to lack a physical dimension*”, the concept of value chain takes on a different value in which the different agents become co-producers simultaneously and the value is produced throughout the system itself. The **value network process becomes particularly interesting and applicable for those services and products that are an internet-based service and can leverage on key characteristics of transmission network** (Pepperd, 2006). A value network is naturally dynamic, where all the players are interconnected, and each action has repercussions on all agents. This is particularly crucial for companies which rely on the network as a value proposition for their product or/and service since the elements that have to be controlled are strictly related to each other.

Global Readiness

Born Global Firm: Theoretical Application to 3D Ways

1. ORGANIZATIONAL

The **organizational structure of 3D Ways has the usual characteristics of a start-up**; The company is still at the seed stage and is operating with a limited number of employees. The company **operates under the condition of *asset parsimony*** in terms of human and financial resources, a fundamental characteristic of *Born Global* firms. Moreover, the 3D Ways' management has shown an **entrepreneur spirit inside a fast-changing environment**, producing new ideas which can help the company to differentiate from their competitors, more specifically its remote-control network service.

3. ENVIRONMENTAL

As previously assessed through the Porter's National Diamond framework, **Portugal does not provide a country advantage to companies which seek for opportunities and growth in the 3D industry**. Moreover, for 3D Ways to become successful through its service, the company must exploit and enter different markets, since it is crucial to scale the network and gain a competitive advantage. Due to its remote properties, physical boundaries are negligible for the specific process of internationalization.

Considering the nature of the IT characteristics of the service and the global environment in which they operate, the environmental context represents the aspects which distinguishes these firms.

2. PRODUCT STRATEGY

The remote-control network service is backed by an in-house developed software which can be defined as a self-developed product which has unique attributes and features. Even though, currently it does not represent a competitive advantage, as it is not yet fully developed and protected. As soon as the **network increases in scale and the software is protected**, the corresponding **business model will result in a competitive advantage for 3D Ways**.

Looking at its current product portfolio, the condition of scarcity is represented in its range of products of services. Indeed, currently the company's main business core is the production of 3D products according to customer orders. While, the network of 3D printing factories is still to become 3D Ways' business core.

4. NETWORK

The fourth dimension, is extremely crucial for 3D Ways. Even though literature has still not set specific boundaries and characteristics to distinguish a *Born Global* firm from a traditional firm, it is possible to assume that the company's business model must rely on the characteristics before described for the networking theory. Moreover, the concept of value network helps to link the concept of the network theory with 3D Ways' workflows.

It is important to state that at the current stage, the company still does not rely on these characteristics. However, due to their business model and intention to internationalize, it is likely to assume that in the close future, it will be possible to find supporting premises for this specific dimension.

After the literature review on the first slide of this section, the following introduction illustrates the four dimensions which are decisive to determine if a firm can operate as a *Born Global* firm. Specifically, this slide assesses the motives that explain why 3D Ways can be considered a *Born Global* firm. For these **four dimensions**, it has been provided a **match to the characteristics of 3D Way**. As a result, **3D Ways possesses the main components which are illustrated according to the literature on this topic**. A special consideration has been made on the fourth dimension, *Network*. Since the remote-control service is still at an early stage, it can only be considered (so far as) a business model. It is legitimate to assume, that **once the network increases in scale as the company internationalizes, it will be possible to observe significant results**. Therefore, and for the remainder of this analysis, 3D Ways will be considered a *Born Global* firm and the related strategies will be applied.

Global Readiness

Motives to Internationalize

MOTIVES

According to Dunning(1993) a firm seeks internationalization for four different motives: market-seeking, efficiency-seeking, resource-seeking and asset-seeking.

Market-seeking motives are represented by following (or seeking) customers abroad. **Efficiency-seeking motives** are for companies aiming at lowering their costs of economic activities or monitoring their foreign-based activities. **Resource-seeking** are mainly for companies that seek for resources abroad, as these are accessible at lower costs or not available in their home market. Lastly, **asset-seeking** motives are represented by the aim of exploiting new assets abroad. Particularly, these are usually related to technology and R&D products.

Considering the different motives illustrated by Dunning (1993), it is plausible to state that 3DWAYS is seeking mainly internationalization for a **market-seeking purpose**.

In order to pursue an internationalization process, a company can adopt two different strategic approaches: reactive or proactive. If a company decides to follow the major customers abroad, is pursuing a reactive strategy. On the other hand, if the firm is seeking higher growth market abroad is pursuing a proactive strategy. Indeed, the strategy that 3DWAYS is pursuing is primarily **proactive**, since its aim is to gain access to new and more profitable markets. In fact, 3DWAYS aims at following key customers with greater purchasing power.

PUSH FACTORS

The push factors represents those circumstances in 3DWAYS' domestic market that motivate it to enter into new markets.

Considering 3DWAYS' domestic market, two main limitations can be found. They are represented by a **limited home market where the 3D printing industry market is not fully developed at this stage** and the **market adoption rate of this technology which is still low**. This is affecting customer awareness. Consequently, this illustrates a low and unstable domestic demand. This is particularly noticeable when compared with similar markets, like Spain or Italy.

PULL FACTORS

The pull factors represents the circumstances in international markets that create an opportunity for the company.

For 3DWAYS is **essential to scale its network**. By doing so, the company could achieve a competitive advantage. Additionally, the company should **seek for a profit advantage** reaching new and more developed markets in 3DP and consequently a higher adoption rate. This would allow 3DWAYS to increase sales and extend the customer base.

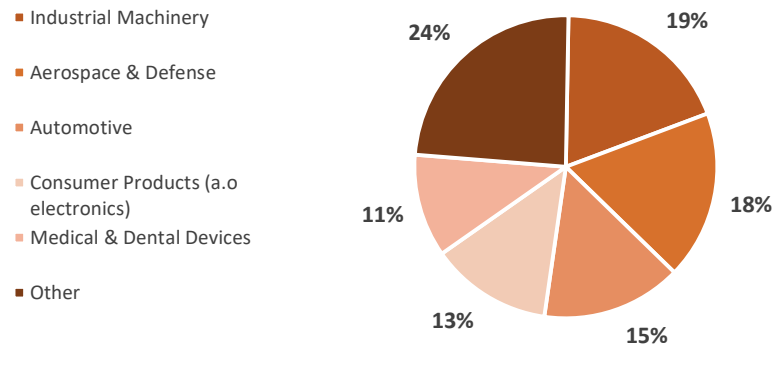
The **essence of a Born Global firm is to seek an early and rapid internationalization**. However, deep diving the **motives for 3DWAYS to internationalize** the **market-seeking** reason seems the most appropriate. The business model based on a network and remote-control service could be successful if applied on a large and international customer base.

Sectors Overview

Current 3DP Applications across Different Industries

Although 3D Ways has already defined the scope of the project as focusing its international activities in the healthcare sector, it was decided to conduct an **overview of different sectors** with the aim of assessing which is the one where **3DP technology** is expected to play a **more disruptive role** in the future. Performing a further analysis seems to be needed due to the **high degree of uncertainty** that is characterizing 3DP technology and its related applications.

Share in sales of 3D printers (2016)

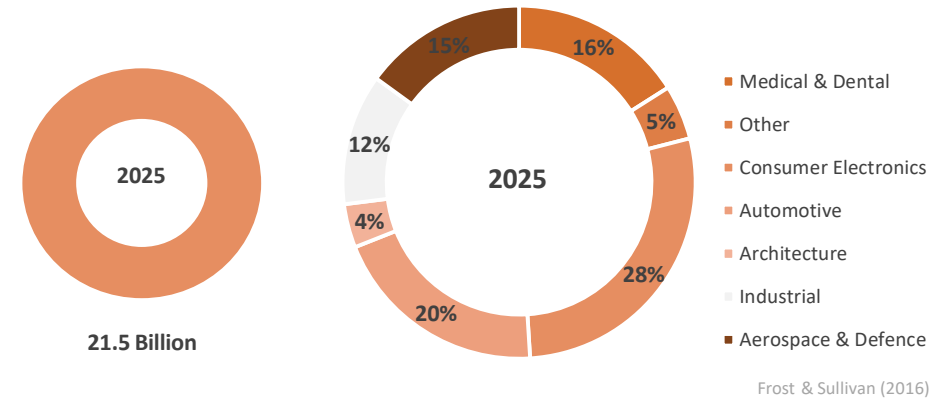


Currently, there are five industries where 3DP technologies have been adopted for a longer time, representing the largest buyers of printers and related services: **industrial machinery** (19%), **aerospace and defence** (18%), **automotive** (15%), **consumer products** (i.e. electronics) (13%) and **medical and dental devices** (11%). Particularly, they account for 75% of all investments in 3D printing, with **industrial machines and aerospace and defence** ranging between 15-20% share in total 3DP investments, while **consumer products and medical and dental** standing between 10-15%.



With relatively small gaps among all the sectors, it is possible to state that **medical and dental** is nowadays **slightly underdeveloped** compared to the other industries. However, since 3DP technologies are rapidly subject to disruptive forces, it is necessary to not only evaluate **the current status** but rather the **future trends** that are going to shape the landscape in which 3D Ways will operate.

Global Revenue Generation in Manufacturing Sectors (2025)



AIRCRAFT

CAGR (2015-2025): 26%

- **Opportunities:** out-of-production legacy aircraft, spares' availability in remote locations.
- **Challenges:** regulatory approval, manufacturing large parts, cybersecurity.

AUTO MOTIVE

CAGR (2015-2025): 36%

- **Opportunities:** on-site fabrication, optimized delivery time and spares' availability.
- **Challenges:** high-volume production, manufacturing large parts, copyright concerns.

MEDICAL

CAGR (2015-2025): 23%

- **Opportunities:** on-site bio-printing tissues and organs, on-site drug dosage and delivery.
- **Challenges:** unrealistic expectations and hypes, regulatory approval, counterfeit medications, copyright concerns.

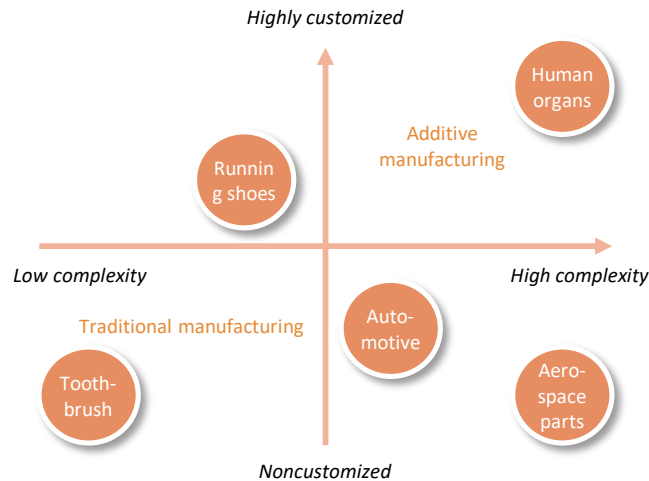
Frost & Sullivan (2016)

Sectors Overview

Healthcare as 3D Ways' Best Option

CUSTOMIZATION AND COMPLEXITY

In order to assess the potential impact of 3D printing, it is necessary to look closer at the **characteristics** of the **products** that the different industries are offering, since **each sector** will be **affected** according to the **positioning** of their **core products** among **two dimensions of disruption: customization** and **complexity**. 3D printing will be more advantageous when applied to highly customized products with a high degree of complexity, for which the traditional manufacturing process results extremely unprofitable, especially due to its high complexity costs (compared to 3DP).



Rand Corporation (2018)

Medical and Dental devices, ranging from implants and stents to the most innovative bio-printing applications of human organs and tissues, distinguish themselves for the need of **high-end personalized** and **complex internal structures**, which require a time-consuming production process. In particular, **orthopaedics** is expected to remain the **most profitable segment** for AM in healthcare, accounting for 44% of overall market for 3DP medical devices.

3DWAYS' FITNESS

Firstly, the **Aerospace and Defence** industry does not represent currently a viable option for 3D Ways mainly due to the **seed stage** in which the company currently operates. In fact, because of the scarce financial and organizational resources, 3D Ways does not seem ready to penetrate such **high-demanding** industry in terms of **quality certifications**, to which a more added weight is given compared to other sectors. Although standardization rules for safety of air and space crafts are still undeveloped, the *European Aviation Safety Agency* and *Federal Aviation Administration* identified a list of concerns regarding 3DP qualifications, especially in terms of terminology standards, standard test artefacts, requirement for purchased AM components and design guidelines.

Secondly, the **Automotive** industry does not represent the best suitable alternative for 3D Ways since **3DP** is already on a **relatively advanced stage**. 3D printing potential strategic importance, regarding both the production process and the aftermarket service, for which delivery time and parts availability are at the basis of the competition, will lead companies operating in the **Automotive** industry to invest on their **fully-own set of 3D printers**. Thus displaying a **lower potential interest** in the **networking** component of 3D Ways' service. In fact, the need for large-volume **production** will probably force car manufacturers to not be dependable on third-party service providers, investing on having on-site engineers and technicians with the necessary expertise in 3DP technology.

Finally, the **Medical and Dental** industry provides with greater probability the **most significant growth opportunities** for 3D Ways, as a result of its value proposition. In particular, the healthcare sector, referring especially to both public and private hospitals, is characterized by a **lack of technical expertise** in both **traditional** and **additive manufacturing**, since neither of them are part of their core business. This crucial aspect opens up a great market potential for 3D Ways, whose remote management control system aims at supplying unexperienced clients in the medical field with 3DP expertise. Moreover, healthcare facilities greatly benefit from the manufacturing network due to the limited investment capacity in advance 3DP assembling technologies and the possibility to monetize 3D printers' idle time.

Sectors Overview

Opportunities and Threats in Healthcare

KEY DRIVERS AND TRENDS

Regarding the **Healthcare** sector, it is possible to identify **two different key drivers** which can either promote or prevent the adoption of 3DP technologies among medical facilities, namely technology and regulation. A **synergy between technological advancements and regulatory efforts is necessary to fully explore the disruptive role that 3DP can play in the industry.**

For both drivers, an optimistic and a pessimistic trend can be suggested, which combined together can generate four different scenarios, namely *underground*, *regulatory driven niche*, *technology driven niche* and *mainstream*. Each of them can represent a possible future representation of the 3DP industry related to the medical sector.

	Technology	Regulation
Optimistic	<ul style="list-style-type: none"> Development of biocompatible materials and multi-material printers. Competitive 3DP market structure compared to traditional medical device production. 	<ul style="list-style-type: none"> Establishment of specific standards for 3D printing. Clear and structured regulation will allow for 3DP applications' diversification.
Pessimistic	<ul style="list-style-type: none"> Limitations on biocompatible materials and multi-materiality printers. Uncompetitive 3DP market structure, not allowing for realistic devices in a short time. 	<ul style="list-style-type: none"> Establishment of production standards only for certain sectors, with no major progress in healthcare. Unclear and unstructured regulation will lead to 3DP applications' limitations.

Deloitte (2018)

FOUR POSSIBLE SCENARIOS

	Pessimistic	Optimistic
Pessimistic	<p>UNDERGROUND</p> <ul style="list-style-type: none"> Regulatory framework will be incremental, favouring the adoption of 3DP but having a limited impact. 3DP technologies and materials will grow exponentially but, regarding the medical sector, such technologies will be unavailable, unusable or too expensive. 	<p>REGULATORY DRIVEN NICHE</p> <ul style="list-style-type: none"> Regulatory framework will maximise the use of 3DP materials and technologies, allowing to print many types of medical devices in hospitals or in pharmacies. 3DP technologies and materials will grow exponentially but applications in the healthcare sector will not grow proportionally.
Optimistic	<p>TECHNOLOGY DRIVEN NICHE</p> <ul style="list-style-type: none"> Regulatory framework will be incremental, favouring the adoption of 3DP but having a limited impact. 3DP technologies and materials will continue to evolve, leading the health sector to increase the use of 3DP in all fields. 	<p>MAINSTREAM</p> <ul style="list-style-type: none"> Regulatory framework will push the transformation of health sector towards 3DP in all its applications as a result of defining production standards etc. 3DP technologies and materials will become mainstream, spreading in every hospital with specialized technicians and favouring the diffusion of customized medicine.

Deloitte (2018)

According to the EU Commission (2015), bio-printing applications, as a result of biocompatible inks, are forecasted to grow significantly, reaching a 20% market share of the overall 3DP market for medical devices by 2026. On the other side, in terms of 3DP technologies, advancements in inkjet and polyjet are most likely to reach a peak over the next 10 years. Finally, regarding improvements on legislative frameworks, the *U.S. Food and Administration Authority (FDA)* released 3DP manufacturers guidelines, namely "*Technical Considerations for Additive Manufactured Medical Devices*", whose specifications are likely to be adopted and improved by other nations.

After describing all the four possible landscapes, the most disruptive scenario named **Mainstream** can be considered as the most probable one, which is a conclusion based on the current paths that 3DP is nowadays already undertaking both in terms of technology and regulation.

2. INTERNATIONAL MARKET SELECTION

- Selection Criteria
- Country Screening:
 - Country Clustering Analysis
 - Country Ranking Analysis
- Selection of Final Countries

International Market Selection

Selection Criteria

COUNTRY SELECTION PROCESS

3D Ways is a company that operates in the 3D printing industry. This industry is currently at a premature stage since it is based upon a technology that is rapidly growing. However, it is still embryonic compared to its full potential. Finding concrete data for this industry, especially on a country level to its full extent, was extremely difficult. Therefore, it was necessary to develop proxies and restructure indexes to create an analysis that is as similar as possible to the reality of the industry on a global level.

Additionally, there are a few countries that missed values on indexes and variables. Thus, some proxies were established using countries that were similar on an economic, judicial, innovative, cultural and development basis to those in question. For economic indexes and variables, the *GDP PPP per capita* was used as weight. For judicial indexes and variables, the weight used was the *Rule of Law Index* and for innovation indexes and variables, the *Global Innovation Index* was the weight chosen.

Out of 195 countries in the world, 100 countries were removed because they lacked data across the majority of indexes and variables chosen for the analysis. If proxies were established between these countries and similar ones, the validity of the analysis would be affected because of the high amount of data that would have been needed to estimate. Therefore, 95 countries were chosen for the Country Clustering and Country Ranking analysis, which are presented on the right.

Note: For indexes that integrate a lot of variables, e.g. *Economic Freedom Index* and *Ease of Doing Business Index*, the raw data was extracted. This was done with the purpose of not interfering with the standardization of the final score, when countries were removed from the sample for the Country Clustering and Country Ranking analysis. This way, when the standardization of the final scores was done with the final data, it remains valid.

COUNTRY LIST – 95 COUNTRIES

- | | | | |
|--------------------------|------------------------|----------------------|------------------------|
| • Algeria | • Egypt, Arab Rep. | • Lebanon | • Senegal |
| • Angola | • El Salvador | • Lithuania | • Serbia |
| • Argentina | • Estonia | • Luxembourg | • Singapore |
| • Australia | • Finland | • Malaysia | • Slovak Republic |
| • Austria | • France | • Malta | • Slovenia |
| • Azerbaijan | • Georgia | • Mexico | • South Africa |
| • Bahrain | • Germany | • Moldova | • Spain |
| • Belgium | • Greece | • Morocco | • Sri Lanka |
| • Bolivia | • Guatemala | • Mozambique | • Sweden |
| • Bosnia and Herzegovina | • Honduras | • Namibia | • Switzerland |
| • Botswana | • Hong Kong SAR, China | • Netherlands | • Thailand |
| • Brazil | • Hungary | • New Zealand | • Tunisia |
| • Bulgaria | • Iceland | • Nigeria | • Turkey |
| • Cameroon | • India | • Norway | • Uganda |
| • Canada | • Indonesia | • Oman | • Ukraine |
| • Chile | • Iran, Islamic Rep. | • Pakistan | • United Arab Emirates |
| • China | • Ireland | • Paraguay | • United Kingdom |
| • Colombia | • Israel | • Peru | • United States |
| • Costa Rica | • Italy | • Philippines | • Uruguay |
| • Croatia | • Japan | • Poland | • Vietnam |
| • Cyprus | • Jordan | • Portugal | |
| • Czech Republic | • Kazakhstan | • Qatar | |
| • Denmark | • Kenya | • Romania | |
| • Dominican Republic | • Korea, Rep. | • Russian Federation | |
| • Ecuador | • Latvia | • Saudi Arabia | |

International Market Selection

Selection Criteria

EXPLANATION

With the intent of including the *Global Competitiveness Index* in the upcoming Country Clustering & Country Ranking analysis, it was required to eliminate a selected number of variables from this index as they would generate redundancy, or some were not appropriate since they did not resemble the characteristics of the industry.

With the extracted variables, it was performed via *SPSS* a *principal component analysis*, but with a slightly different purpose compared to the traditional scope assumed in the country clustering. In fact, the goal was to assess the correlation between these variables in order to join them together and create an index(es) for the upcoming analysis.

The output shows 3 different components and the respective correlation with each variable. Based on the values of the correlations, three distinct indexes were developed by agglomerating the variables with the highest values in each component (as shown in the figure on the right). Thus, resulting in the following indexes: **Innovation Ecosystem**, measuring the institutional, economic and behavioural propensity towards innovation, **Protection of Inventions**, considering property rights applications, and **R&D investments**, consisting in the R&D developments in terms of expenditures and prominence.

These three indexes were included both in the upcoming Country Clustering and Country Ranking analysis.

FACTOR ANALYSIS OUTPUT & RESULTING INDEXES

	Rotated Component Matrix ^a		
	Component		
	1	2	3
Companies embracing disruptive ideas ^b	,886		
Growth of innovative companies	,883		
Multistakeholder collaboration	,877	,354	
Attitudes towards entrepreneurial risk	,845		
Financing of SMEs	,825	,308	
Willingness to delegate authority ^c	,803	,395	
Future Orientation of Government	,791		
State of cluster development	,788	,402	
Diversity of workforce	,779		
Buyer sophistication	,767	,377	
Ease of finding skilled employees	,736		
Digital skills of population	,729	,446	
Competition in Services	,653	,354	
Trademark applications		,796	
International co-inventions	,481	,774	
Patent applications	,491	,754	
R&D expenditures			,826
Research institutions prominence	,393		,500

Innovation Ecosystem

Future Orientation of Government	Growth of innovative companies
Digital skills of population	Companies embracing disruptive ideas
Ease of finding skilled employees	Diversity of workforce
Competition in Services	State of cluster development
Financing of SMEs	Multi-stakeholder collaboration
Attitudes towards entrepreneurial risk	Buyer sophistication
Willingness to delegate authority	

Protection of Inventions

International co-inventions
Trademark applications
Patent applications

R&D Investments

R&D expenditures
Research institutions prominence

International Market Selection

Selection Criteria

Group	Weight	Indexes	Sub-Indexes	Description	Year
Economic Variables	5%	Market Size	Domestic Market Size Index	Sum of gross domestic product plus value of imports of goods and services, minus value of exports of goods and services, normalized on a 1–7 (best) scale	2017
			Foreign Market Size Index	Value of exports of goods and services, normalized on a 1–7 (best) scale	
			GDP (PPP)	Gross domestic product valued at purchasing power parity (PPP) in billions of international dollars	
			Exports (% GDP)	Exports of goods and services as a percentage of gross domestic product	
	2.5%	Market Intensity	GNI per Capita (PPP)	GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad.	2017
			Private Consumption (% GDP)	Measures the consumer expenditure as a percentage of the country GDP.	
	5%	Market Growth	GDP Growth Rate (Annual Percentage)	It measures economic growth as it relates to the gross domestic product (GDP) from one period to another, adjusted for inflation, and expressed in real terms as opposed to nominal terms.	2017
	2.5%	Market Consumption Capacity	Consumer Expenditure	Consumer spending is the total money spent on final goods and services by individuals and households for personal use and enjoyment in an economy.	2017
			Median Disposable Income per Household	Measures the average of every form of income, near cash government transfers and investment gains in a household. Used as an indicator for the monetary well-being of a country's citizens.	
			Middle Class Households % of the total Households	Income Share of Middle-Class Households as a percentage of the total Households	
	2.5%	Ease of Doing Business Index	Starting a Business	Procedures, time, cost, and minimum capital to open a new business	2018
			Dealing with Construction Permits	Procedures, time, and cost to build a warehouse/office	
			Getting Electricity	Procedures, time, and cost required for a business to obtain a permanent electricity connection for a new warehouse/office	
Getting Credit			Strength of legal rights index, depth of credit information index		
Protecting Minority Investors			Indices on the extent of disclosure, extent of director liability, and ease of shareholder suits		
Paying Taxes			Number of taxes paid, hours per year spent preparing tax returns, and total tax payable as share of gross profit		
Trading across Borders			Number of documents, cost, and time necessary to export and import		
Enforcing Contracts			Procedures, time, and cost to enforce a debt contract		
Resolving Insolvency	The time, cost, and recovery rate (%) under bankruptcy proceeding				

International Market Selection

Selection Criteria

Group	Weight	Indexes	Sub-Indexes	Description	Year
Economic Variables	5%	Economic Freedom	Government Size	Government Spending, Tax Burden, Fiscal Health	2018
			Regulatory Efficiency	Business Freedom, Labor Freedom, Monetary Freedom	
			Open Markets	Trade Freedom, Investment Freedom, Financial Freedom	
	5%	Macroeconomic Variables	Manufacturing, Value Added	Measures the manufacturing output of a country's economy	2017
Services, Value Added			Measures the services output of a country's economy		
Trade (%GDP)			The trade-to-GDP ratio is an indicator of the relative importance of international trade in the economy of a country. It is calculated by dividing the aggregate value of imports and exports over a period by the gross domestic product for the same period.		
Innovation Variables	7.5%	Logistic Performance Index	High Technology Exports	High-technology exports are manufactured products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery.	2018
			Customs	The efficiency of customs and border management clearance.	
			Infrastructures	The quality of trade- and transport-related infrastructure.	
			International Shipments	The ease of arranging competitively priced international shipments.	
			Logistics Competence	The competence and quality of logistics services.	
	10%	Intellectual Property Rights Index	Tracking and Tracing	The ability to track and trace consignments.	2018
			Timeliness	The frequency with which shipments reach consignees within the scheduled or expected delivery time.	
			Legal and Political Environment	Judicial Independence, Rule of Law, Political Stability and Control of Corruption	
	10%	Global Innovation Index	Physical Property Rights	Protection of Physical Property Rights, Registering Property, Ease of Access to Loans	2018
			Intellectual Property Rights	Protection of Intellectual Property Rights, Patent Protection, Copyright Piracy	
10%	Global Innovation Index	Innovation Input Sub-Index	Institutions, Human Capital and Research, Infrastructure, Market Sophistication and Business Sophistication	2018	
		Innovation Output Sub-Index	Knowledge and Technology Outputs, Creative Outputs		

International Market Selection

Selection Criteria

Group	Weight	Indexes	Sub-Indexes	Description	Year
Innovation Variables	10%	Information and Communication Technology Index	ICT access	Fixed-telephone subscriptions per 100 inhabitants, Mobile-telephone subscriptions per 100 inhabitants, International internet bandwidth per internet user, % of households with a computer, % of households with internet access	2018
			ICT use	% of individuals using internet, fixed broadband subscriptions per 100 inhabitants, Active mobile broadband subscriptions per 100 inhabitants	
			ICT skills	Mean years of schooling, Secondary gross enrolment ratio, Tertiary gross enrolment ratio	
	10%	Global Competitiveness Report	Innovation Ecosystem	Future Orientation of Government, Digital Skills of the Population, Ease of Finding Skilled Employees, Competition in Services, Financing of SMEs, Attitudes Towards Entrepreneurial Risk, Willingness to Delegate Authority, Growth of Innovative Companies, Companies Embracing Disruptive Ideas, Diversity of Workforce, State of Cluster Development, Multistakeholder Prominence, Buyer Sophistication	2018
			R&D Investment	R&D expenditures, Research institutions prominence	
			Protection of Inventions	Patent Applications, International Co-inventions, Trademark Applications	
	2.5%	Energy Infrastructure	-	Quality of the energy infrastructure in each country ranked from 0-7	2018
2.5%	Availability of Scientists and Engineers	-	To what extent are scientists and engineers available, ranked from 0-7	2018	
2.5 %	Average Monthly Wage (After- Tax)	-	Average Net Income of take-home pay remaining after all withholdings and deductions removed from a person's salary		
Health Variables	7.5%	Current Health Expenditure (%GDP)	-	Current health expenditure is the sum of public and private health expenditures as a ratio of the GDP. It includes healthcare goods and services consumed during each year. This indicator does not include capital health expenditures such as buildings, machinery, IT and stocks of vaccines for emergency or outbreaks.	2016
		Healthcare Index	-	Health Care Index is an estimation of the overall quality of the health care system, health care professionals, equipment, staff, doctors, cost, etc.	
Environmental Variables	2.5%	Environmental Performance Index	-	The 2018 Environmental Performance Index (EPI) ranks 180 countries on 24 performance indicators across ten issue categories covering environmental health and ecosystem vitality. These metrics provide a gauge on a national scale of how close countries are to meeting established environmental policy goals.	

International Market Selection

Selection Criteria

Group	Indexes	Justification
Economic Variables	Market Size	Market Size, as a combination of national and foreign markets, gives a concrete representation of the size of an economy, going beyond its political boundaries. By impacting on the overall national productivity in terms of economies of scale and incentives for innovation, it is particularly relevant for 3DWays due to its aspiration for scalability and its innovative service offering.
	Market Intensity	Market Intensity refers to the factors that will most drastically affect prices and demand for goods. It was important to include in this analysis to assess fluctuations in the market. Huge fluctuations can impact the company because of its small structure
	Market Growth	Related to the market size, it is important to assess and estimate the future growth of markets that 3DWays wishes to enter.
	Market Consumption Capacity	By measuring the overall economic well-being of residents, especially related to the middle-class category, Market Consumption Capacity represents a good proxy for the national purchasing power. In particular, 3DWays aims at targeting companies and sectors that distinguish themselves for high opportunities of spending.
	Ease of Doing Business Index	Although 3DWays is not expecting to open any facility throughout its international process, Ease of Doing Business has been included in the analysis due to its nature of B2B business. In fact, having in place a regulatory framework, which facilitates corporations in its operations of starting a business, accessing finance and dealing with day-to-day activities, is essential to create an environment in which enterprises can easily flourish.

Group	Indexes	Justification
Economic Variables	Economic Freedom	The <i>Economic Freedom Index</i> represents a fundamental dimension expressing the intensity of institutional boundaries imposed on the society in terms of human, financial and goods movements. Operating in an economically-free environment, characterized by high degrees of regulatory efficiency and markets' openness, can facilitate 3DWays accessing and eventually exiting the foreign country.
	Macroeconomic Variables	Besides the macro-economic variables included in the previous indexes, also other factors, such as Manufacturing (Valued Added), Services (Value Added), Trade (%GDP) and High Technology Exports, are necessary to be included in the analysis because 3DWays operates in the Manufacturing (sells 3D printed objects and assembles printers) and in the Services (remotely managed 3D printers) market.
	Logistic Performance Index	The <i>Logistic Performance Index</i> is an essential indicator concerning the 3D printing industry: there is little sense of adopting 3DP technology when finished products or their parts can be easily obtained from nearby retailers. This occurs especially in the case of 3DWays, as a result of the business model innovation which 3DWays is offering to its clients, based on the remote-control management. In fact, the benefits of a value network, in which 3DWays is operating as intermediary among its customers, are fully maximized in case of underdeveloped infrastructure and logistic capacity.
Innovation Variables	Intellectual Property Rights Index	The <i>Intellectual Property Rights Index</i> is another indicator which embodies one of the main challenges preventing the 3DP industry to easily grow. IP protection for 3D designs is an on-going industry concern, thus the governments' efforts in limiting risks of counterfeiting is essential for 3DWays to enter in the 3DP ecosystem with more confidence.
	Global Innovation Index	The <i>Global Innovation Index</i> is essential to assess both the resources dedicated to innovation advancements and the outcomes achieved as a result of the investments in innovation. Therefore, 3DWays should target a country in which innovation is a crucial driver of the overall economy, especially due to its radically disruptive service. In fact, an innovation mind-set from different players (e.g. policymakers, corporations and consumers) is required to guarantee a higher adoption rate.

International Market Selection

Selection Criteria

Group	Indexes	Justification
Innovation Variables	Information and Communication Technology Index	Due to the nature of 3DWays offering, relying on an online software implantable on the 3D printing machines, the <i>Information and Communication Technology Index</i> provides a good proxy for the national ICT readiness, assessing the advancements of not only ICT infrastructure (access) but also the ICT use (intensity) and capabilities (skills).
	Global Competitiveness Report	<p>Within all the variables included in the <i>Global Competitiveness Index</i>, three sub-indexes have been generated with the qualitative dimensions that can be considered as mostly relevant to 3DWays' success:</p> <ul style="list-style-type: none"> - <i>Innovation Ecosystem</i>, enclosing the mind-set towards innovation, namely Future Orientation of Government, Financing of SMEs, Attitudes toward Entrepreneurial Risk, Willingness to Delegate Authority, Multistakeholder Collaboration, Buyer Sophistication, along with the resources available to technological advancements, namely Digital Skills of Population, Easy of finding Skilled Employees, Diversity of Workforce, State of Cluster Development, and the success of companies prioritizing innovation within their corporate strategy, namely Growth of Innovative Companies, Companies embracing Disruptive Ideas, Competition in Services. - <i>Protection of Inventions</i>, including specifically the number of trademarks and patents, as well as the number of international co-inventions. - <i>R&D Investments</i>, considering not only the R&D expenditure as a % of GDP but also the prominence of public and private research institutions.
	Energy Infrastructure	Due to the nature of 3DWays offering, especially its remote printing service, it is important to assess the level of energy infrastructure in each country, since the company relies on it to perform its service.
	Availability of Scientists and Engineers	This variable was included in the analysis because some companies who rely on engineers, especially where wages are extremely high, may be looking for alternative solutions, such as 3DWays remote printing service which is a significantly cheaper solution compared to having a present engineer in the company. Combined with the index below, it was used as a proxy to assess the previously mentioned reasoning.
Health Variables	Average Monthly Wage (After- Tax)	Average Monthly Wage (After Tax) is been used as a proxy for capturing the value of engineers' salaries. The more expensive is for companies to have in-house engineers with an expertise in 3DP, the more 3DWays represents a good opportunity for cost savings.
	Health	Due to the focus of 3DWays on medical industry, it was necessary to introduce healthcare-specific variables in the preliminary screening. Together with the healthcare expenditure as % of GDP, the <i>Healthcare Index</i> allows 3DWays to evaluate national health systems, in particular in terms of equipment for modern diagnosis and treatments.
Environmental Variables	Environmental Performance Index	The <i>Environmental Performance Index</i> , assessing both the Environmental Health and the Ecosystem Vitality, expresses the progress that each national is implementing towards environmental sustainability. Higher awareness concerning the environmental impact that both corporations and individuals can cause with their actions is at the base of 3DP technology, whose benefits include mainly reduced waste generation.

International Market Selection

Country Screening: Country Clustering & Country Ranking

INDEXES GENERATION - WEIGHTS

In light of the fact that the company operates in a new industry that is mostly shifted by innovation and technology, some changes were made on the weights of compounded indexes that integrate a vast number of variables such as the *Economic Freedom Index* and the *Ease of Doing Business Index* (For the *Global Competitiveness Report*, it was used a different procedure that is explained in the following slide).

Firstly, the *Economic Freedom Index* has four sub-indexes (*Property Rights*, *Government Size*, *Regulatory Efficiency* and *Open Markets*), each of them composed by a large set of indicators. The final score is calculated by doing the average of the scores obtained for every sub-index. Since we already included the *Intellectual Property Rights Index*, which is a more complete index that better fits the purpose of the project, the *Property Rights* sub-indexes were removed from the *Economic Freedom Index*. With the remaining three sub-indexes, instead of calculating the average, different weights were given to each variable that composed the sub-indexes. By doing so, this method better suits the characteristics of the industry and sector that 3Dways is looking to operate in. *Business and Investment Freedom* are the variables to which a higher weight (20%) has been assigned due to the importance for 3Dways to be able to easily conduct their business and move their financial resources in and out of the selected country with the lowest possible restrictions. A 15% weight has been attributed to both *Monetary and Financial Freedom*, with the aim of favoring price stability and banking efficiency. Particularly, price represents a key factor on which 3Dways can potentially establish its differentiation strategy compared to its international competitors. *Government Spending*, *Tax Burden*, *Fiscal Health* and *Trade Freedom*, each weigh 5% and are ranked as the least relevant dimensions since all of them are included in further detailed indexes, which provide a deeper representation of the intended factors. The same criteria was used to calculate the *Ease of Doing Business Index*. Instead of following the original method, which determined that each sub-index has the same weight, it was decided to change the weights to better suit the characteristics of the markets that 3Dways is looking to operate in. The same criteria was used to calculate the *Ease of Doing Business Index*. Instead of following the original method, which determined that each sub-index has the same weight, it was decided to change the weights to better suit the characteristics of the markets that 3Dways is looking to operate in. Two variables were withdrawn from this Index, *Dealing with Construction Permits* and *Registering Property*, since they did not reflect the in any circumstance the characteristics of the markets. With a total of 25%, *Starting a Business* represents the most highly weighted variable within the *Ease of Doing Business Index* since it is not only essential in the context of international expansion, but it also embodies a critical factor for the future customers that the company can potentially target in a foreign country. The same logic can be extended to the other highly weighted variables, namely *Getting Credit* with 17.5% and *Paying Taxes* with 15%. 3Dways needs to expand where there can be a nourishing business environment, where corporations can easily operate and grow with the lowest judicial burdens, *Enforcing Contracts* and *Resolving Insolvency* are equally ranked with a 15% weight. For *Getting Electricity*, a weight of 5% was assigned since electricity is crucial for 3Dways' service to work. Lastly, 5% was given to *Trading Across Borders*, since some printers inside the global network may be required to produce products that can be more easily shipped to neighboring countries than shipping them from the companies' origin country.

COUNTRY RANKING ANALYSIS

After the Country Clustering analysis, it was performed the Country Ranking Analysis. The same variables were used as before since all were valuable for the analysis. The goal was to combine this analysis with the Cluster analysis to reduce the number of countries to five potential country markets to further advance with the project and initiate the in-depth market analysis.

To form the final country ranking, different weights were given to the 18 Indexes, combining in a total weight of 100%. The weights were distributed to reflect the characteristics of the 3DP industry and the specific features of the service that 3Dways offers to their clients. Therefore, the highest weight, 10%, was given to the variables included in the *Innovation Group: Intellectual Property Rights Index* because of the importance of protecting the software for the majority of 3DP companies that rely on software as their main source of profit. In 3Dways' specific case, it is important to protect the software, because of its features even though it is not the only source that allows the company to achieve a competitive advantage and scale the network. Also, to the *Global Innovation Index*, the *Information and Communication Technology Index* and the *Global Competitiveness Report* since it is important to the company to enter a market that has a high adoption rate of this technology and where country demand can be potentially higher and more stable than in Portugal. Additionally, a 7.5% weight has been attributed to the variables in the *Health Group*, namely *Current Health Expenditure* and the *Healthcare Index*, as 3Dways has expressed its desire to focus on the healthcare segment for its international expansion. The same weight was given to *Logistics Performance Index* since the company innovative business model perpetuated through the remote-management service is more likely to thrive in countries with a lower level of infrastructure development. *Market Size*, *Market Growth*, *Economic Freedom* and the remaining *Macroeconomic variables* were given a weight of 5%. When internationalizing the company should always take into consideration the economic environment in each country, expressed vastly by these indicators. However, some of the indicators within the Economic indexes can play a more significant role compared to others. Particularly, *Market Intensity* and *Market Consumption Capacity* were given a lower weight of 2.5%. Even though they are used to assess the market potential of each country, they are related to the B2C sphere while 3Dways operates in the B2B sphere. Also, to the *Ease of Doing Business Index* because of the nature of the remote service, the company can operate from its home country and does not have the need to open a physical subsidiary in another country. *Availability of Scientists and Engineers* and *Average Monthly Wage (After-Tax)* have been included in the analysis only as a proxy for the number of engineers and the average amount of their salary. While the *Environmental Performance Index* has been used as a representation of the trends of corporate social responsibility. These variables received a weight of 2.5% since their intrinsic value is not as accurate as the ones included within the *Innovation Group*. Lastly, *Energy Infrastructure* received the same weight since it is important to assess the energy infrastructure in each country as 3Dways' solution relies on it. For each country, the standardized score of each of the 18 indexes was multiplied by the respective weight. Adding up all these values resulted in the final score for each country. Finally, countries were ranked based on their score, the first one being the highest scoring country. The fifty highest ranking countries are shown in slide 41.

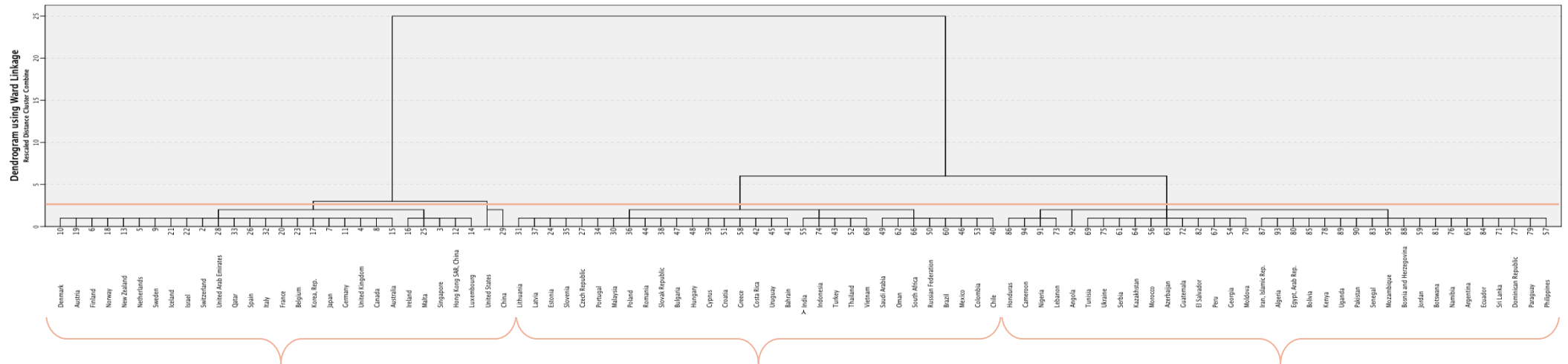
International Market Selection

Country Screening: Country Clustering

COUNTRY CLUSTERING



For the Country Analysis explanation, please check Appendix 6)



CLUSTER #1

1. Denmark	12. Qatar	23. Ireland
2. Austria	13. Spain	24. Malta
3. Finland	14. Italy	25. Singapore
4. Norway	15. France	26. Hong Kong
5. New Zealand	16. Belgium	27. Luxembourg
6. Netherlands	17. Korea, Rep.	28. United States
7. Sweden	18. Japan	29. China
8. Iceland	19. Germany	
9. Israel	20. United Kingdom	
10. Switzerland	21. Canada	
11. UAE	22. Australia	

CLUSTER #2

1. Lithuania	12. Hungary	23. Vietnam
2. Latvia	13. Cyprus	24. Saudi Arabia
3. Estonia	14. Croatia	25. Oman
4. Slovenia	15. Greece	26. South Africa
5. Czech Republic	16. Costa Rica	27. Russian Federation
6. Portugal	17. Uruguay	28. Brazil
7. Malaysia	18. Bahrain	29. Mexico
8. Poland	19. India	30. Colombia
9. Romania	20. Indonesia	31. Chile
10. Slovak Republic	21. Turkey	
11. Bulgaria	22. Thailand	

CLUSTER #3

1. Honduras	12. Guatemala	23. Mozambique
2. Cameroon	13. El Salvador	24. Bosnia Herzegovina
3. Nigeria	14. Peru	25. Jordan
4. Lebanon	15. Georgia	26. Botswana
5. Angola	16. Moldova	27. Namibia
6. Tunisia	17. Iran, Islamic Rep.	28. Argentina
7. Ukraine	18. Bolivia	29. Ecuador
8. Serbia	19. Kenya	30. Sri Lanka
9. Kazakhstan	20. Uganda	31. Dominican Republic
10. Morocco	21. Pakistan	32. Paraguay
11. Azerbaijan	22. Senegal	33. Philippines

The final result of the Country Clustering is presented in the figure above. The line for the Rescaled Distance Cluster Combine was set a 2.5, resulting in identification of three separate clusters. The first cluster is composed by the countries which scored the highest in the country ranking, meaning that the cluster is composed by countries which are more prone to innovation, have higher levels of economic, financial and judicial development and lower levels of country risk. The second cluster is composed by countries that have medium scores on the country ranking, showing small to medium levels of innovation, medium to high levels of economic, financial and judicial development and some country risk. Finally, the third cluster is composed by the countries that have scored the lowest on the country ranking, having almost no incentives towards innovation, small to medium levels of economic, financial and judicial development and a medium to high levels of country risk.

International Market Selection

Country Screening: Country Ranking & Selection of Final Countries

COUNTRY RANKING

Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
1	United States	58.22	18	Norway	49.41	35	Slovenia	38.80
2	Switzerland	56.41	19	Austria	49.30	36	Poland	38.53
3	Singapore	54.99	20	France	48.75	37	Latvia	37.66
4	United Kingdom	54.64	21	Iceland	48.46	38	Slovak Rep.	36.89
5	Netherlands	53.81	22	Israel	47.92	39	Cyprus	36.86
6	Finland	52.37	23	Belgium	45.13	40	Chile	36.64
7	Japan	52.25	24	Estonia	44.62	41	Bahrain	36.63
8	Canada	51.95	25	Malta	44.54	42	Costa Rica	35.81
9	Sweden	51.92	26	Spain	44.36	43	Turkey	35.38
10	Denmark	51.79	27	Czech Rep.	41.95	44	Romania	35.27
11	Germany	51.63	28	UAE	41.75	45	Uruguay	35.28
12	Hong Kong	51.60	29	China	41.75	46	Mexico	34.60
13	New Zealand	51.03	30	Malaysia	41.09	47	Bulgaria	34.18
14	Luxembourg	50.95	31	Lithuania	40.49	48	Hungary	34.06
15	Australia	50.66	32	Italy	40.59	49	Saudi Arabia	33.98
16	Ireland	50.59	33	Qatar	40.09	50	Russia	33.96
17	Korea, Rep.	50.05	34	Portugal	39.83			

CLUSTER #1

- | | | | |
|-------------------|-----------------|-----------------|-----------|
| 1. United States | 9. Sweden | 17. Korea, Rep. | 26. Spain |
| 2. Switzerland | 10. Denmark | 18. Norway | 28. UAE |
| 3. Singapore | 11. Germany | 19. Austria | 29. China |
| 4. United Kingdom | 12. Hong Kong | 20. France | 32. Italy |
| 5. Netherlands | 13. New Zealand | 21. Iceland | 33. Qatar |
| 6. Finland | 14. Luxembourg | 22. Israel | |
| 7. Japan | 15. Australia | 23. Belgium | |
| 8. Canada | 16. Ireland | 25. Malta | |

The Country Clustering and Country Ranking analysis show that, based on the combining results of the Country Clustering and Country Ranking and after a consultation with 3D Ways' management team, the countries with the most potential are those included within the Cluster #1. Henceforth, the subsequent analysis (in-depth market analysis) will be done upon five countries belonging to the mentioned cluster. Afterwards, countries will be prioritized from one to five and the most attractive one will be further analysed. Fundamentally, a plan of action will be developed, starting with an entry strategy that will englobe a financial and marketing plan.

The final list of five countries was chosen based on the results of the Country Clustering and the Country Ranking analysis, combined with the feedback that 3D Ways provided. After a careful deliberation, it was decided to reject the United States as the 3D printing industry is the most evolved in the world, with a lot of competition that could be quite harmful for 3D Ways. Canada was not included as Germany presents itself as a more attractive option regarding the 3D Printing (A.T. Kearney, 2018). Also, 3D Ways has shown interest in first starting its internationalization process by expanding to countries closer to the home country, highlighting Germany as one of their preferred market choices. Singapore and Japan were also rejected because of the cultural differences and difficulties in securing intellectual property rights for software. Finland was rejected as Sweden is characterized by a more profitable healthcare sector, twice the size of the Finnish healthcare providers value, and software industry, accounting for 35% of the entire Scandinavian market (Marketline, 2019). Afterwards, since both countries are extremely similar, 3D Ways could leverage what it has learned from entering in Sweden and apply it to the Finnish market. Therefore, resulting in the **final list of five countries: Switzerland, United Kingdom, Netherlands, Sweden and Germany.**

3. IN-DEPTH MARKET ANALYSIS

- Germany
- The Netherlands
- Sweden
- Switzerland
- The United Kingdom
- Country Selection
 - Selection of Final Country

The United Kingdom

Contacts

When internationalizing into a new country, with different cultural and market practices, it is important to have the right contacts, to form alliances and smooth the overall process. For 3DWays, forming contacts with hospitals and healthcare organizations would be promising, since they are the firm's end-user, and some are pioneers in Additive Manufacturing (AM) R&D. Another good connection can come from universities, namely the ones who are at the forefront of research in the area. Furthermore, printer and material vendors are good connections to make, since they will be the suppliers for 3DWays's clients. Technology and innovation-supporting organizations can also be an important allies, for assistance and knowledge of the regional market, as well as Government agencies.

Hospitals and Healthcare companies

- > Regarding relationships with hospitals and health providers, 3DWays' initial idea coming into this project was to form alliances with private organizations, since the firm believes there are too many barriers and bureaucratic rules involved in creating associations with public hospitals. The largest players in the private healthcare sector are priority in terms of connections, since they have the most capabilities for investing in innovative technological enhancements. As stated by MarketLine's report on UK Healthcare Providers (2019), the leading companies are:
 - > **BMI Healthcare Ltd.** This organization is a private provider of medical services, that offers treatment services for both men's and women's health, bones and joints, cancer treatment and eye care. It also provides several surgery options, for both cosmetics and treatment (such as cancer surgery, cervical spine, knee replacement, etc.). It is headquartered in London and operates several hospitals and clinics across the country. According to the NHS website, it operates 47 hospitals and 7 clinics across the UK.
 - > **HCA Healthcare, Inc.** Private company that owns, administers and operates in 20 US states and England, where it has three head offices, all in London. In the UK, it manages 109 units, among which 8 hospitals, 78 clinic/specialist units, 5 General Practice services, 15 outpatient/diagnostic centers, and 3 research facilities.
 - > **Ramsay Health Care Limited.** This group operates over a total of 235 facilities (hospitals, day surgery and treatment centers, rehabilitation and psychiatric centers) in several countries, from Australia, Indonesia, Malaysia, and France to the UK. The UK branch offers 34 hospitals and day procedure units that can perform complex surgery procedures, catering to private and self-insured patients as well as NHS-referred patients. Moreover, the organization manages a diagnostic imaging service unit and offers neurological services from its three neuro-rehabilitation centers.
 - > **Spire Healthcare Group Plc.** Private provider of healthcare, with a portfolio of services ranging from surgery and treatments, several specialized consultations, cancer investigation and treatment, etc. The group is headquartered in London and operates 39 hospitals and 8 clinics across the UK.
 - > Finally, albeit not being a private organization, **Nottingham University Hospitals** can prove to be an important ally, since they are pioneers in AM research and its applications for health. In this NHS group, the most prominent units are the QMC, City Hospital, Ropewalk House and Children's Hospital.

Universities

- > Universities can become important allies, in the sense that they are largely involved in AM R&D projects and can be a connection between 3DWays and organizations in the industry.
- > According to a 2016 review of the UK's publicly funded R&D activities, published by Innovate UK, the biggest University concerning number of publications is the **University of Sheffield**, followed by the **University of Nottingham** and **Loughborough University**.
- > As for other relevant universities, the **Universities of Cambridge, Birmingham, Bristol and Oxford** have all received enough funds for research to be among the top 20 most funded organizations in the country, of which the University of Nottingham has received the largest sum.
- > The University of Cambridge, **University of Manchester**, University of Bristol, **Newcastle University**, the **Imperial College of London** and **King's College of London** have all received funding for specific research projects in biomedical application for AM, for the period of 2016 to 2019, as stated by The Imperial College London's report on AM research in the country (2016).

Printer and Materials Vendors

- > As for UK companies that specialize in 3D printing as their business model, there are printer manufacturers, resellers and distributors, and 3D printing service companies. There are not many printer manufacturers in the country, and the best-known is **Renishaw**, in the metal AM sector, that is also a printer vendor. Some examples of resellers, a much larger segment than printer manufacturers, are **Makerbot, Lulzbot, and Ultimaker**. Some promising material manufacturers are **Victrex** (polymers), **Versarien** (graphene-based) and **ProPhotonix** (lights and lasers).

The United Kingdom

Contacts

Associations and Organizations

- > There are several associations and organizations that support small firms with technologically innovative business models in the UK. These could prove to be strong partners and open doors for 3D Ways to make contacts and relations in the AM industry in the country. Some examples are:
- > The **High Value Manufacturing Catapult** (HVM), that supports both SMEs and largest firms to grasp their full potential and connects them to the right partners. It is devoted to assisting with the adoption of AM practices in the UK manufacturing industry.
- > **CHEATA**, or the Centre for Healthcare Equipment & Technology Adoption, which is part of the Clinical Engineering at Nottingham University Hospitals, and offers support to medical technology developers, for academic and industrial purposes.
- > Part of the Manufacturing Technology Centre, the **National Centre for Additive Manufacturing** (NCAM) aims to help develop the appropriate technology and systems needed to adopt AM into the manufacturing value-chain. It supports the incorporation of AM practices by firms and new initiatives (such as REACH) with the objective of aiding SME's in their AM technology implementation.
- > The **Academic Health Science Network** (AHSN), with its 15 branches for different areas of the UK, acts as the innovation center for the NHS. It connects partners across a number of segments, from academia, local authorities, industries and residents.
- > **Additive Manufacturing UK** is an independent agency that aims to support AM implementation in the UK. It is responsible for the creation and promotion of the UK Additive Manufacturing Strategy Report, that details a strategy for the country to become a leader in the industry in the next 5 years.
- > Moreover, a few industrial firms have played a major role in leading AM research in the country, and could become powerful allies, namely **The Welding Institute** (TWI), **Centre for Defense Enterprise, Manufacturing Technology Centre** (MTC) and Renishaw.

Government Agencies

- > Formed to assist the country's innovation strategy, the **Industrial Strategy Challenge Fund** connects businesses to leading researchers.
- > The EIT, a body of the European Union, more specifically, the **EIT Health UK-Ireland** is an organization that, along with academic institutions and companies, works to improve quality of life and the sustainability of healthcare services. A group like this could become a link to form a network of AM and health-related connections for 3D Ways.
- > The **Enterprise Europe Network** supports SME's in the improvement of their innovation strategies and internationalization of their business. Their network is composed of more than 500 contacts, over 44 European countries and was created for the program of Competitiveness and Innovation in the EU.
- > **Innovate UK** is a government agency for the country's innovation and technological advance.
- > **NHS Improvement** is an organization that supports the NHS to deliver better care to the patients.
- > **The Medical Research Council** (MRC) funds and manages medical research in the country. It works with several organizations, like Innovate UK, to revolutionize the country's health sector.
- > Another possible connection that could prove fruitful for 3D Ways is the **Department for International Trade** (DIT), which aims to aid UK firms export and internationalize into global markets, as well as support international companies locate and expand in the UK.
- > Finally, the **British Embassy**, located in Lisbon, could provide some important information regarding starting a business in the UK, as well as guidance for Brexit. Similarly, the **Portuguese embassy** in the UK would be a key contact for 3D Ways.

This is a non exhaustive list; there are many other possible partners that could benefit 3D Ways in its endeavor to build a network in the UK. Many other private healthcare institutions exist in the country, and even NHS trusts could be a potential ally. Although there aren't many UK based 3D printer manufacturers, there are plenty of resellers and material suppliers that could take part of the network. The UK is currently investing heavily on AM research and technology, and as such, it should not be hard to find partners amongst R&D organizations, innovation catapults and tech supporting associations, as well as government support.

The United Kingdom

Competitor Analysis

Regardless of the potential in the AM industry, UK companies, specially SME's, are not adopting it as a core practice, as they lack awareness and resources. As stated in a study by Ernst and Young, 17% of British firms have experience with AM, as opposed to 37% in Germany and 24% in China (Maier 2018). Nevertheless, some organizations have realized the potential of the industry, and are using AM in their business practices. Among them feature household names in the UK business landscape, such as BAE Systems (in the defense and security sector), Dyson (in the consumer products sector), GE (in several sectors, but highlighting its GE Healthcare 3DP center), GKN (in aerospace and automotive), GSK (in the healthcare sector), Johnson Matthey (for sustainable technologies, in sectors like Pharmaceutical products and services), McLaren and Rolls-Royce. Most of the efforts done by these firms in AM are in a R&D stage and, even for those that are already being actively implemented, they comprise a very small part of the firm's operations. As for UK companies that specialize in 3D printing as their business model, there are several 3DP service firms across the country (Gregurić, 2019). Some examples are:

Medical device Suppliers		For more detail on other AM firms, please check Appendix 7)	Other AM firms		
Company	Activity Description		3D Printing Solutions		3D-printed Product Manufacturers
Axial3D Ltd	Offers innovative software and technical know-how to healthcare professionals and organizations. The company is headquartered in Belfast but is present around the world (EU and US), offering 3D solutions in various healthcare segments such as orthopedics, cardiology, neurological surgery and pre-operative planning. It is working with the NHS in Northern Ireland and Wales, and its latest venture is a partnership to set up a 3D printing lab in Newcastle Hospitals.		HK3D Solutions	3D Print Direct	Handydans 3dprint
3D LifePrints	It designs, manufactures, sells and delivers products through hubs, catering to NHS hospitals, private healthcare suppliers, and schools, as well as working with clinicians and academics to deliver the best possible solutions. It offers printing services, CMF guides and implants, anatomical models, design and segmentation and orthopedic solutions, among others. Among its clients is the Alder Hey children's hospital. The firm is present in the Wrightington Hospital (Greater Manchester), Health Foundry (London) and Nuffield Orthopedics Centre (Oxford).		Print My Part	Ryobe 3D	3dfilaprint
Arum 3D Solutions Ltd	Present all over Europe, this firm offers technical support, scanning, design, 3D printing, amongst others, to medical organizations. It also sells its own milling machines and dental CAM software. Moreover, it provides a library with implant files to be downloaded and printed.		3DPL		
3D Dental Aligner Laboratory Ltd	Orthodontic laboratory that specializes in 3D printing dental appliances using the latest AM technologies. It caters to dental practices worldwide.		Extrude	Lancashire3D	Plastiprint3d
VET3D Ltd	Focused on the veterinarian practice, this firms offers bone printing, surgical and neurosurgical guides, and orthopedic guides to its clients .		STEP 3D	Hobs 3D	Paragon Rapid Technologies
3D Bio-Tissues Ltd	Active since 2018, this firm is a medical device manufacturer, as well as a researcher an experimental developer of biotechnology.		3D Parts Ltd		
Cast3D Wrist Ltd	UK based designer and manufacturer of medical devices, active since 2018.		Simply Rhino	3DPrintUK	HiETA Technologies Limited
			Addition Design		
			AMMA Solutions	Laser Prototypes Europe	The Plasticom Group
			Tri-Tech 3D		
			GoPrint3d	3dprintman	AddQual

Table 1. Medical AM companies

Table 2. Other AM companies

According to The Institute of Manufacturing of Cambridge University's 2017 review of patents and literature in AM, there were **121 organizations patenting and publishing content** related to AM in the UK between 2005 and 2016 (among which **42 were in the health and pharmaceutical industry**), which means that the companies previously presented are but a small example of some firms in the industry (List and Tietze, 2015). In 2019, the total of patents filed in 3DP industry was 8 719. However, it is plausible to assume that the most direct competitors are going to be small firms, like 3D Ways, mostly in the start-up stage. Nonetheless, no company offers quite the same business proposition as 3D Ways, therefore direct competition is not a major concern.

The United Kingdom

Competitor Analysis

When moving into the UK, 3D Ways will have to face competition from already established firms. Even though 3D Ways' service is innovative, since it revolves around consulting to clients that lack AM know-how, remotely controlling every step of their production, and providing a network of players in the 3DP value chain for them to form relations with, there is still competition, even if other firms don't offer exactly the same service. Since the focus of the internationalization is on the health industry, every company that currently supplies hospitals and healthcare facilities can be a competitor.. The leading players in the healthcare equipment and supplies (MarketLine, 2019) are:

Johnson & Johnson

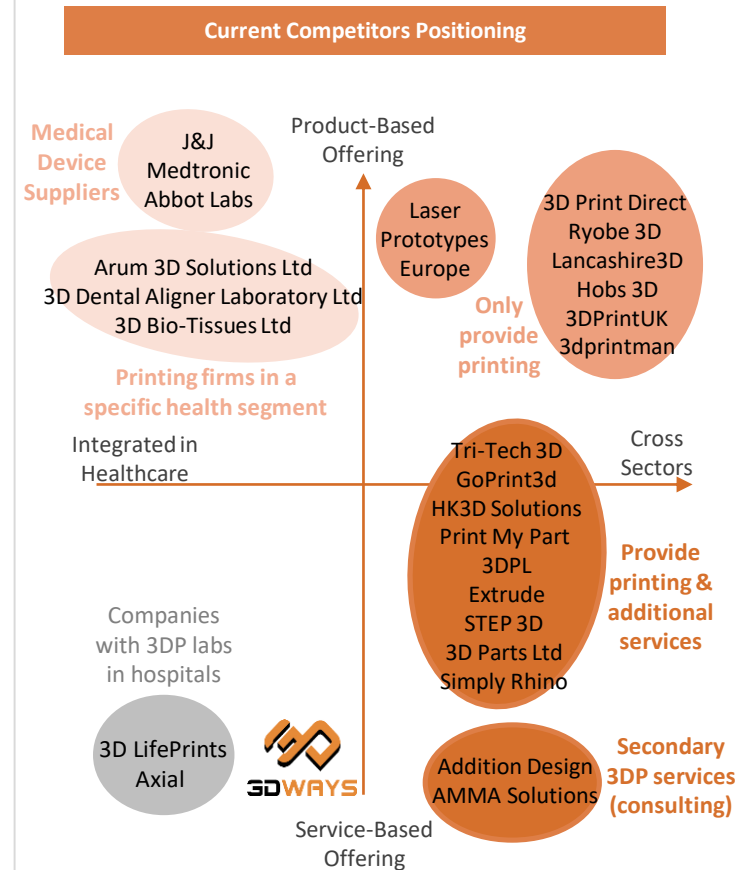
- > This is one of the largest American multinational companies, with presence in more than 60 countries worldwide ("Johnson & Johnson Annual Report", 2018). It is present in the medical device, pharmaceutical and consumer goods industries. In the UK, it is one of the most relevant players in the health sector, with its R&D, production and sale of products for the industry. Its product portfolio for the medical segment includes surgical tools, orthopedics, insulin delivery devices, vision care, among others, which are distributed to wholesalers, hospitals and retailers. Its main capabilities are in-house research and a market-leading station, which allow it to strengthen its position over competitors, even when under criticism for claims of product deficiencies. The company has been investing in expanding its offerings portfolio, through the creation of R&D facilities. Some examples of recent product innovations in the medical field are the 2018 approved *ERLEADA* for the treatment of prostate cancer. In December 2018, the company **reported revenues of \$81 581m** (\$26 994m, or 33,1% in the Medical Segment), which translates into an increase of 6,7% from the previous year. Its operating margin and net margin for 2018 were 22,1% and 18,8%, respectively, compared to 23,1% and 1,7% from 2017.

Medtronic, Inc.

- > Headquartered in Ireland, and with most of its revenue resulting from US sales, the firm is present in more than 150 countries, having over 350 locations. It is one of the largest players in the medical device field in the UK, providing products for the treatment of several diseases, such as cardiac, neurological, muscular and spinal conditions. The company is aiming to expand its operation, by forming strategic alliances, such as the 2018 pact with Revo Health to co-develop payment models, or the 5-year agreement with Lehigh Valley Health Network, to develop programs for therapy optimization. Moreover, in an effort to reduce costs, the company has committed to improve its offerings portfolio, by engaging a structuring initiative (Enterprise Excellence) to optimize its business model. The objective is to save from \$500m to \$700m per year until 2022, aiming for a total cost saving. of \$3bn. The firm has reported **revenues for April 2019 of \$30 557m**, increasing 2% from the previous year. The operating margin and net margin were 19% and 15,2%, respectively, compared with 22% and 10,4% from 2018. Revenues are mainly derived from the Cardiac and Vascular segment (37,7%), followed by Diabetes segment(27,7%), Minimally Invasive Therapies (26,8%), and finally, Restorative Therapies (7,8%).

Abbott Laboratories

- > Headquartered in the US, this organization is one of the largest healthcare equipment suppliers in the UK, while also having activities in international markets. Its product portfolio is very wide, ranging from diagnostic, vascular and nutritional to the pharmaceutical sector. Still, its activities are largely customized according to each country's specific market needs. One of its main strengths is its R&D capabilities, having over 400 projects in development for the expansion of their product offerings, for which it expended more than \$2.28bn in 2018. The company is planning to grow by launching new patented and differentiated products. Some examples of recent development by the firm are the 2019 expansion of its *MitraClip* device, that repairs mitral valves without the need for open-heart surgery, or the approval of the *Amplatzer Piccolo Occluder* device, to be implanted in babies for the treatment of *ductus arteriosus*. However, a major concern for the firm are product defects, which can threaten their business viability. In terms of **total revenue, it made \$18,9bn in 2019**, which makes it the 7th largest medical device company worldwide (Ellis, 2019).



The United Kingdom

Country Overview

To analyze the overall country environment, a PESTLE Analysis (MarketLine, 2019) will be performed, mainly focusing on outlining the key political, economical and technological aspects that characterize the UK.

PESTLE

Political

- > A significant political force, the UK is part of the UN Security Council, NATO and the G8. A law was approved in September 2019 to prohibit a Brexit with no deal. Moreover, the government has committed to fund healthcare for 6 months in the case of a no deal departure. According to the World Bank's governance indicators, the UK was one of the most effective countries in 2018 regarding **application of voice and accountability** (93,6%), **rule of law** (91,%), **corruption control** (93,3%), **government efficacy** (87,98%), as well as **regulatory quality** (96,15%).

Economic

- > The UK has one of the highest values of GDP per capita (ppp) (\$ 45 720), and according to the World Bank, is the **9th best country in the world to do business in**. It takes an average of **4,5 days to start a business**, when compared to the OECD high income nation's value of 9,3. Moreover, the UK was 7th in the "**Getting electricity**" rank, 14th in "**Resolving Insolvency**" and 15th in its ability to "**Protect Minority Investors**". It's a highly competitive economy (**8th out of 140 countries** in the World Economic Forum 2018 Report), as well as innovative (4th in **innovation ecosystem**; 7th in **business dynamism, innovation capability and entrepreneurial culture**). The impact of Brexit has led to a slowdown in the economy, as real GDP growth decreased from 1,7% in 2017 to 1,4% in 2018.

Social

- > The country's education and health systems are considered some of the best in the world. **Healthcare expenditure as a percentage of GDP** has been rising over the years (6,94% in 2010, 8,8% in 2016, 9,7% in 2017). However, the number of **doctors per 1000 residents** in 2018 is lower than other EU countries (2,9 in the UK and 3,4 in France, for example).

Technological

- > There are effective **IP rights systems** in place, and IPR legislation is often updated as technological development are made. **R&D** is a priority, and expenditure in this area has been increasing (investments of \$44,32bn in R&D in 2017 and €26,29bn in Business R&D). The country lacks IT talent in the workforce, something that it is aiming to change by 2030, by which year it plans to be the world **leader in innovation**. However, the country is struggling in terms of **cybersecurity**. The National Cyber Security Centre has reported over 1 167 cyber incidents since it was created, in 2016. Small firms are exposed to nearly 10 000 cyber-attacks in a day, which cost a total of \$5,8bn.

Law

- > The UK ranks **7th in the Economic Freedom Index** (and 3rd in Europe) and has an effective regulatory system (437 days to enforce a contract, lower than the OECD average of 582,4). The **corporate tax** rate was reduced to 19% on April 1st, 2017, and unchanged ever since. **Total tax rate** in the nation was 30,7%, lower than the 39,6% average for the EU.

Environmental

- > Target to **reduce emissions to zero** by 2020. CO2 emissions are currently being reduced on average 2,9% per year.

As of now, the UK presents a stable environment in all aspects of the PESTLE examination. It is a safe and effective country in terms of business setting, with helpful systems in place to combat illicit behavior. A competitive economy, it represents a good country to do business in, where it takes a relatively short time to start a company. It is an innovative, dynamic and technologically developed country, although dealing with some cybersecurity issues. It looks promising for 3D Ways, since healthcare expenditure is rising, and IT talent lacking. Tax rate is also advantageous, since it is lower than the EU average. Nevertheless, since the UK is currently concerned with environmental issues, and 3D printing represents a way to reduce waste in manufacturing, it opens an opportunity to enter the market.

The United Kingdom

Market Revenue Potential

3DWAYS' business model is difficult to categorize into one specific sector. It consists of a self-developed software, that allows for remotely controlled manufacturing of 3D printed parts. It can be seen as a service outsource, since clients aren't required to find personnel with additive manufacturing know-how, leaving the operational activities to 3DWAYS. Therefore, when accessing the overall market potential of a country for internationalization, it becomes relevant to evaluate several markets. Firstly, the **IT services** and **Software** industries are significant, as 3DWAYS is selling a software-based outsourcing service. The **AM** industry is also important, since the objective of the software is to control 3D printed manufacture. Finally, as 3DWAYS' goal is to target the **healthcare sector** as their clients, an overview of this industry, and their current **suppliers of equipment and devices** is also relevant to understand the potential of the market. As such, an overview for all the previously mentioned industries is performed for the United Kingdom, in an effort to understand the county's potential for 3DWAYS.

IT Services Industry



For the detailed 5 Forces Analysis, please check Appendix 8)

- > The IT services industry obtained **total revenues of \$65,7bn in 2018** (CAGR 2014-2018 of 12,3%). The UK is the **European market leader**, with 23% of the market, followed by Germany (16,5%) and France (12,6%). (Marketline, 2019)
- > The sector is expected to grow with a CAGR of 12,9% from 2018 to 2023, reaching a total of **\$120,7bn**. In 2020, the year of 3DWAYS' internationalization, it is estimated to be worth **\$29,54bn**.

Software Industry



For the detailed 5 Forces Analysis, please check Appendix 9)

- > The Software industry in the UK reached a **total revenue of \$23,6bn in 2018**, growing at 11,1% CAGR between 2014 and 2018. It is the second largest market in Europe, representing **17,4% of the EU market**, while Germany (19,1%) and France (12,6%) occupy the first and third places, respectively. (Marketline, 2019)
- > It is **expected to reach a total of \$47,87bn by 2023**, corresponding to an increase of 103,2% since 2018 (15,2% CAGR). In 2020, the year of 3DWAYS' internationalization, it is estimated to be worth **\$29,54bn**.

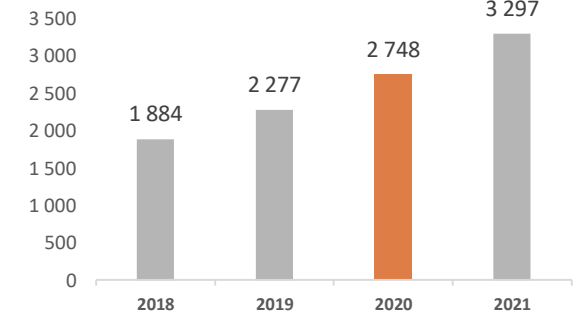
Additive Manufacturing Industry



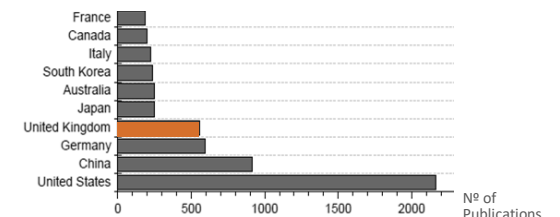
For a SWOT Analysis, please check Appendix 10)

- > There is great potential for the UK to take advantage of AM practices. Worldwide, according to Statista (Citi Research, 2018), the market for 3D manufactured products and related services was estimated to be worth over \$12bn in 2018 and rising fast. In terms of market share, the **UK holds 15,7% of the world's industry** (the 2nd largest share, after the US's 38,1%), translating into a **market value of \$1,88bn for 2018** (3D Hubs, 2018).
- > By 2020, the global market value for **AM is expected to be worth approximately \$17,5bn**. This growth is expected to increase in speed as time goes by, as standards, consistency of materials, IP protection and verification practices are improved. Assuming the UK global market share of 15,7% is maintained, the **potential AM market value for 2020 will be around \$2,75bn**.
- > Currently, the UK has a strategy planned to become the largest industry in the AM sector by 2025. It is estimated that **the country can amount to 8% (\$6,44bn) of the market**, which is expected to reach \$88,86bn by 2025, according to Additive Manufacturing UK (2018).
- > To reach the objective of becoming a market leader, there is a **planned industry investment of £600m (~\$773m)** over the following five years. There are currently initiatives taking place to assist small groups in comprehending and using AM technologies, like the HVM Catapult's REACH. The UK is in an advantageous position to exploit this opportunity, since it is already a global force in advanced materials, technological development, life science and high value manufacture. Moreover, it possesses an established government and industry-funded center for AM, as well as globally recognized universities, organized catapults and R&D establishments.
- > AM research funding in the country doubled from 2012 to 2014, putting the UK **in number four on the top 20 countries working on AM research worldwide** (Myant, Li, and Wu, 2016). Similarly, the number of organizations engaged in the industry has doubled to 250. Among the organizations involved in AM research, a small number has received sizeable funding, namely a few universities (Nottingham, Sheffield, Loughborough, and Cambridge) and some enterprises, such as The Welding Institute, Renishaw, Centre for Defense Enterprise, Materials Solutions and Rolls-Royce. Amongst commercial partners involved in R&D, **medical companies rank 4th** in terms of number, only surpassed by engineering, AM, and materials companies. The combined investment from UK's EPSRC and Innovate UK in R&D for this sector has surpassed **£200m (~\$257,56m)**. The average value of funding per party in 2012 was around £289 188 (~\$372 410) (Hague, Reeves, and Jones, 2015).

The UK's predicted Market Size for AM (million \$)



Top 10 Countries working on AM research



The United Kingdom

Market Revenue Potential

Health Sector Overview



For a 5 Forces Analysis, please check Appendix 11)

- > The Health provider sector in the UK grew 3,2% between 2014 and 2018, reaching a total value of **\$270,1bn**. **The estimated turnover for 2020 is \$281,3bn**. Moreover, it is forecasted to increase a total of **13,9% until 2023, achieving \$307,7bn**. This corresponds to a deceleration in the market, with a CAGR of 2,6% between 2018 and 2023 (Marketline, 2019). The UK market accounts for 13,4% of EU value creation in this sector, and the biggest segment in the country is outpatient care (27% of UK created value, or \$73,1bn). The medical goods segment accounts for 13,2% of the market (\$35,6bn). Moreover, private healthcare amounts to 22,3% of the market.
- > According to OECD.stat (2019), the **number of hospitals in 2018 was 1910**, lower than the values for the previous two years (1922 in 2016 and 1920 in 2017). According to the Care Quality Commission (2019), the health services independent regulator, there were **1059 independent facilities** in the UK in 2018/2019 (**548 of which are hospitals**) and **223 NHS trusts**. The largest private healthcare organizations in the country are BMI Healthcare, with 54 facilities, HCA Healthcare, with 109, Ramsay Health Care, with 34, and Spire Healthcare Group, with 47. Together, they operate a total of 244 facilities in the UK.

Healthcare Equipment and Supplies Sector Overview

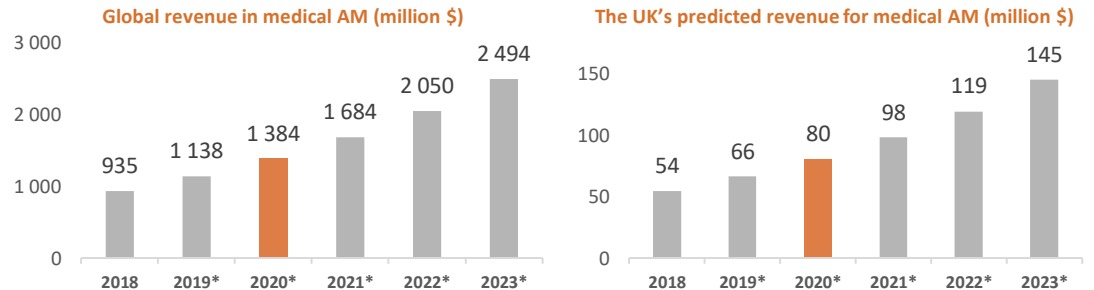


For a 5 Forces Analysis, please check Appendix 12)

- > The Healthcare Equipment and Supplies industry in the UK grew 1,8% in 2018, reaching a total value of **\$17 065,7m** (2014-2018 CAGR of 0,7). **The estimated turnover for 2020 is \$17,98bn**. It is forecasted to increase a total of **9,6% until 2023, achieving \$17,71bn**. As such, and although the market has been growing at a slow rate, it is expected to accelerate, with a 2018-2023 CAGR of 1,9% (Marketline, 2019).
- > 50,5% of the total value created in the UK market is derived from the “Disposable equipment & supplies” segment (\$8,6bn). As for the EU market, valued at \$140,4bn, the UK represents 12,2% of value created, being the third biggest share (only surpassed by Germany at 30,3% and France at 15,3%).
- > According to the 2019 Annual Business Survey from the UK’s Office for National Statistics, the manufacture of medical and dental devices in 2018 in the country had a turnover of \$6,6bn.

Additive Manufacturing in Healthcare Services

- > In 2018, the medical AM market reached a total revenue of \$ 935m (Statista 2018). The UK holds 5,81% of the market (Visiongain, 2016), which translates into a total value of \$ 54m. Assuming that this percentage holds in future years, and with a global estimated turnover of \$1 384m for 2020, the **market potential in healthcare devices’ additive manufacture for the UK will be of \$ 80,41m**.
- > For the most part, growth in this sector has been compelled by demand for orthopedic prosthesis, cranial implants and dental repair. Regarding market share by revenue, according to IndustryARC, the three biggest segments in medical 3D printing are dental implants (34%), generic implants (19%) and prosthetics (13%) (Barrow, 2018).
- > The NHS has already begun to implement AM practices in healthcare facilities (Baxter, 2018). The first adult to child kidney transplant in the country was performed in 2016 with the help of this technology. Still on that year, 3DP was used to enhance exactness and accuracy of robotic cancer surgery, by allowing surgeons to better see the tumor, and plan the best robotic removal practice.



Examples

- > **University of Birmingham’s Centre for Custom Medical Devices (CMD)** is a laboratory that contains two **Renishaw** metal 3D printers, enabling the design, production and evaluation of medical devices.
- > **North Manchester General Hospital** established its own 3D printing facility, in partnership with the NHS. It is mostly used for reconstruction on head and neck cancer patients, but future applications are expected in areas such as orthopedics and neurology.
- > **Axial3D**, a UK based AM firm in the medical field is set to launch an in-house 3D print lab at **Newcastle Hospitals**.

The number of independent healthcare facilities in the UK is high, which is advantageous for 3D Ways, since working with the private sector presents less barriers than the public sector in terms of bureaucratic rules and can return higher profits. Most of the medical supply industry is occupied by “Disposable Devices”, suggesting that there is high demand in the UK for these types of equipment, which 3D Ways can provide with its software. Regarding the AM industry, the UK holds 16% of the world’s market value, and expecting investment in the next few years. Specifically in health, the country holds 6% of the worldwide AM market, with a market potential of \$ 80,41m for 2020. Therefore, it looks like a promising industry for 3D Ways to penetrate.

The United Kingdom

Company Revenue Potential

Assumptions

- > To calculate the potential revenue for the firm after internationalization, some assumptions were made. Firstly, the only healthcare facilities included in these projections are hospitals. This stems from the fact that the only numbers available for private facilities are the total number of hospitals and the aggregate number of facilities, that includes hospitals, specialist facilities, clinics, mental health practices, etc. Since this last value would include several facilities that do not require 3D Printing services (like mental health practices), its usage would lead to an overestimation of revenue. Therefore, **only the number of private hospitals is taken into consideration**. Furthermore, it is assumed that **each NHS trust in the UK manages approximately 6 hospitals**. While this value is only true for English NSH trusts, since 85% of hospitals in the UK are in England, a generalization was made.
- > The global **Software as a Service penetration rate for 2020 (9%)** (Various sources, 2017) is used as a proxy of the penetration rate for 3DWays' service in the UK, in terms of number of institutions. Moreover, 3DWays will control no more than **one printer per hospital**, as happens in Portugal with José de Mello Saúde. Additionally, as a simplification, it is assumed that the **expected annual revenue per printer calculated by 3DWays applies in the UK** (Table 3). Finally, the annual growth rate of revenue used is **the worldwide 2018-2024 CAGR, at 21,68%**.

Expected Revenue

- > To estimate total potential revenue until 2023, the number of active printers each year was multiplied by the yearly revenue per printer, calculated by 3DWays. In order to find the number of printers, the following process was applied:
 - > Since the total number of private hospitals in the UK is 548 and there are 233 NHS trusts, with a 9% penetration rate, 3DWays would be able to reach 49 private facilities in 2020, as well as 20 trusts. Since one trusts manages, on average, a little over 6 hospitals, 3DWays could potentially reach 121 public hospitals. In total, for both private and public facilities, this translates into **170 printers** (Table 4).
 - > On a first analysis, the **expected revenue per printer was fixed on €6 000** for all years, meaning that revenue for 2020 would be €1,02m (170 x €6000). As the amount of printers in the network increases each year, **the growth rate was applied**. Consequently, the expected revenue per year was derived (Table 5).
 - > Finally, by dividing the previous values by the fixed revenue per printer, the **total number of active printers** can be obtained for each year (Table 6). With this figure and the expected revenue per printer of each year, as seen on table 3, the true revenue potential for 3DWays in the UK presented on table 6 was attained.

Table 4. Institution Penetration

Global SaaS penetration for operations/manufacturing 2020
9%
Total infrastructure in the UK
223 NHS trusts + 548 private hospitals
UK facility penetration
20 trusts x ~6 hospitals + 49 independent facilities = 170

Table 3. Expected Revenue per printer in Portugal

Year	Revenue/year/printer
2020	6 000 €
2021	7 200 €
2022	8 400 €
2023	9 600 €

Table 5. Revenue in the UK (with revenue per printer fixed at 6000€)

Year	Revenue/year
2020	170 x 6 000 = 1 020 000 €
2021	x 1,22 = 1 241 136 €
2022	x 1,22 = 1 510 214 €
2023	x 1,22 = 1 837 629 €

Table 6. Final Potential Revenue in the UK

Year	# Printers	Revenue/year
2020	1 020 000/6 000 = 170	170 x 6 000 = 1 020 000 €
2021	1 241 136/6 000 = 207	207 x 7 200 = 1 489 363 €
2022	1 510 214/6 000 = 252	252 x 8 400 = 2 114 300 €
2023	1 837 629/6 000 = 306	306 x 9 600 = 2 940 206 €

The expected revenues per printer for 2020, according to 3DWays, are of €6 000. With 170 printers, the **total expected revenue for 2020 in the UK would be of €1 020 000**. Since the expected revenue for the company is high and estimated to grow every year to potentially reach **€2,94m in 2023**, the UK looks very promising for the company to internationalize to.

The United Kingdom

Market Entry Conditions

To analyze market entry conditions, some key aspects are examined, namely, ease of starting a business, IP rights and Data Protection, Taxation systems, Custom Duties and Distribution Channels. Furthermore, some guidance and regulations portraying to the technological and medical fields will be evaluated. Since the country is still belonging to the EU, market entry should be relatively accessible to 3D Ways, coming from Portugal, another EU nation. However, with the threat of Brexit in the horizon, some possible expected consequences for 3D Ways will be reviewed, on a tentative note.

Starting a Business

When expanding a business to another country, it is important to consider how to establish a fitting business structure (Desai, Foley and Vranakis, 2019). This will differ depending on the business itself, but, in the UK, the main forms are:

- > Trading through a limited liability firm or group;
- > Setting up an establishment in the UK (a branch or place of business);
- > Using a licensing model or a franchise;
- > Using an agent or a distributor;
- > Via joint venture with a third party.

UK firms are subject to accounting tax, audit and regulatory requirements. A firm can be formed, on average, in 4,5 days, and it doesn't require prior establishment of a bank account.

Moreover, when dealing with firms already instituted in the UK, it is relevant to consider adapting contracts under the English law, to smooth the sales process and ensure that the terms comply with the law.

Intellectual Property and Data Protection

- > IP rights in the UK are broad and wide-ranging, being automatically implemented in some instances and needing registration in others. Examples include designs, trademarks, patents, and copyrights. The UK is part of the World Intellectual Property Organization, the Paris Convention for the Protection of Industrial Property, the Universal Copyright Convention and the Patent Cooperation Treaty. Furthermore, the country is subject to EU Directives regarding IP rights.
- > The EU General Data Protection Regulation is in effect in the UK as of 2018. Fines for non-compliance can go up to 4% of annual global turnover, or € 20m. Furthermore, it can trigger a negative brand image, which is very important for consumers in the country, as well as negative PR, regulator prosecution or legal action.

Taxation System

- > The UK tax system is very competitive, with a smaller number of payments per year (8,0) and a lower total share of taxes as percent of profit (30,0) when compared with the OECD average (10,9 and 40,9 respectively), the USA (10,6 and 43,8) and Germany (9,0 and 49,0).
- > Corporation tax rate is 19%, planned to decrease to 17% by April 2020. Additionally, there is no withholding tax on dividends to shareholders, regardless of where the firm is located.
- > UK resident firms are taxable on their worldwide income. Non-resident firms are only subject to corporation tax on trading profits of either UK permanent establishments or referring to dealings in UK land. Moreover, from April 6, 2019, non-resident companies are also taxable on the direct (and some indirect) disposals of UK property. Finally, all other UK-source income is subject to income tax at the 19% rate (Santander, 2019).

Custom Duties and Import Tariffs

- > The Customs threshold from which tariffs are mandatory is when the imported goods are valued over £135. The average Custom Duties Rate in 2014 was 1,46% for manufactured goods, minerals and metals in the EU. For countries outside Europe, duties are, on average, 4,2%.

Distribution and Sales Channels

- > The country has well established channels for sales and distribution. These range from wholly-owned subsidiaries, independent resellers, sales agents, and stocking distributors, to independent trading companies. They are easily available and going through a growth period, for which the increase in international e-commerce has greatly contributed (Export.gov, 2019).

The UK is the top 10 of the easiest countries to start a business in, as seen in the PESTLE analysis from previous slides. It is a safe country to do business in, with effective laws, and measures in place to protect Intellectual Property and Data. The taxation system is one of the most moderate in the world, with lower rates than most European countries. Custom Duties are low, specially for other EU countries, and Distribution Channels are abundant and accessible. However, the country uses a different currency than the rest of the EU, using British Pound, or Pound Sterling (GBP) instead of Euros. Nonetheless, it is still considered a great country to do business in, and very promising to 3D Ways.

The United Kingdom

Market Entry Conditions

Software as a Service and Technology Standards

- > The supply of technology or software from one country to another is considered an export. Certain categories of software are under export control between the UK and the EU, namely software designed for military purposes and dual-use items, which are design for civilian use but could be potentially used for military as well. Since 3DWays provides remote manufacturing control software and is not planning on focusing on the defense sector, but on healthcare, it should have no issue with the product entering the country.
- > Service providers in the UK are subject to the **Provision of Service Regulations 2009** Directive. It applies to business services, management consultancy, professional services, training providers, etc., as long as they are providing services in the country, whether they are UK based or come from another EEA state. They also apply regardless of whether the firm has a UK office or operates remotely. Manufacture and sale of goods are not affected by the Regulations, but there are several exceptions, such as ancillary services. Since 3DWays is not a manufacturer, but rather a manager of the production process, the rules should still apply. The Directive provides guidance in matters of information availability and supply, conduct to follow in case of complaints, discrimination rules, and authorization and license rules.

Outsourcing in the UK

- > UK law does not regulate outsourcing transactions specifically, nor does it regulate outsourcing of IT systems and services. However, firms are expected to perform due diligence before entering a contract with a third-party provider, namely by ensuring the contract complies with requirements, like record of contracts, access to data and its security, risk management, the provider's adherence to international standards, accountability, etc.
- > Outsourcing firms deal with information from their clients and are therefore expected to comply with data protection laws and **General Data Protection Regulation 2016/679**, supplemented by the **Data Protection Act 2018** (Richard Brown, et. All, 2019). Issues regarding these rules may arise if there is a transfer of employees or processing of personal data of EU citizens, none of which apply to 3DWays' case. For the transfer of copyrighted data, the only restriction is that the transfer is executed in writing.

Manufacture of Medical Equipment Guidance

- > The authority responsible for healthcare equipment and pharmaceuticals regulations is the **Medicines and Healthcare products Regulatory Agency** (MHRA).
- > For a healthcare facility to manufacture medical devices in-house, it needs to follow the **Medical Devices Regulations 2002**. However, there are some activities not covered by the scope of the Regulations, such as when the purpose of production is not to place the device on the market, or when the device is assembled by a professional with the intent of being used by them. Since the objective of 3DWays is to have healthcare facilities produce items to be used by patients and doctors within the establishment, and not to be sold or exchanged with other hospitals, the regulations should not apply. In addition to the previous regulation, the manufacture of medical devices meant to be put into service in the UK must respect the **General Product Safety Regulations 2005**, with rules regarding product safety and information provided to consumers.
- > Manufacturers need to register their products with a valid **CE marking**, which signals conformity with EU regulations, valid for 5 years. This can be done via the **Devices Online Registration System**, with a fee of £100 for each application.

Brexit influence on business

- > The impact of Brexit on business is uncertain, as there is still no consensus on whether the UK will leave the EU with a deal or not, and what that deal would entail exactly. However, some general predictions can be made, regarding, for example, restriction of movement for professionals, difficulty in accessing talent, etc. Specific impact will vary for different types of business and how they provide services. For 3DWays, since the business model is based on remote service and does not require establishing physical presence in the country, the impact should be minimal.
- > However, after Brexit, there will be modifications to the **Provision of Services Regulation** discussed previously. These alterations include the change of regulation rules, and UK's recognition of professional qualifications from countries in the EEA and Switzerland. They will affect both UK companies with presence in the EEA and EEA firms with presence in the UK.

As for guidance and regulations that 3DWays needs to abide to in the UK, the most relevant are the Provision of Service Regulations, General Product Safety Regulations, General Data Protection Regulation and the Data Protection Act. However, the firm should already be complying with these standards, since they are common to all EU countries. As such, there should be no problem arising regarding the internationalization to the UK in terms of regulation fulfillment. Nonetheless, there is a large issue still to consider, since the extent to which international relations will be impacted by Brexit is still unknown. In the worst-case scenario, EU countries will be seen by the UK as third-party external nations, to which the rules to apply should be similar to those that are already in place for those counties. In any case, since 3DWays is acting remotely, the impact should not be too severe.

Country Selection

Selection of Final Country

GERMANY

ADVANTAGES

- High market and company potential revenues;
- There are many hospitals, with a large share being allocated to the private sector;
- There are attractive regulations being a member of the EU;
- Home to one of the largest start-up cultures worldwide, there is knowledge sharing and R&D within the 3D printing sector.

DISADVANTAGES

- The 3D printing segment is already a highly developed industry in Germany; second highest in the world, with a lot of multinational companies operating in the 3DP industry;
- There is a high level of competition in the SMEs field, with many companies already operating in the 3DP service provider segment with similar software services. Therefore, it could be harder for 3DWays to enter an attain market share.

The market of additive manufacturing in Germany is well-developed, with various companies adopting 3D Printing technologies. As result, leading to high market and company potential revenues. The developed market is represented by a significant number of competitors with different corporate sizes, providing similar solutions to the one offered by 3DWays . Moreover, there are competitors already operating as service providers in the healthcare sector. The intense competitive environment raises entry barriers for 3DWays and, thus, the entry conditions are challenging for a first international move. Accordingly to the market characteristics, Germany is better suited to be a future region to scale 3DWays' global network, once the company has reached sufficient growth and reputation to be able to exploit this market to its full potential.

NETHERLANDS

ADVANTAGES

- Although there are lots of competitors with similar software solutions, for which users must have a technical know-how, their software is bound to the companies' printers.
- There is currently a highly developed 3D printing market, with a high adoption rate of 3D printers across different industries
- Belonging to the EU, business can benefit from a free trade agreement, making it easier for 3DWays to offer its service;
- With an open economy allowing international developments, the Netherlands incorporates a vibrant, collaborative start-up ecosystem, being ranked 3rd in the EU on the 2019 Global Innovation Index;
- There are 322 patents for 3D printing (when compared to that of Sweden or Switzerland), which takes 3 months less than Portugal, however, patents in the Netherlands are typically more expensive.

DISADVANTAGES

- There is a high level of competition, due to the advancements in technology. These competitors not only have a software, but they are highly integrated into the health sector already;
- The employment law is quite complex and it gives employees a strong legal position, which can be unfair to small businesses and start-ups, where consistent funds and resources are difficult to maintain.

The strong start-up culture and an open economy that characterize the Netherlands , has allowed companies to establish and achieve great results in the field of additive manufacturing. The competitive landscape in the industry is fierce with successful and well-known competition operating in the healthcare. The entry barriers are high considering that hospitals do not favour SME's, only trusting larger companies with a high reputation. Thus, making 3DWays entrance in the healthcare segment very arduous. On the other hand, the Netherlands belong to the EU, easing up regulations for companies.

Country Selection

Selection of Final Country

SWEDEN

ADVANTAGES

- The Swedish healthcare system is one of the most developed in Europe, having one of the highest current health expenditures worldwide;
- With an overall low competition within the AM industry, most of the companies are 3D printing manufacturers, thus not directly affecting the software and services segment in which 3DWays operates. Moreover, competitors mainly focus on the automotive and aerospace industry, opening up space for 3DWays to penetrate into the health sector;
- There are many materials and metal powders suppliers that are drivers for Additive Manufacturing in Sweden. A large number Swedish companies present in that sub-sector allow for more network abilities;
- The number of collaborations among universities, companies and research institutes is increasing within 3DP field, therefore, more space for software and respective expertise to integrate within these.

DISADVANTAGES

- International partners are despised, Swedish companies are preferred when doing business within the country, especially for public-private partnerships;
- There is still a low adoption rate of 3DP technologies. However, awareness of its benefits is increasing – mostly related to SME's;
- AM for healthcare market size is fairly small and is not expected to grow as much as the other countries. In particular, the market share of Sweden compared to the global market size will decrease as its growth rate will not be enough compared to other countries.

The Swedish landscape for 3Dprinting technology is currently not exploited and developed compared to similar European countries, however it has significant future potential and positive trends. Even though it is possible to forecast a positive trend in the future, the lack of 3D printing investment in the healthcare sector labels Sweden as a sceptical option to pursuit expansion. Furthermore, the market size does not seem appealing for the company, with potential revenues comparable to the ones that 3DWays can achieve in Portugal.

SWITZERLAND

ADVANTAGES

- Favour Low to Medium competition, mainly composed by SME'S enterprises, highly appealing to 3DWays current stage;
- Med-tech and healthcare sector are both highly developed;
- Home to various large pharmaceutical headquarters, creating an appealing market for future adoption of 3D printing;
- Large amounts of funding are invested towards start-ups and their R&D activities, thus further promoting 3DWays activities to make it the best it can be;
- 3D printing market is already well-developed; however, healthcare needs to be further advanced.

DISADVANTAGES

- Many competitors have partnerships with hospitals, spin-off with research institutes, and already established networking. This could potentially mean that there will be high customer switching costs for 3DWays potential customers;
- The market potential is limited because there is not enough advancement within the healthcare sector; including implementation and utilization of 3D printers.

Switzerland does not seem like an appealing option, since a direct competitor, Axial3D, is already supplying 3D printing services to the biggest hospital group in the country. Particularly, Axial3D provides a substitutional offering, due to its software, which is aimed at managing 3D printing workflows. The company already has a close relationship with medical facilities and a strong reliability within this field. Therefore, it makes it harder for 3DWays to penetrate the industry with its offering. In addition, the smaller competitors that are already operating in the additive manufacturing industry for healthcare indicate strong competition, since they have partnerships with organizations, meaning that there already are relationship networks in place in this country.

Country Selection

Selection of Final Country

UNITED KINGDOM

ADVANTAGES

- There is a lot of activity in developing new technology platforms and software, with majority being from SME's;
- The UK wants to be the #1 player in the global market for 3D printing, resulting in a lot of R&D. Similarly, there are many universities and organizations investing in R&D for 3D printing;
- Some 3D printing practices are already being adopted in hospitals and clinics;
- The UK is lacking technical skills and expertise on the 3D printing market, this is a chance for 3D Ways know-how to shine;
- The UK has a good market and strong company potential.

DISADVANTAGES

- Some competitors are already involved in projects with hospitals;
- There is a high uncertainty due to of Brexit; regulations on services and technology will change.

Although there is a lot of uncertainty with Brexit and multiple changes associated with this scenario, in this case, in the service providing regulation, the market size and potential revenue represent a realistic scenario for 3D Ways to enter. Moreover, the healthcare industry has already started to adopt 3DP technologies. Furthermore, even though there is some competition, it is believed that there is still space for 3D Ways to explore and attain market share. Especially in the healthcare sector, as competition is still low. Additionally, if Brexit happens, this can be result in potential positive chance for 3D Ways to explore, as it will be harder to find skilled employees, leaving 3D Ways with an opportunity to integrate its remote know-how to clients that need it. Finally, there are several R&D initiatives through universities and centres, that are rapidly growing benefiting from investments, representing another potential area for 3D Ways to become a global player.

Country Selection

Selection of Final Country

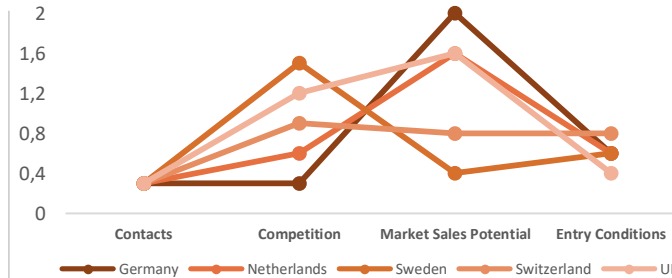
COUNTRIES' ASSESSMENT OF DIMENSIONS

Countries	Rank							
	Contacts	Weight	Competition	Weight	Market Sales Potential	Weight	Entry Conditions	Weight
Germany	3		1		5		3	
Netherlands	3		2		4		3	
Sweden	3	0.1	5	0.3	1	0.4	3	0.2
Switzerland	3		3		2		4	
UK	3		4		4		2	

In order to proceed with a market selection, it was decided to attribute a value, from 1 to 5 (5 representing the most favourable one) to each of the final countries, according to the dimensions that have been considered during the in-depth market analysis. **The country that will be chosen as the target market for 3DWAYS international expansion will be the one presenting the following most favourable characteristics: high quality of contacts, low degree of market competition, high market sales potential and advantageous market entry conditions.** After assigning different values, we also decided to attribute to each dimension (contacts, competition, market sales potential and entry conditions) a specific weight, based on the following logic:

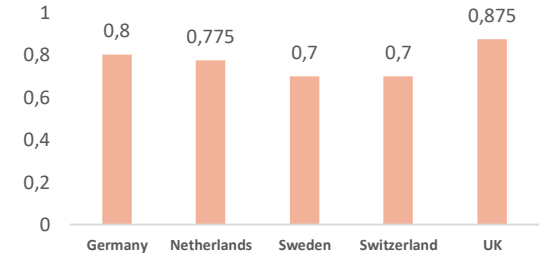
- > With a weight of 0.4, market sales potential is the most significant variable for 3DWAYS, whose scope is to gain the highest possible profit margins in a relatively short amount of time with the aim of being sold to a big competitor and obtain the highest possible returns on the investments made.
- > Competition is the second most relevant factor, with a weight equal to 0.3. In fact, due to the heavy inexperience and low brand consideration of 3DWAYS on the competitive landscape, high level of competitions can seriously ditch company's success in its attempt of acquiring and retaining customers.
- > With a weight of 0.4, entry conditions are considered less crucial, since countries are positioning quite similarly on this variable, as a result of being all part of the EU (except for Switzerland and UK).
- > Contacts appear to be similar among all the selected countries, which are not displaying any significant discrepancy among each other and, thus, the lowest weight (0,1) has been assigned as a result of the low significance of this dimension.

COUNTRY COMPARISON



As displayed by the graph above, while on contacts and entry conditions, all 5 countries provide equal opportunities to 3DWAYS, competition and market sale potential are significantly different. Regarding the level of competition, Germany 3DP industry appears to be highly competitive since the industry is already placed at an advanced stage, while Netherlands has a slightly lower competition that, at the same time, is concentrated within the healthcare sector, with stable relationships already in place. Similarly, Switzerland comes just behind Netherlands due to the highly developed healthcare and med-tech sectors, which are driving competition within 3DP service providers dedicated to health facilities. As a result of late investments in 3DP industry and without an outstanding performance in terms of health system, the UK 3DP industry for healthcare sector does not appear to have reached its full potential, positioning itself relatively well in terms of competition for 3DWAYS. Finally, the presence of competitors in Sweden, especially related to the healthcare, is extremely low, due to the emerging stage characterising 3DP industry in Sweden. Concerning the market sales potential, the following ranking can be implemented: Germany, Netherlands and the UK at the same position, Switzerland and, finally, Sweden. As it is possible to notice, countries in which the market sales potential reaches the highest values are those in which the competition is extremely intense.

FINAL SCORE & COUNTRY CHOICE



Based on the previous assessment, the **UK ranks at the first place**, with a total value of 0.875, thus **embodying the country in which 3DWAYS can fully exploit and benefit from its competitive advantage.**

With a total score of 0.8, Germany classifies 2nd in the ranking, mostly due to the enormous size of its market and the company's sales potential.

Netherlands follows Germany, which has a positive gap on competition but an equal negative gap on market sales potential, thus collocating Netherlands on third position with a final value of 0.775.

Finally, having both a final score of 0.7, Sweden and Switzerland are ranked at the last positions. In fact, these two nations have a similar market sales position and market entry condition (1 absolute point of difference but weighted differently), while the gap in terms of competition become wider, reaching two absolute points.

Brexit Implications in Healthcare

Expected Consequences of a Hard or No-Deal Brexit

NO-DEAL IMPLICATIONS

Currently, healthcare in the UK is regulated by the EU. After a no-deal Brexit, UK regulations would diverge from EU standards, turning the country into a less attractive market. However, because a no-deal would mean more freedom to the UK to depart from EU state-aid laws, the government could amend legislation to counteract some negative impacts of Brexit. Nonetheless, the UK's economic relations with the EEA as they are today would end, negatively impacting the NHS with supply shortages for medicines, price increases, difficulty in accessing specialized staff, increased demand from British nationals returning to the country, etc. (Holmes, Baird, and McKenna 2019).

ACCESS TO HEALTHCARE

Regarding access to healthcare, currently there are reciprocal healthcare rights in place, meaning that British citizens can be treated in another country, and EU citizens can access treatments in the UK hospitals. These rights are meant to hold in the transition period, while Britain secures new agreements. However, in the case of a no-deal, there would be no transition period, meaning that these rights would be lost. Although some member states have already signed bilateral agreements to ensure the continuity of the current health care rights for their citizens, even in a no-deal scenario, the implications for the UK citizens living in countries where no such agreements were reached could mean that they have to **return to the UK in order to have access to healthcare**, which would strain NHS services. British citizens living abroad are older, on average, than EU citizens living in Britain, and more likely to need healthcare services, so the balance of people coming into the NHS versus the people leaving would be negative for the UK's public health system. Moreover, as the sterling weakens, it could drive an influx of international patients looking for excellent private healthcare. The 2008/2009 crisis saw an increase of affluence into private hospitals, with people who were afraid of losing their jobs taking advantage of their private healthcare coverage while they could.

NHS STAFF STATE

- > Currently, the NHS is under a shortage of staff (9% of posts), which is depending on international talent coming into Britain to fill these roles.
- > 5.5% of the NHS workforce are EU workers; 10% of the NHS doctors are EU nationals.
- > Since 2016, the number of foreign doctors/nurses registered in the UK has fell, a consequence of the Brexit referendum.
- > As the pound value falls, staff feels more discouraged to come to Britain, as they would earn better salaries in their home-countries.
- > Foreign staff that is currently working there can remain in Britain after Brexit if they apply for the EU settlement scheme by July 2021. The government plans to keep acquiring talent from abroad after Brexit, but with an earning threshold of £30,000, which would **negatively impact the attraction of foreign staff for the NHS**. However, this threshold is currently being analyzed, in a report due by January 2020, and could possibly change.

FINANCIAL IMPACT

Since the referendum, the government has committed to a **yearly investment in the NHS of £20.5 bn**. However, according to estimations from the Office for Budget Responsibility, a no-deal Brexit with medium disruption levels would have yearly costs for the British economy of £30bn, and the Institute of Fiscal Studies estimates a government borrowing, in the same scenario, of £100bn a year, which would strain the economy. A recession in the British economy would not necessarily involve a decrease of spending in healthcare, but even the agreement reached for the NHS funding does not cover the entirety of healthcare services. It does not include public health, training, or spending on building and **equipment**. Therefore, these areas would feel the deepest impact in the case of a no-deal Brexit.

Britain's main concerns regarding the consequences of a Hard Brexit for healthcare are related with **shortage of medicine and medical supplies, shortage of staff and talent acquisition, difficulty for British nationals living in EU to access healthcare** and their return to the country, straining even further the already burdened system, and the effects of a possible recession on the Nation's Healthcare budget. However, these issues could be an advantage for 3D Ways, as it offers a cheaper and more efficient alternative for facilities to obtain medical devices and equipment, in a time when the sector is strained and in need of solutions.

4. INTERNATIONAL ENTRY STRATEGIES

- Entry Modes Overview
- Assessment
- Entry Mode Selection

International Entry Strategy

Market Entry Strategy Overview

VARIABLES	INTERNATIONALIZATION	INTERMEDIATE	EXTERNALIZATION
Costs	High	Medium	Low
Flexibility	Low	Medium to low	High
Risk	High	Medium to high	Low
Control	High	Medium	Low

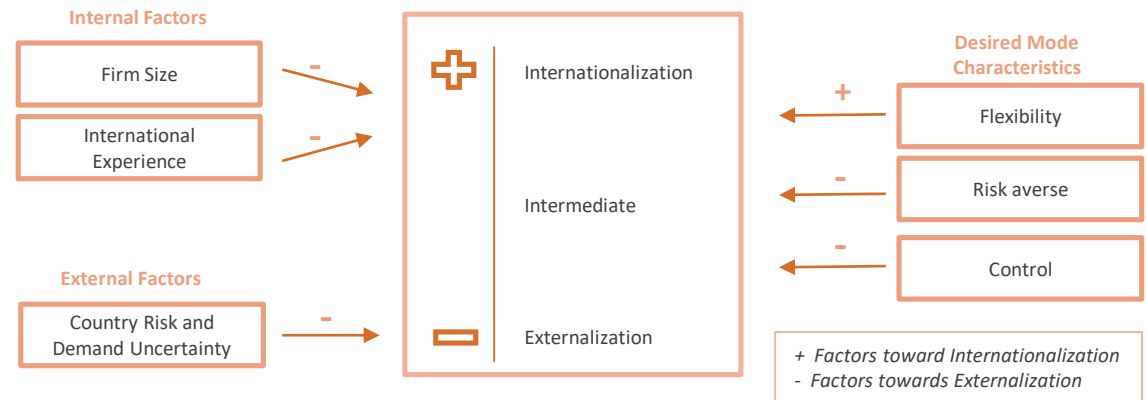
The entry mode for an international market has a significant and crucial impact on the performance of a company. It can be impacted positively if the strategy is adequate or negatively if it is not appropriate to the firm characteristics and goals (Hill, Kwang & Kim, 1990).

The internationalization strategy of a firm should take in consideration many factors, both internal and external. It is important to assess whether the company has the resources, the degree of expertise and the flexibility for a specific entry mode. There are several types of entry strategies which are based on four common dimensions: *cost*, *flexibility*, *risk* and *control*. *Cost* is represented by the amount of resource commitment needed for the internationalization process. *Flexibility* is the easiness of adapting to change in the overall strategy of the company (the highest the resource commitment invested the lower is the company flexibility). *Risk* is characterized by the degree and level of potential risks connected to the process of internationalization (i.e. risk of insolvency, regulatory risks, currency fluctuations and market risks). The degree of *Control* is considered as the extent of the possibility to control the product and distribution in the foreign country.

Firms that seek an Internationalization entry mode are usually multinational enterprises with an established experience in the international market and strong performance in the domestic market. Usually, these firms adopt equity modes strategies, which are characterized by a significant investment from the firm in international expansion (Pan & Tse, 2000). It usually happens when the company seeks for higher control of their international market. These strategies are: Foreign Direct Investment (FDI), Wholly-owned Subsidiary or Mergers & Acquisition.

The Intermediate entry strategies could be both equity or non-equity modes (Hollensen, 2009). This relies on a compromising degree of risk, flexibility, control and costs depending on the strategy adopted. The most common strategies are: Joint-Ventures, Strategic Alliances, Franchising and Licensing (Root, 1994). The former are equity based (a significant investment) while the latter are non-equity.

The entry strategy that is mostly adopted and suitable for small-medium enterprises that seek their first internationalization is Externalization. This entry mode is based on exporting, a non-equity mode, which could be performed through three different methods (direct, indirect or company-owned foreign subsidiary (Cavusgil & Knight, 2004).



Adapted from Hollensen, S. (2009) "Essential of Global Marketing" Chapter 8 Ed. Prentice Hall

3DWAYS		
INTERNAL FACTORS	EXTERNAL FACTORS	DESIRED MODE CHARACTERISTICS
<p>From an internal factor standpoint, small scale and no previous international track record could make an internationalization strategy challenging and cumbersome. Along with the fact that the scarce resources and the complexity of their service suggest an entry strategy focused on externalization.</p>	<p>The external factors take in consideration for 3D Ways' internationalization are <i>risks</i> and <i>demand uncertainty</i>. First of all, the service is still premature (only on client) and affecting the potential of the demand. Besides that, the newness of the industry and service could also negatively impact the demand. Furthermore, Brexit is a crucial factor in terms of country risk (currency instability, trade and entry barriers).</p>	<p>3D Ways has an entrepreneurial spirit that could be translated in strong appetite for risk. However, it is essential to avoid high <i>risks</i> and look for <i>high flexibility</i> for their first international experience regarding its service. Flexibility should be a crucial factor for the analysis of the entry strategy selection. Market uncertainty and the fast development of the industry, should be taken into consideration. 3D Ways must be able to adapt or change rapidly its strategy accordingly.</p>

The conclusion from the following qualitative assessment suggests the implementation of an externalization (or even an intermediate entry mode strategy). Considering 3D Ways lack of financial resources it should be further analyzed only non-equity modes for intermediate entry strategies. This result reflects the nature of the company as a small-medium enterprise. Indeed, according to Cavusgil & Knight (2004), SMEs are prone to undertake strategies which requires a lower resource commitment due to the lack of strong financial resources

International Entry Strategy

Entry Mode Assessment

Before analyzing the possible entry strategies for 3DWays in the United Kingdom, it is important to revise a few characteristics of the company and the nature of its 3D printing factory network. First, the company is assumed to be a *Born Global Firm*, as previously analyzed and explained in the respective slides. The common and distinctive characteristics of these firms is the adoption of an *early* and *rapid internationalization* process, which in this case is internationalizing a self-developed technology service, the remotely managed 3D printing factory network. Second, in 2019, the company was able to secure €300,000 in funding, which intends to channel a portion to the internationalization process. Hence, the entry strategy must ponder the amount available of capital requirements (*asset parsimony*). Finally, 3DWays' final goal is to be acquired. In order to become an attractive acquisition target in the next years, 3DWays must increase its revenue and profitability. To do so, the company needs to scale its business model fast, since Portugal does not provide that possibility. Thus, the first internationalization process must be finalized soon.

NON-EQUITY MODES

CONTRACTUAL AGREEMENTS

Licensing is a contractual agreement where the licensor gave the right to access their patents, trademarks or technology to another firm (licensor) for a royalty. The fee is usually around 2-5% and the contract usually lasts for 5 to 7 years. This entry mode is most suitable for standardized products which have no risks of dissipation of technology advantages. This entry strategy should be considered in a later stage of internationalization when the company wants to have control over firm advantages for technology. Like licensing, **franchising** is a contractual agreement between the franchisee (third party) and the franchisor (the company). Being quite like licensing but with a few differences. The franchisor guarantees access to the brand image, know-how, training and procurement to the franchisee which has the task to take the personality of the brand in a foreign country where is located. The franchisee must be responsible for the personnel, the operations management and investment in the country where is located. (Pan & Tse, 2000)

EXPORTING

Exporting is the easiest way to start internationalizing. This method consists of the sales of the goods and services of the company abroad. This can be done in three ways: through direct export or indirect export and through a company-owned foreign subsidiary. The main advantages of this entry mode are that resource commitment which is extremely low, and it is an easy process to establish compared to other methods. Additionally, it is an extremely flexible method since resource commitment is low, allowing firms to easily adapt to the market needs and demands or eventually change rapidly to another market. However, this entry mode gives the firm limited control in the foreign market. Furthermore, the company could lack specific knowledge on the market, especially on its customers.

ASSESSMENT

The firm is yet to find regularity in its home market regarding their network business model. Therefore, the internationalization process should be thought off to avoid big risks and should consider high flexibility to test the market abroad and be able to change and reach new markets rapidly, according to the demand, to scale the network fast.

Looking at both non-equity methods, even though that contractual agreements are very similar to exporting, it is not a viable option because of the nature of 3Dways' solution and its competitive advantage. Providing the right to sell its software to another entity without a patent is an extremely risky move for the company. Since the firm has still not be able to protect their business model and service with a patent, they can not be protected legally from potential threats by being represented through external intermediaries. Therefore, the most appropriate entry mode for 3DWays at this stage, taking into consideration the characteristics and limits of the company is exporting.

3DWAYS EXPORTING

3DWays need to scale its solution fast, since their home market is small and there are not many opportunities for the firm to grow. Another factor to take into consideration is the company's limited financial resources. This scarcity pushes the company to focus on a wider geographical market to scale its network fast. Also, considering of the nature of the solution to be internationalized, being a service which is remotely managed through the company's software, there is no need for the company to establish its operations in its new target market, nor open a physical location. In support of this assessment, various authors and researchers have shown that, for born global firms, the entry strategy mostly adopted is exporting which allows the company to have a rapid and flexible internationalization (Cavusgil & Knight, 2004).

As a result, 3DWays can reach a vast number of markets without investing a significant amount of resources nor having to establish operations in every market. This, in turn, is a method that has a lower risk associated. Henceforth, exporting seems to be the most suitable strategy for 3DWays to enter in the United Kingdom. The flexibility which distinguishes this strategy allows the company to easily shift its focus to other countries or to more appropriate strategies, without significant losses. The main disadvantage of this method is that the limited control of foreign operations. However, this is not a substantial concern for 3DWays because of the nature of its cloud-computing service, company operations are remotely managed easily.

As previously mentioned, exporting can be executed through three different procedures: direct or indirect exporting or establishing a company-owned foreign subsidiary. All three methods are explained and analysed in the following slides.

International Entry Strategy

Entry Mode selection: Exporting

INDIRECT EXPORTING

Indirect Exporting is when all exporting functions are performed by an intermediary, in this case is a contracted exporting management company of the firm's home country. The company sells to an intermediary in its own country, which in turn sells to the final international market and takes on the responsibility of organizing paperwork and permits, organizing shipping and arranging marketing (Roy, E., 2017).

It is the cheapest and most flexible entry strategy available to a company, as sales, marketing and other costs are shared between the company and the intermediary. The biggest advantage is that companies do not have to worry about the exporting process since the intermediary organizations handle all the exporting activities and take on all the risks associated with it. Additionally, the initial market entry and sales growth can be fast as the company is using its partner's existing channels and customer base, benefiting from the partner's existing knowledge and networks. Also, the intermediary's local presence might be reassuring for some customers (NTZE, 2019).

The biggest disadvantage is that the control of activities overseas is lost to the intermediary organization (pricing, branding and marketing). The company also loses valuable knowledge about the foreign market and possible customers. Also, the company reputation might be affected in the foreign country since it has no responsibility for foreign operations. If the intermediary represents a lot of companies, it may lose focus. Finally, the profit margin will be narrower since there is an intermediary involved (NTZE, 2019).

DIRECT EXPORTING

Direct exporting is when the company is responsible for the whole exporting process (establishing contact with overseas clients, logistics and the overall processing of the transaction). Or, some export functions are performed by contracted intermediaries from the foreign market, like agents, sales representatives, foreign retailers or distributors. Usually, these functions are downstream value-chain activities like sales and marketing (Whetzel, J., 2019).

Direct exporting eliminates most intermediaries, allowing for direct marketing and profit maximization. Also, the company has more control over all aspects of the transaction, it gets to know its customers and thus they feel more secure in doing business directly with the firm. The company can send its own employees on sales calls to companies with a direct need for the product, leading to a better understanding of the marketplace. Direct exports offer more control over marketing, more protection for intellectual property and timelier feedback from foreign markets (Delaney, L. 2019).

On the other hand, it requires more time and money, including the cost of creating an exporting department or hiring an exporting responsible. Also, there is the need for educating employees about export documentation, establishing shipping procedures and the ability to make and receive international payments. There is a higher degree of responsibility and accountability from every level of the organization. Direct exports are costly for companies lacking the human resources for field sales and the financial resources to promote their products internationally (Delaney, L. 2019).

COMPANY-OWNED FOREIGN SUBSIDIARY

This is a similar method to direct exporting. However, the company establishes its own foreign subsidiary in the foreign market, a sales subsidiary (OAEC, 2013).

The main advantage is that the parent company can still provide guidance, direction and support to its subsidiary, having significant influence over the principles, vision, and tactics that govern the subsidiary. Another advantage of a foreign-owned subsidiary is that the parent company can share its resources, especially financial resources. The subsidiary receives a framework, from which it can quickly ramp up its operations, ensuring that the foundation of the subsidiary is strong. In addition, the parent company can provide cash flow and investment, should the subsidiary suffer unexpected losses. It enables a parent company to expand its target consumer and to introduce its services to new customers. It can have the tangential effect of helping the subsidiary access markets in neighbouring countries (Howard, F., 2017).

The main drawback of a foreign-owned subsidiary is that it is very expensive to build. Also, there could be language barriers, cultural differences, and a lack of workers skilled in the areas you need, which could negatively affect the success of that subsidiary. It is important to remember that the parent company holds all responsibility for the subsidiary and, therefore, any legal or financial action taken could lead to implications for the parent company (Quain, S., 2019).

Direct exporting requires more time and management of resources but maximizes profits for the producer or supplier. Indirect exporting costs money, taking away from the bottom line, but it frees up time and management of resources, making them available for creating more and better products.

International Entry Strategy

Entry Mode Selection: Direct Exporting in the UK

DIRECT EXPORTING

Before choosing a final exporting method, it is important to frame the characteristics and limits of the company with the features of each method. Establishing a company owned-foreign subsidiary is similar to direct exporting, but it is a costlier method. Thus, not being the appropriate method for 3D Ways. The biggest difference between indirect and direct exporting, is that with indirect exporting the company sells its service or product to an intermediary, and the last will handle the exporting process, selling it to customers in foreign market. Although this method is cheaper than direct exporting, because of the nature of 3D Ways' service, it is not applicable. 3D Ways is providing a highly technical knowledge service, that requires constant technical support and supervision by the company. Also, the company wants to continue developing and upgrading the features of its software and, consequently, its final service. Which in turn, a part of it relies on direct feedback from the clients. Therefore, direct exporting seems to be the best method for the company. It also eliminates intermediaries, allowing for direct marketing and profit maximization, which the company is currently seeking.

With this method, the company has two options. It either looks for clients on its own, losing more time, or it contracts a sales agency to do so. Since the company does not have any market knowledge on the United Kingdom, nor does it have a direct contact with whom they worked previously with, it is recommended that it follows the last option. Even though it is a bit more expensive, it saves a lot of time and human resources, which is important when taking into consideration the size of the company (Proposify, 2019). *Evolve* and *Star Medical* are two companies operating in the United Kingdom that outsource a sale and market access service to companies, specifically in the healthcare sector, and both have experience in the med-tech segment.

HARD BREXIT

Considering the case scenario of a Hard Brexit, the UK will leave the EU Single Market and EU Customs Union. Consequently, imports of goods and services will be affected and will be applied new trade import tariffs and regulations. Regarding specifically the moving of a software which provides a service (SaaS) the legal framework still lacks a detailed and regulated framework. 3D Ways should be aware that there is the chance that for software that can be electronically downloaded, the UK could apply exports control. Consequently, the company should ensure to follow all the steps regarding compliance and data protection laws. (Bickerstaff, 2019).

The trade for services between the UK and EU in case of No-Deal Brexit is still uncertain. The General Agreements on Trade in Services (GATS) is part of the agreement with the World Trade Organization to establish barriers for trade in services after Brexit. However, it is still not clear which legal barriers will be applied for services but is likely that will be stricter than the barriers for goods in trading.

SOFT BREXIT

Considering if there is a Soft Brexit, the UK may abide by particular EU FTAs (depending on the FTA partner country) and continue to count in favour of EU origin. Therefore, it would be a more "strategic partnership agreement" between the UK and the EU. If this would be the chosen scenario then both the EU and the UK would maintain mutual market access and avoid application of non-tariff barriers to trade in goods and services. This would imply that the UK would need to maintain full compliance with EU legislation for all goods and services imported and exported with the EU single market, thus including regulation on software movement between countries. Depending on how the agreement is to be negotiated, the country will either remain at its current trading status with the EU or re-establish a trading relationship with the EU single market under the framework of the WTO.

Direct Exporting is the most suitable method for 3D Ways due to the nature of the service and its specifications. It does not require substantial resource commitment, giving the company the necessary flexibility to adapt to the UK market and, at the same time, move to new markets to scale its network. Furthermore, 3D Ways should consider contracting a partner to explore the UK healthcare market and find customers, since the company does not have any previous experience operating in the UK.

5. MARKETING PLAN

- **Marketing Objectives**
 - 3DWAYS' Marketing in line with its Strategic Objectives
- **Market Segmentation and Customer Needs**
 - Customers' KPIs, 3DWAYS Beneficial Impact
 - Segmentation, Targeting and Positioning Analysis
- **Targeting**
 - Geographical Targeting by Density
 - In-depth Analysis of Great London and South-East in England
 - Pros & Cons of Big Public and Small-Medium Private Infrastructures
 - Decisional and Financial Flow in Big Public Infrastructures
- **Positioning**
 - Positioning Map and PoP/PoD analysis
 - Value Proposition & Positioning Statement
- **Marketing Mix**
 - Place, Promotion, Physical Evidence and People at the center of Organizational Restructure
 - Promotion: Application of 7Ps on 3DWAYS healthcare targets
 - Promotion: 3DWAYS' Tools
 - People: Organization & Structure
 - Physical Evidence

Marketing Objectives

3DWAYS' Marketing in line with its Strategic Objectives

MACRO MARKETING & STRATEGIC OBJECTIVES

Marketing objectives are represented by the goals that a company wants to pursue in view of its marketing strategy. They can be both qualitative and quantitative, but the most common goals are usually related to the following outcomes: profits, market share, return on invested capital and/or customer-based factors (such as satisfaction and repurchase rate) (Gupta S., 2014). With the need of prioritizing one or few of them, due to the contradictory logics and mechanisms behind each of them, the **selected objectives need to be strictly in line with the strategic objectives at the base of the overall corporate plan of actions**. Specifically, **3DWAYS long-term objective is to be acquired by potential targeted companies operating within the 3D printing industry**. For this reason, it is **crucial for 3DWAYS to grow the business by maximizing the projected profits**, being also aware of the difficulty of conquering a large market share in the UK, where the targeted market is already populated by experienced market players.

Once “increasing profits” has been chosen as macro marketing objective, 3DWAYS can undertake three different paths for achieving this common goal: increase price, increase quantity or reduce costs (due to the profits' equation $P*Q-C$). Both price and quantity of units sold are the dimensions impacted by a marketing strategy and, since price is settled as a subscription fee on which negotiation will have a significant role, the **increase of sales in terms of units of products sold (software installed per printer) will be the overall marketing goal**.

SMART APPROACH AND MISSION STATEMENT

According to the SMART approach (CMI, 2014), companies need to identify marketing objectives, at the base of an execution plans, which satisfy the following characteristics;

1. **Specific:** 3DWAYS needs to specifically outline and share the selected objectives among the organization, in order to align the objectives with the appropriate strategic actions.
2. **Measurable:** 3DWAYS need to define a set of Key Performance Indicators (KPIs) and benchmarks, necessary to track its progress towards the predefined goals;
3. **Achievable:** 3DWAYS needs to possess the necessary abilities required to achieve the defined objectives, which need to involve factors under the its control;
4. **Relevant:** 3DWAYS selected goals need to be aligned with the business vision and mission, in line with the strategic path chosen by the founders;
5. **Time-bound:** 3DWAYS needs to define a timeline stating the beginning and ending for which the objectives must be accomplished.

3DWAYS mission statement, which can summarise the key objectives in one paragraph, will be the following: **“3DWAYS will register a yearly revenue growth rate at approximately 50% from the next five years”**. This goal has been set accordingly to the annual average growth rate of SaaS companies' revenues, around 44% in 2015, 48% in 2016 and 52% in 2017 (Chan V., 2018; Sytnik R., 2019).

3DWAYS MARKETING MICRO GOALS

In order to increase 3DWAYS' sales, the following specific goals/actions need to be coordinated and are necessary to improve and measure awareness, intents and purchases :

1. **Grow brand awareness**, due to the newness of both the company and the type of service provided, both in Portugal and in the UK;
2. **Increase lead generation**, due to the unexploited market potential in the UK, mainly derived by the undiscovered benefits the 3DP services can provide to healthcare facilities; **Main KPIs:** *Number of leads:* total number of new leads brought in; *Increase in leads:* percentage change in lead generation compared to other time frames; *Cost per lead:* amount of money spent to acquire one new lead; *Conversion rate:* percentage of your traffic that becomes a lead after visiting your website.
3. **Acquire new customers**, at the base of the growth phase expected for its remote-control management service, considered the “star product”, which does not involve any client in Portugal at the moment. **Main KPIs:** *Number of new customers:* the amount of new customers acquired over a certain period; *Increase in new customers:* percentage change of new customers compared to other time frames; *Cost per new customer:* the amount of money spent to acquire a new customer; *Lead-to-customer ratio:* percentage of leads that become paying customers

The **long-term objective for 3DWAYS is to be able to implement a large network of 3DP factories**, with a considerable amount of inter-connected clients, in order to be acquired by an established company. For this reason, 3DWAYS' marketing objectives for the next 5 years can be translated into a **targeted revenue growth rate at 50%**, supported by a marketing strategy aimed at increasing brand awareness, generating new leads and focusing on new customer acquisition.

Market Segmentation and Customer Needs

Customers' KPIs, 3D Ways Beneficial Impact and Successful Examples

HOSPITALS' PERFORMANCE INDICATORS

Healthcare services providers' performance can be evaluated based on 4 different dimensions: safety, effectiveness, responsiveness and governance, all of them assessed by *CareQuality Commission*. Particularly, healthcare facilities can perform differently on each of these quality indicators, thus being characterized by different needs.

- > **Safety**, as a consequence of bad medical diagnosis and treatment, is assured by having in place high-surgical environments and equipment, along with high-skilled personnel. This aspect is extremely important for any corporation operating in the medical sector.
- > **Effectiveness**, represented by the ability to successfully diagnose and treat patients, is at the base of public healthcare competitive advantage. In fact, while private healthcare facilities distinguish mainly for good pre-admission assessment, patients characterized by more sophisticated needs or complex conditions are treated in the NHS system.
- > **Responsiveness**, expressed in terms of short referral to treatment times, affects the management of patients flow, which can benefit from low levels of cancelled or delayed admissions or procedures. This aspect is crucial to private healthcare since patients and insurers are specifically paying for prompt access to medical services.
- > **Governance**, revealed by well-led services in place, is ensured by the implementation of formalized processes which guarantee systematic and robust "best practices". This aspect can be particularly weak for smaller facilities, in which management and informational flows within the organizations are not structured.

3DP & 3DWAYS SOLUTION'S BENEFITS

3DP technologies and 3D Ways service solution can both provide significant opportunities for improvement in the four key success factors on which the competitive advantage of healthcare providers (specific to hospitals) is based on.

	3DP TECHNOLOGIES	3DWAYS' TURN-KEY SOLUTION
SAFETY	Nowadays, the quality of 3DP finished products is very satisfying, with implants and prosthetics that allow for less risks during surgical operations and less time to recover.	3D Ways allows hospitals, whose medical expertise does not expand into highly advanced manufacturing process, to take advantage of 3DP technologies, without the technical know-how required.
EFFECTIVENESS	3DP technologies represent an extremely flexible and adaptable solution. In fact, they are particularly suitable in those cases requiring high complexity and customization, thus allowing for more effective interventions.	With its robust knowledge and experience, 3D Ways is able to provide high-quality standards, enhanced by its quality checking system in place.
RESPONSIVENESS	3DP allows to reduce not only the time of prototyping and producing, but also lower the logistic time as a result of on-site production.	3D Ways provides the possibility for its customers to pay an additional fee in order to have their orders prioritized along the queue. This can be extremely useful in case of emergencies, which often occur in hospitals with acute medical services.
GOVERNANCE	3DP technologies and their related software can contribute to the implementation of a more structured work-flow, as a result of the automation introduced throughout the overall supply chain.	3D Ways service reckons on an organized process, which promotes the gathering and sharing of information across the organization and with 3D Ways itself, by involving the active participation of hospitals' personnel.

SUCCESSFUL EXAMPLES OF 3DP ADOPTION


Across the United Kingdom, three NHS hospitals have started to adopt 3D printing technology for surgeries and implants with the establishment of in-house laboratories and 3D printer's software.

1. The **North Manchester General Hospital** has set up, in 2018, an in-house 3D printing lab starting with a focus on reconstruction for cancer surgeries. The hospital was already adopting 3D printed material for surgeries even though it was outsourced. In order to save money and to cut delivery time through an improved workflow without the need of communication to third parties. (Haria, 2018)
2. The **Newcastle Hospitals NHS Foundation** have, in collaboration with *Axial3D*, an on-site printing laboratory. The main application regard orthopaedics and spinal surgery allowing surgeons and doctor to save time in critical stage of a surgery. The lab is situated in the Royal Victoria Infirmary, where it will be produced pre-surgical products while more complex supplies will be directly sent from *Axial3D* industry which is places in Belfast. (Jackson, 2019)
3. An additional NHS hospital that has adopt 3D printing technology is **Belfast City Hospital**. This hospital has adopted 3D printing technology with *axial3d*, which has helped the surgeon to succeed in a complex kidney transplant. (Haria, 2018)

These three cases of NHS hospitals adopting 3D printing technology demonstrate and support the objective of 3D Ways to operate in the healthcare segment and the potential of UK for this technology.

Market Segmentation and Customer Needs

Segmentation, Targeting and Positioning Analysis

SEGMENTATION	TARGETING	POSITIONING
Objective: group customers based on similar needs and profile each segment	Objective: assess attractiveness of each segment and select segments to target	Objective: define value proposition for target segments and develop and action plan
<p>In order to segment the healthcare industry in the UK, it was considered the overall amount of both public and private healthcare organizations operating across the country. However, it was decided to exclude from the analysis the entire category of independent/individual private facilities that do not belong to any large private healthcare group. In fact, in addition to NHS foundation trusts, the segmentation and targeting criteria are applied to the top ten private healthcare operators by acute medical/surgical revenues, representing the branch of the secondary care which is based on short-term rather than chronic and long-term treatments and in which 3DP can find the majority of medical applications (such as dental, orthopaedics etc.). The reason why 3DWays should consider exclusively large healthcare operators, managing a variety of infrastructures, consists of the opportunity for the company to easily and rapidly scale the networking system that 3DWays intend to build at base of its unique offering. Also, at the same time reduce its customer acquisition costs. In fact, large healthcare providers not only can benefit from higher internal synergies, sharing the 3DP services among their own facilities, but can also contribute to the establishment of strategic partnerships, by sharing their capacity with the other public and private actors with the aim of building an integrated healthcare system.</p> <p>Taking into consideration the B2B business model of 3DWays within the 3DP industry, the Segmentation criteria applied are the following:</p> <ul style="list-style-type: none"> > Firmographic criteria, embodied by the type of funding categorizing hospitals into publicly or privately funded. > Geographic criteria, which can be firstly expressed into the four different regions composing the United Kingdom (<u>first geographical targeting</u>); secondly, the seven different counties composing England (<u>second geographical targeting</u>); finally, the two targeted counties, namely <i>Great London</i> and <i>South East</i> of England (<u>scope targeting</u>). > Size of healthcare infrastructures (introduced only for the scope targeting), which can be expressed by the number of inpatients beds, categorized into the two following segments: big and small-medium. <p>The resulting segments, 8 segments for <u>first geographical targeting</u> (4*2), 14 segments for the <u>second geographical targeting</u> (7*2) and 8 segments for the <u>scope targeting</u> (4*2), possess different characteristics and needs, that will be further assessed through the targeting criteria with the aim of selecting the one that better suits 3DWays' offering.</p>	<p>Three different targeting processes have been performed to not exclude at priori any of the alternative segments that 3DWays could potentially reach. However, the selected targeting criteria, namely density, computed as number of hospitals/geographic area(km²), will be repetitively applied during the geographical targeting process. Specifically, higher density of hospitals is crucial for 3DWays to maximise its market potential, as well as facilitate the process of building a network. On the other hand, for the third and final scope targeting, the criteria applied will be quantity, represented by the number of facilities. Therefore, two different types of targeting have been conducted:</p> <ul style="list-style-type: none"> > Geographical Targeting: <ol style="list-style-type: none"> <u>1. First geographical targeting</u> was performed differentiating both public and private hospitals according to the four different regions composing the United Kingdom, namely: <i>Scotland, Northern Ireland, Wales</i> and <i>England</i>, for a total number of 8 segments. By applying the density criteria, England was found to be the region with the greatest potential for 3DWays. <u>2. Second geographical targeting</u> was performed differentiating both public and private hospitals based on the seven different counties composing England, namely: <i>North East & Yorkshire, North West, South East, South West, London, East of England</i> and <i>Midlands</i>, for a total number of 14 segments. By applying the density criteria, the counties of both Great London and South East appeared to be the most attractive ones for 3DWays. > Scope Targeting: <ol style="list-style-type: none"> <u>3. The aim of ranging the final targeting</u> within public and private hospitals placed in Great London and South East of England is to restrict the amount of targeted healthcare facilities because of 3DWays significant constrained resources, which in turn would consequently limit the possibility of the company to reach and penetrate the entire set of 181 acute/general hospitals within the two counties. Among a total number of 8 segments (4 in Great London and 4 in South East), 4 should be 3DWays' final segments on which the company should focus its marketing and commercial efforts: Big Public Healthcare Facilities and Small-Medium Private Healthcare Facilities, in both London and South East counties. 	<p>Being aware of the different characteristics (purchasing behaviours) and needs (convenience, quality, safety etc.) of public and private hospitals, it will be necessary for 3DWays to implement two different value propositions, in order to capture as much as possible the potential benefits sought characterizing the different healthcare operators.</p> <p>By assessing both Points of Difference and Points of Parity compared to its direct competitors, the added value of 3DWays' networking, built on its innovative business model proposition, will play a different but equally significant role for each of the two targeted segments, Big Public and Small-Medium Private healthcare facilities. Particularly, with the value networking being 3DWays only Point of Difference, it will be the decisive factor in leading potential customers to choose 3DWays' offering instead of its closest competitors. Therefore, this is the beneficial functionality that will be mostly highlighted in both value propositions.</p> <div data-bbox="1855 1271 2195 1337" style="border: 1px solid gray; padding: 5px;">  <p>For description of 10 top private healthcare providers, please check Appendix 13)</p> </div>

Targeting

Geographical Targeting by Density

In view of the significant geographical differences affecting the healthcare sector in the UK, both on a macro (regions) and micro (counties) level, it was decided to look at the geographical distribution of healthcare organizations and their facilities. Thus, "density" was applied as targeting criteria to choose a geographical focus for 3DWays, especially due to its scarce resources limiting its potential actions. A higher number of large healthcare operators established on each territory corresponds to a higher market potential for 3DWays whose scope is to reach large public and private medical providers in control of several facilities.

1. FIRST GEOGRAPHICAL TARGETING

Segmentation criteria	Type of funding; Regions of UK		N° of NHS trusts/ boards	N° of NHS Hospitals	N° of health-care private operators	N° of private health-care facilities
N° of segments	8 (Public and Private hospitals for each of the 4 regions)	Scotland	14	279	5	7
Targeting criteria	Density	Northern Ireland	5	41	0	0
N° of targeted segments	2 (Public and Private hospitals in England)	England	145	865	10	198
		Wales	7	71	3	6

	Area (km2)	N° of Total Hospitals	Density per km2	Density per 1000 km2
Scotland	80,077	286	0.0036	3.57
Northern Ireland	14,130	41	0.0029	2.90
Wales	20,735	77	0.0037	3.71
England	130,395	1063	0.0082	8.15

England (865) accounts for the 85% of the total number of NHS hospitals in UK (1.256), followed by Scotland (279). In England, a trust is responsible for approximately 6 healthcare infrastructures on average (865/145), while in Scotland the number increases up to 20 (279/14). The private sector has a similar structure to the public one, with all the 10 private large groups focusing their activity in England (198 hospitals), followed by Scotland (7 facilities) in which 5 out of the top 10 private healthcare providers are operating. As a result, private healthcare in Scotland appears to be highly spread, with a very low presence of infrastructures owned by a relatively large number of private medical services suppliers. **Considering the density of hospital in each region, England stands out for the highest density of hospitals per 1000 km² (hospitals/area).** Hence, it is considered the most attractive region for 3DWays' expansion, even though the NHS system is more decentralized. In fact, while establishing a relationship with one of the NHS trusts facilitates the process of reaching other trusts, the same logic cannot be applied to the private sector. In fact, private operators are independent from each other, thus it is extremely important to have as many private healthcare facilities as possible under the same operator (19.8 in England vs 1.4 in Scotland on average).

2. SECOND GEOGRAPHICAL TARGETING

	PRIVATE														Area (Km2)	Density (H/Km2)	Segmentation criteria	Type of funding; Counties of England
	PUBLIC	#Trusts Acute	#Spire	#Aspen	#HCA	#Circle	#BUPA	#London Clinic	#Nuffield	BMI	Ramsay	CareUK	#H Region					
North East-Yorkshire	20	5	2	0	0	0	0	6	6	5	0	44	20,495	2.15	N° of segments	14 (Public and Private hospitals for each of the 7 counties)		
North West	25	6	0	2	0	0	0	3	5	4	1	46	20,165	2.28				
South East	19	9	0	0	1	0	0	9	4	2	2	46	19,096	2.41				
South West	17	1	0	0	1	0	0	5	6	3	4	37	23,800	1.55				
Greater London	23	5	3	6	0	2	2	2	12	3	1	59	1,569	37.60			Targeting criteria	Density
East of England	18	4	1	1	0	0	0	1	5	7	0	37	19,120	1.94			N° of targeted segments	4 (Public and Private hospitals in London and South East)
Midlands	23	5	1	0	1	1	0	3	5	4	1	44	28,627	1.54				

While comparing the 7 counties that compose England, the area called *Greater London* distinguishes itself because of its high number of NHS acute trusts (23) and private hospitals (36). Likewise, *South East* is a very attractive county, in which both the public and private healthcare organizations are well represented, with 19 NHS trusts and 27 private hospitals. Similarly, the *North West* county registers the highest number of NHS acute trusts in England (25) but has a lower presence of private healthcare infrastructures (21).

Considering density of hospitals, it is easily noticeable the same conclusion. The two counties of *Greater London* and *South East* represent the most attractive target for 3DWays with a density of about 38 hospitals in *Greater London* and 2 hospitals per 1000 km² in *South East*, respectively. Therefore, **the regions where 3DWays can have the highest market potential are both the area of *Great London* and *South East*, the latter being preferred to *North West* for its stronger presence of private operators.**

Targeting

Scope Targeting by Quantity: In-depth Analysis of Great London and South East in England

NEW SEGMENTATION CRITERIA

When looking at the composition of the healthcare sector across the two selected geographical areas, namely *Great London* and *South East* of England, it was listed all the **healthcare facilities which can be labelled under the categories of general or acute hospitals**. Specifically, it were excluded from the analysis all specialty hospitals such as psychiatric or maternity fields, in which 3DP applications appear to be quite limited. An **additional segmentation criteria** has been introduced to provide a **clearer distinction between the different sizes of healthcare facilities** within healthcare organizations, which is indicated below:

- **Size of healthcare infrastructures**, which can be expressed by the number of inpatients beds and, thus, categorized into the two following segments: **Big** (>400) and **small-medium** (<400) in the case of London (>300) and **big** and **small-medium** (<300) in the case of South East, considering the different ratio of population per surface.

As a result, different segments per region can be identified, namely as **Big Public Infrastructures**, **Big Private Infrastructures**, **Small-Medium Public Infrastructures** and **Small-Medium Private Infrastructures**, reaching a total number of eight different segments, on which a new targeting criteria, namely quantity, expressed by the number of facilities, is applied. From then on, *Density* will not be anymore a valuable criteria, since both counties will be automatically targeted for the following motives:

1. High competition faced in the area of *Great London*, which represents a high entry barrier for 3DWAYS;
2. Geographical proximity, allowing 3DWAYS to reach and directly sell both areas with minimum operational costs.
3. Networking effects, enabled by expanding the geographical reach of 3DWAYS customer base.

EIGHT FINAL SEGMENTS

Segmentation criteria	Type of funding; Two counties of England, Great London and South East; Size of healthcare infrastructures
N° of segments	8 (Big/Small Public and Private hospitals for each of the two counties)
Targeting criteria	Quantity
N° of targeted segments	4 (Big Public and Small Private hospitals in Great London and South East)



Great London	N° of Public Hospitals	N° of Private Hospitals
Small-Medium	21	29
Big	25	1
Total Target Hospitals	54	

South East	N° of Public Hospitals	N° of Private Hospitals
Small-Medium	24	37
Big	25	0
Total Target Hospitals	62	



For the hospital in London & South East regions, please check Appendix 14) & 15)

THIRD FINAL TARGETING

By applying the *Quantity* criteria, aimed at guaranteeing the highest number of potential customers for 3DWAYS, the segments that should be targeted, both in *Great London* and *South East*, are **Big Public Healthcare Infrastructures** and **Small-Medium Private Healthcare Infrastructures**, representing very attractive options in terms of company fit as well. In fact, **Small-Medium Private infrastructures can not only benefit from the service 3DWAYS is offering, but also serve as extremely useful resources in view of the networking system**, due to the probability of under-utilization of their 3D printers. Thus, allowing organizations to monetize printers' idle time. At the same time, focusing exclusively on the private segment would not allow 3DWAYS to sufficiently diversify its customer base and lower the intrinsic risk of its international expansion. In fact, **3DWAYS' fast and cheap manufacturing method could potentially improve the current status of public hospitals, suiting the specific needs of public operators**, such as low financial resources and long waiting times compared to the private sector. **Excluding public healthcare providers would also extensively limit 3DWAYS market potential since they represent the largest share of healthcare sector in both regions, accounting for 58.64% of the total amount of hospitals**. However, Big Public Infrastructures are preferred to the Small-Medium Public Infrastructures due to higher level of disposable resources and extent specialization, which typically lack in small public facilities. In fact, **Big Public Infrastructures are those that seem to be at the forefront for 3DP technologies adoption**, as proven by the cases of Newcastle General Hospital, North Manchester General Hospital (481 beds) and Belfast City Hospital (900 beds).

A **fundamental aspect** that can be taken into consideration in the assessment of the targeted hospitals, both public and private, is the **advancement of each hospital within the orthopaedic field**, for which the number of "trauma and orthopaedic consultations" can be used as a proxy. Since 3DP current applications in the medical sector are mostly implemented within the orthopaedic department, 3DWAYS should implement its marketing and communication strategy by focusing specifically on these specialized hospitals, having a higher probability of adopting 3D printers and thus maximising the penetration rate.

Targeting

Pros & Cons of Big Public and Small-Medium Private Infrastructures

BIG PUBLIC INFRASTRUCTURES	
<p>PROS</p> <ul style="list-style-type: none"> - High number of inpatients admissions - High specialization in secondary care, benefitting from the most innovative medical technologies - Strong interconnected system under a common authority 	<p>CONS</p> <ul style="list-style-type: none"> - Unstable profitability flow - Complex procurement process, involving high number of public institutions
<p>Benefits sought:</p> <ul style="list-style-type: none"> - Safety - Convenience - Quality 	

SMALL-MEDIUM PRIVATE INFRASTRUCTURES	
<p>PROS</p> <ul style="list-style-type: none"> - Well-established network among facilities belonging to large healthcare groups - High focus in fields where 3DP applications are more advanced (dental, orthopaedic, cosmetic etc.) - High purchasing power, being able to set an independent price - Efficient and effective procurement process 	<p>CONS</p> <ul style="list-style-type: none"> - High dependency on unsteady private investments – in case of losing the contract with a large insurer, hospitals register decreases in their revenues - High share of income coming from NHS subsidiaries - Low specialization in acute care
<p>Benefits sought:</p> <ul style="list-style-type: none"> - Safety - Quality - Convenience 	

PUBLIC & PRIVATE: FINANCIAL OVERVIEW

The United Kingdom market size for healthcare, both public and private, were respectively (in billion pounds): £146.9 and £23.8 in 2017, £150 and £25.1 in 2018 and £153.4 and £26.4 in 2019 (PwC, 2016). Although public hospitals account for the largest share of healthcare expenditure (around 77.7% in 2018), the private sector is estimated to grow at a faster rate: the CAGR from 2014 to 2020 is 2.6% for public healthcare, compared to 5.3% for the private sector (PwC, 2016). Private hospitals and clinics have registered an increase in revenues, mainly due to the contribution given by NHS as a result of both *Darzi* reforms, which gave the possibility to be treated as NHS patient at private hospitals, and public capacity constraints, which were causing significant waiting times (Competition and Market Authority, 2014). In fact, NHS expenditures on privately-funded healthcare providers were £9.2 billion in 2018 (Campbell, 2019). Precisely, around 20% of NHS expenses for private medical services were related to hip and knee replacements occurred in private hospitals and clinics, highlighting the intense specialization of private infrastructures on orthopaedic (Competition and Market Authority, 2014). However, not all hospitals have based their core strategy on NHS contributions, but on the contrary, on the sophistication of medical devices to diagnose, monitor and treat patients. With an intended focus on high-value, high-acuity medical specializations, not all the hospitals are benefitting from high revenues. Especially TCL and HCA, because of significant investments in equipment and facilities to try to dominate certain segments of healthcare, specifically oncology.

Around 70% of the total private sector's revenues were generated by the five largest private hospitals groups (Competition & Markets Authority, 2014). On the other hand, public medical facilities have registered losses of £2.5 billion (2015-2016), outlying unprecedented financial stress in the system (PwC, 2016).

OPPORTUNITIES FOR 3DWAYS

PUBLIC

- 3D Ways can leverage on its **cost efficiency** as it is the base of its turn-key solution. The costs saved by not having an internal 3DP expert/engineer as an employee can represent a crucial benefit for infrastructures in financial deficit.
- The possibility of having access to 3D Ways' 3DP network can be crucial for big public hospitals, which might need to rely on other operators' assets, as they overcome its potential under-capacity caused by not having sufficient 3D printers to satisfy the high demand (high inpatients admissions).

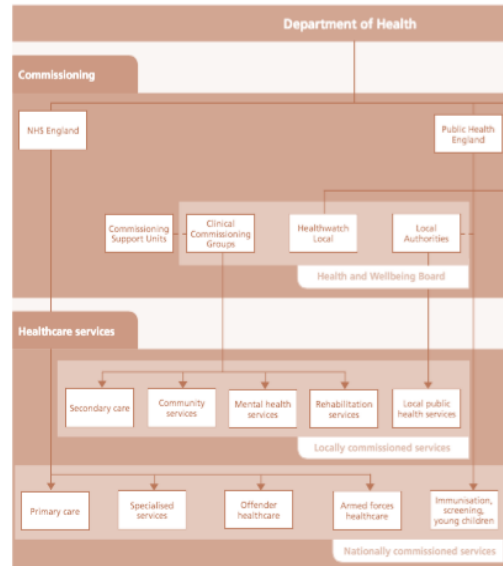
PRIVATE

- 3D Ways can leverage on the **technological innovation** improving the quality of medical services. Quality of healthcare services is the main driver for private providers since it is the key factor influencing care users to choose private medical services.
- The possibility of having access to 3D Ways' 3DP network can be crucial for small-medium private hospitals, which might have the financial resources to invest in 3DP technologies but might not have a high ROI due to a possible underutilization as a result of low inpatients admissions.

Targeting

Decisional and Financial Flow in Big Public Infrastructures

DECISIONAL FLOW

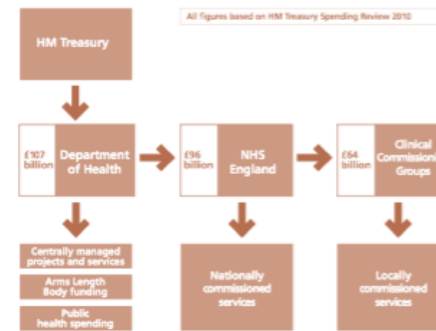


When looking at the commissioning system in place in England, a significant differentiation among **key decision makers** can be identified: public institutions commissioning national healthcare services, which are **NHS England** and **Public Health England**, and local healthcare services, namely **Clinical Commissioning Groups (CCG)** and **Local Authorities**. Particularly, CCG are responsible for commissioning the following types of services: secondary care, community services, mental health services and rehabilitation services. Specifically, most activities occurring in **acute trusts**, **secondary care** and **specialised services** are mainly commissioned by CCG, which are a total of 211.

Therefore, in order to gain a contract with a public hospital, 3D Ways should be able to interact and influence the CCG.

NHS (2014)

FINANCIAL FLOW



> Nearly half (47%) of NHS budget is spent on **acute and emergency care**.

> CCG budgets are allocating on a “**weighted cap**tion” basis, which implies that **budgets are set according to the population size and other secondary factors** such as age profile, health and location of the population.

> Historically, service providers are remunerated through an annual lump sum and these so called “**block contracts**” were not linked to the quality of the service provided. In 2003/04, a “**Payment by Results (PbR)**” system was introduced so that an **activity-based mechanism** allows for **compensations of providers at an agreed national price**. **Quality of care and health outcomes** are the **parameters** on which England and local commissioners are implementing their **reimbursement payments**.

NHS (2014)

PROCUREMENT PROCESS

Contracts of value between £101k-£164k (full life of contract) are assigned by following the procedure below:

- > The Commissioning lead will produce a brief on the service required;
- > The CCG has confirmed that, to ensure compliance with the procurement regulations, all contracts above £101k will be advertised on Contracts Finder;
- > The Commissioning lead should ensure that potential providers have enough time to submit offers, as specified under the EU Rules and or when using the Light Touch Regime provisions;
- > The recommended minimum numbers of shortlisted bidders is five, but this is subject to market interest and if there are not five bidders of sufficient quality, fewer may be invited subject to compliance with the procurement regulations;
- > Bids are to be submitted on the on-line procurement portal;
- > The successful provider is identified based on an evaluation with the rationale for the choice being recorded

Suitability of the provider is assessed by checking the following criteria:

- Financial viability
- Economic standing
- Corporate social responsibility
- Clinical capacity and capability
- (where applicable)
- Clinical governance
- (where applicable)
- Quality/Accreditation
- Compliance with the Public Sector Equality Duty

Positioning

Positioning Map and PoP/PoD analysis

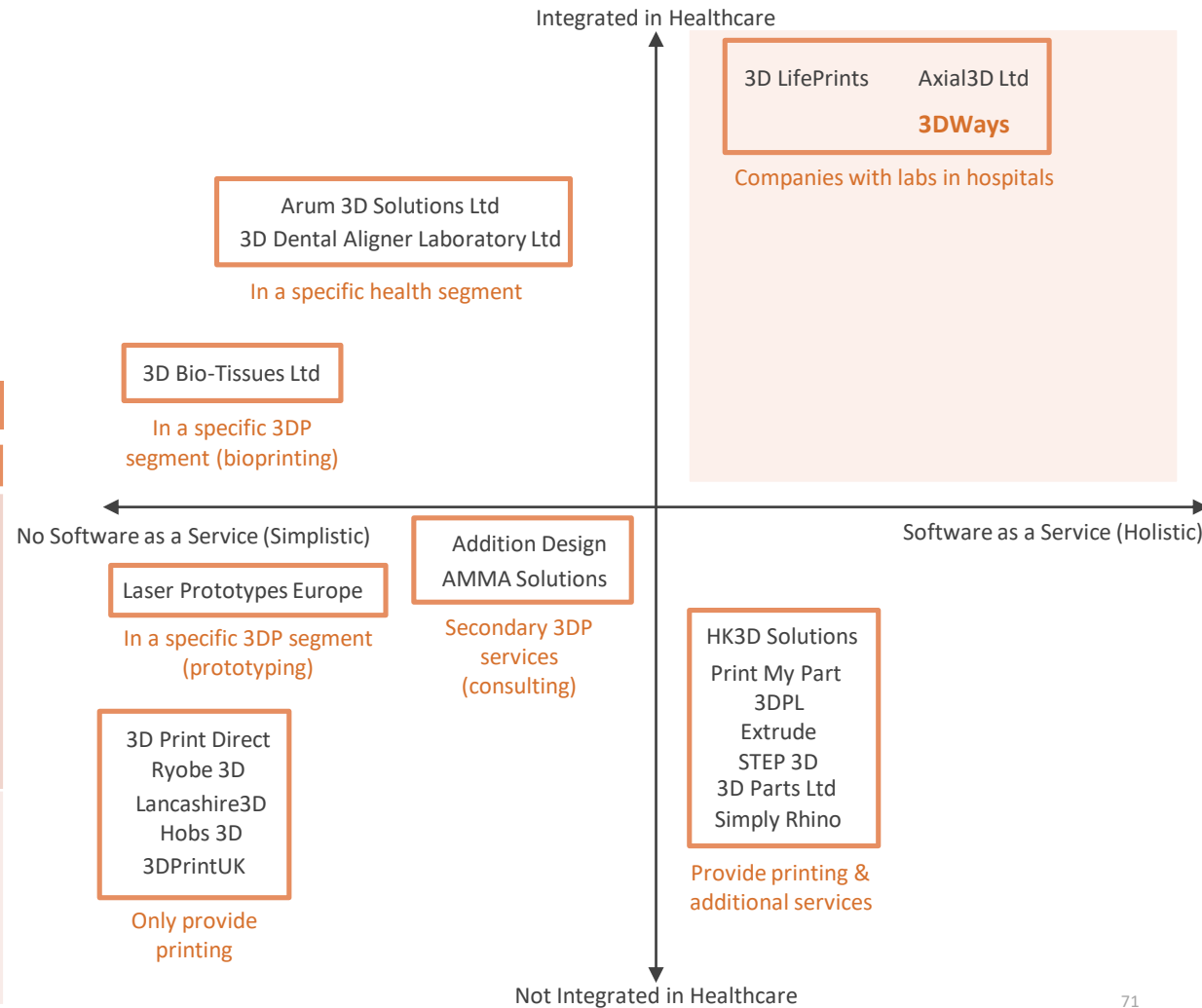
COMPARATIVE ANALYSIS

In order to have a clearer understanding of how 3D Ways is positioned and differentiates from the competition, a perceptual map was created with the variables Software as a Service on the horizontal axis and Integrated in Healthcare along the vertical axis. It was possible to cluster the competitors in the following macro categories: 3DP printer providers, 3DP services providers (both printers' suppliers along with additional complementary services), consulting companies, software as a service companies, of which some of them are well-integrated within the healthcare sector. For the comparative analysis, essential to the development of a clear and effective value proposition, the following two specific aspects were identified in the case of 3D Ways: *Points of Differences* are the "elements that make the suppliers' offering either superior or inferior to the next best alternative" and *Points of Parity* are the "elements that essentially the same performance of functionality as those of the next best alternative" (Anderson J., Narus J. and Van Rossum W., 2006 p.94). For this purpose, the "next best alternatives" are those located in the second quadrant of the positioning map, namely: 3D LifePrints and Axial3D.

POP & POD ANALYSIS

	3D LifePrints	Axial3D	3D Ways
Points of Parity (PoP)	<ul style="list-style-type: none"> - On-site production in healthcare facilities - Remote-control management software - Versatility of products portfolio and applications (prosthetics, implants, surgical guides, medical instruments etc.) - Support in pre and post-production phases: from prototyping to finished products - Interconnected patient data store among clinicians, 3DP experts and hospital hubs - Integrated work-flow and responsive customer-based communication 		
Points of Differences (PoD)	<ul style="list-style-type: none"> - Training & education - Pre-operative planning (360° view of patient anatomy) - Associations with research and academic partners - Well-established cooperation with NHS 		<ul style="list-style-type: none"> - Access to network of other 3DP medical laboratories

POSITIONING MAP



Positioning

Value Proposition & Positioning Statement

VALUE PROPOSITION

3D Ways' value proposition is a fundamental articulation, essential to communicate the key benefits to its buyers. According to Anderson, Narus and Van Rossum (2006), the most effective value proposition configuration is known as "resonating focus". Differently from "all benefits" and "favourable points of difference" types of value proposition, "resonating focus" suggests to communicate and illustrates only a small number (one or two) points of difference that can be superiorly conveyed in comparison to the most similar offerings available on the market. By not highlighting all the benefits (both 3D Ways' *Points of Parity* and *Points of Difference*), a previous customer value research is highly required in order to be able to make comparisons between 3D Ways and the other two significant competitors. However, due to the newness of the industry, customers might lack familiarity with the technology/service. This is particularly true for the private healthcare sector in UK, displaying a very limited number of cases in which 3DP technologies/services were adopted. On the contrary, the public NHS facilities appear to be more mature and knowledgeable in terms of benefits provided by similar services. For this reason, while for public healthcare buyers a "resonating focus" will be adopted, for small and medium healthcare providers a "all benefits" will be applied. Anyway, it is likely that 3D Ways' ability to be chosen among the other similar suppliers will rely exclusively on the value network business model that is meant to be implemented.

ROLE OF NETWORKING

In addition to the different value proposition configuration for the two different segments, Big Public and Small-Medium Private Infrastructures, also the benefits (value added) of the networking system will play a different role, which needs to be explicitly communicated in order to persuade and motivate the two different types of buyers.

	All Benefits	Favourable Points of Difference	Resonating Focus
Consists of:	All benefits customers receive from a market offering	All favourable points of difference a market offering has relative to the next best alternative	The one or two points of differences whose improvement will deliver the greatest value to the customer for the foreseeable future
Answers to common questions	"Why should our firm purchase your offering?"	"Why should our firm purchase our offering instead of your competitor's?"	"What is worthwhile for our firm to keep in mind about your offering?"
Requires	Knowledge of own market offering	Knowledge of own market offering and next best alternative	Knowledge of own market offering delivers superior value to customers, compared with the next-best alternative
Potential pitfalls:	Benefit assertion	Value presumption	Requires customer value research

SMALL & MEDIUM PRIVATE POSITIONING STATEMENTS

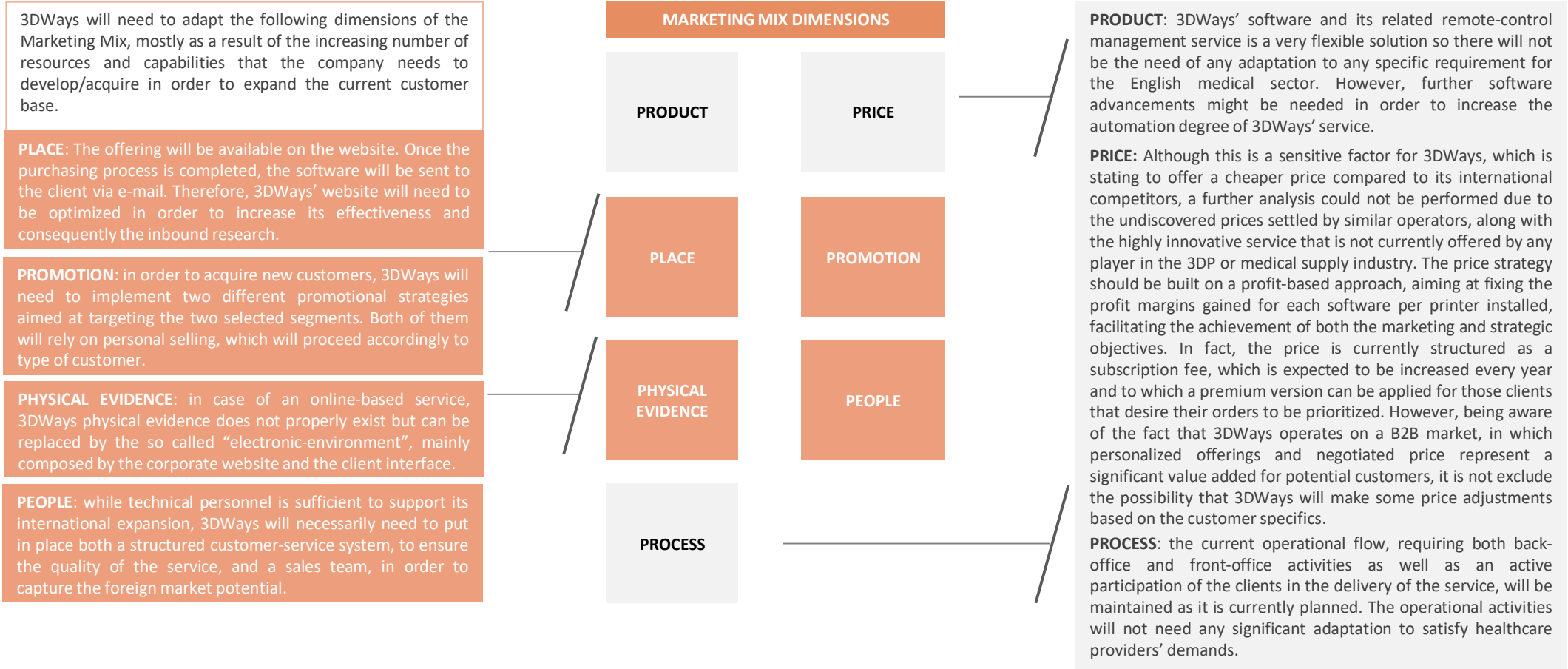
"To small/medium-private healthcare facilities who desire the technological know-how to adequately operate 3D printers, 3D Ways user-friendly remote-controlling software will grant a turn-key solution aimed at producing on-site a wide range of customized medical devices with different applications. Along with an integrated data-centre, small-medium-private healthcare facilities will have access to one-of-a-kind, bundled network of printers owned by other healthcare providers with the aim of monetizing idle times consequence of 3D printers' underutilization."

BIG PUBLIC INFRASTRUCTURES POSITIONING STATEMENTS

"To big-public healthcare facilities who desire a cost-efficient solution to adequately operate 3D printers, 3D Ways user-friendly remote-controlling software will grant the possibility to rely on a one-of-a-kind, bundled network of printers owned by other healthcare facilities. This integrated system will allow big-public healthcare facilities to overcome constraints derived from the 3D printers' overutilization, saving long waiting times for patient care."

Marketing Mix

Place, Promotion, Physical Evidence and People at the centre of Organizational Restructure



Marketing Mix

Promotion: Application of 7Ps on 3DWays healthcare targets

INTEREST CREATION

The interest creation should focus on the advertising through social media campaign with a specific location target and the participation of 3DWays to trade fair specific for healthcare and innovation. For example, *Future Health*, which will take place in March 2020, where they can promote through demonstration and information their service. Along with that, these contexts provide the best occasion to get known 3DWays and to start a network with potential customers. By doing so, they can address both public and private customers according to their different value proposition.

POST-PURCHASE

After the purchase, the customer service needs to be reactive and reliable in order to support the client in case of any necessity/emergency. Since 3DWays does not have a customer service department, it is essential to constitute one. By doing so, the clients can have a positive experience of the overall service and spread positive feedback throughout the healthcare sector.

PRE-PURCHASE

In the pre-purchase, 3DWays must adopt a different strategy for private and public customer segments. It is particularly crucial for 3DWays to identify and influence Organization Buyer Centres. Considering private healthcare groups, the company will have to influence the procurement and commercial division of big private groups, such as the Purchase Manager, Chief Operating Officer (COO) and Chief Financial Officer (CFO). For public healthcare, 3DWays should be able to promote its service directly to the Clinical Commissioning Groups (CCG). By operating locally, they are responsible for responding to the needs of their closer patients. Being a public entity, the process is longer and more time consuming.

ONGOING PURCHASE

In order to retain the clients, it is important to leverage on customer service for after sale. Along with that, 3DWays should adopt technique of direct marketing through emails and personalized newsletter.

PURCHASE

The purchase phase consists in closing the deal and define the terms and conditions of the contract. In this phase, 3DWays can negotiate the price of their service-based offering. It is plausible to assume that public hospital will be more price sensitive but, due to the higher number of inpatients, 3DWays software will be installed on a higher number of 3DP machines, resulting on higher revenues despite of lower prices charged compared. On the other hand, since private hospitals serve a lower number of inpatients, 3DWays software will be responsible of managing a lower number of 3DP machines. However, considering that private healthcare providers are less price sensitive, 3DWays will be able to negotiate a higher subscription fee.

Marketing Mix

Promotion: 3D Ways Tools

Considering its service characteristics (digital offering) and targeted markets (healthcare sector), 3D Ways should adopt both personal selling and digital advertising as main tools for its promotional strategy. However, it is important to underline that, as a result of its B2B business model, digital advertising will have a lower weight in terms of financial and organizational resources that will be invested, due to the required direct contacts necessary to positively impact the purchase decision journey.

DIGITAL ADVERTISING

Considering digital advertising, 3D Ways should promote their service through *Google Search* and *Display Ads*. Search Ads are usually particularly effective for immediate actions since they require an active research from potential buyers, who needs to display an explicit interest in industry-related fields (3D printers, AI, e-health etc.). On the contrary, Display Ads, which consist of banners built through images, text or videos, mainly serve the purpose of building brand awareness and recognition. Both can be easily monitored through different metrics, such as click-through rate (CTR) and conversion rate. Along with their easiness for monitoring, digital marketing has competitive prices compared to the traditional marketing channels. Considering their competitors, such as *Axial3d* and *3DHubs*, 3D Ways should bid for buying the following keywords: “medical 3d”, “3d printing service”, “axial3d” and “3dhubs”. By doing so, the result of their website will show up in the first part of *Google Search* for promoted content.

The social media platform that should be used from 3D Ways is *LinkedIn*. By doing so, the company can sponsor their product offering, targeting and potentially contacting decision makers that can influence the purchasing process, especially within private healthcare providers. Specifically, *LinkedIn* allows companies to customize their promotional campaigns, setting a budget and a range of goals specified by the company. According to a recent study, 26% of B2B decision makers use *LinkedIn* for business purposes, rather than other social media as *Facebook* and *Twitter*. (Mezzanine Group, 2019)

Both of these two ways of advertising should re-direct the customers to their website; 3D Ways website is obsolete and has not been updated in a long time. Considering the nature of their service, it is essential to realize a friendly interface for their personal website with useful and informative contents.

DIRECT SELLING

Along with advertising through digital platforms, it is crucial for 3D Ways to participate with their salespeople, company representatives that interact with potential customers to influence the purchase decision, to trade shows and networking events for 3DP in healthcare.

During the interest creation phase, 3D Ways should rely on a missionary seller, who is the salesperson which has the aim to influence the key decision makers of the targeted healthcare providers. For 3D Ways, this kind of sales representative has the main scope of creating awareness and willingness for the buyers to adopt their service (as Future Health 2020). Their objective is not to close the sale, but to persuade the customer. A missionary seller should have a deep knowledge of the industry, the competitors and the country market in order to demonstrate and present the features and benefits of their services compared to their direct local competitors. Their objective is not to close the sale, but to persuade the customer.

In the pre-purchase and purchase phase, 3D Ways salespeople should act as consultative sellers, focusing on the value proposition of their service for the two-specific types of segment: private and public. It is essential to address in these phases the service according to the needs of the clients, providing a meaningful and necessary demonstration.

The promotion strategies aim to attract and target 3D Ways’ customers and raise brand awareness . The company should focus its investments on **personal selling** for their service, through specialized and knowledgeable salespeople which can attract and persuade key decision makers for hospitals in the UK. However, it should be considered the limited and scarce resources of the company.

Consequently, the company must rely as well on **digital advertising** which is a cheaper alternative to reach a broader audience and raise their brand awareness.

Marketing Mix

People: Organization & Structure

3DWAYS' TEAM

3D Ways has currently five employees operating actively in the company. Considering the remote-control software, only one employee is dedicated to this (3D Ways is finding a software company to further develop its software). Nowadays, the service is not fully operable taking into consideration all its possible features but, if the company considers an expansion, is crucial to improve their customer service and personal selling skills. Regarding the current structure of both management and technical team, 3D Ways should consider to restructure the distribution of tasks and responsibilities to ensure a more efficient and effective operational flow. Regarding the management of the 3DP Factories Network, only two employees (Tiago Elias and Telmo Pereira) are responsible for this business activity but are not exclusively dedicated to it. In view of 3D Ways exporting, the company should clearly separate the “3D printing manufacturing” from the “remotely managed 3D printing” services, in order to initiate a real switch of the core business activity towards the so called “star product”.

Along with that, it would be useful for all the employees (especially the ones responsible for the management of the network) to be briefed on the different needs of hospitals in the UK to assure a customized service.

CUSTOMER SERVICE

Considering the complexity of the software, 3D Ways should implement a direct channel for customer service support. The company should implement two distinctive informative documents: one for existing client as a guideline for using the software and the connected services and another one for potential customers inquires.

Especially for the existing client, it should be implemented a direct line that allows the client to contact 3D Ways remote control factory in case they need support for issues related to the software.

In order to start implementing an appropriate customer service, 3D Ways should rely on CRM software of *Salesforce*, at the average price of €1895 per year (Salesforce.com, 2019). Through this software they can track the customer journey of each client, follow the customer in the after sales with a dedicated line for customer service, manage the marketing campaigns through direct email marketing and social media campaign. Additionally, the usage of this software allows the company to have a record of the trends and the analytics of the sales.

SALESPeOPLE

The customer experience is significantly important in B2B services. 3D Ways should focus in a significant manner on its salesforce. Considering the limited budget that has been allocated for marketing purpose, the company could rely on salespeople outsourced to penetrate the UK market. These, would help 3D Ways to increase their brand awareness and build relationship with their clients.

As previously assessed, the most appropriate way for 3D Ways to penetrate the healthcare market in *South East* and *London* is through direct selling. Considering the specific target of hospitals for the company and the geographical proximity, the salesforce of 3D Ways should adopt an organizational structure based on territory. By adopting this approach, 3D Ways can make an initial investment on their salesforce. The budget constraints allow the company to have an extremely limited salesforce composed by 2 people (41.000€ per person per year ((Source: Payscale.com))). It is essential to apply a fixed salary since the number of projected sales would not be significant for a commission-based salary.

In a service as the one offered by 3D Ways, it is essential to have employees that are specifically dedicated to the service offering. For 3DP Factories Network, 3D Ways should improve and invest on the following three categories: *Company employees*, *customer service* and *salespeople*. Those three elements should act with a specific and common strategy in order to deliver to its clients the best service and customer experience.

Marketing Mix

Physical Evidence

ELECTRONIC ENVIRONMENT

The physical evidence for a service provider is the environment in which the service is delivered, enabling the interaction between the company and the customer through any tangible assets, whose scope is to facilitate the performance and/or communication of the service (Rafiq & Ahmed, 1995). In particular, the definition includes also the so called “service scape” which is the physical place where the service is produced and/or delivered.

In the case of 3D Ways, physical evidence is not relevant due to the nature of remote-control service that is offered. In fact, the interactions with customers occur throughout the client online platform, without the need for any direct physical contact. In this sense, the traditional concept of physical evidence can be substituted with the term “electronic environment” (Koernig, S.K., 2003), starting from the corporate website to the personal account portal through which clients can access and consume the service. Although all the assessed properties can be applied to the corporate website, the “electronic environment” will have a focus on the client portal, which can be defined as a gateway for clients to interact by securely sharing documents, services and information across the Internet.

Under the tag “clients” on the navigation menu, 3D Ways’ clients can log in into a dedicated section with their personal credentials in order to have access to the client interface through which process and monitor orders. This is the environment in which the majority of information is presented and actions are taken: sending of CAD file, insertion of technical parameters needed for manufacturing, start of production after checking availability of printers, quality check performed by customers.

Since 3D Ways client portal does not need any specific aesthetic appeal or financial security, whose aim is more related to influencing the purchasing decision (particularly relevant for its website), both the layout and the functionality are the key aspects on which fundamental improvements should be pursued:

- > *Layout*: refers to the structural organization and arrangement of the port;
- > *Functionality*: extent to which the layout facilitates the customers’ service goals.

LAYOUT & FUNCTIONALITY

In order to build an effective client area, it is important for 3D Ways to incorporate the customers’ needs and requirements and, for this purpose, the layout and its functionality need to present some specific features. In fact, it needs to be usable, informative, customisable and interactively designed (Kühn S.W., Spies H. & Petzer D.J., 2015).

USABILITY

- > Ease with which the customer can use and learn how to use the portal in an efficient and effective way.
- > Usability can be ensured by logical and user-friendly navigation tools as well as commands that are clear in their intent and destination.
- > In this sense, 3D Ways client interface is already well-developed, with the usage of meaningful colours and icons that facilitate customers’ understanding of their possible actions.

INFORMABILITY

- > The information presented on the interface should be relevant to the customer needs, as well as easy to find.
- > Since customers have no technical know-how, 3D Ways should facilitate customers’ interaction by providing more guidance in what is expected from them to do. Each section should then provide clear instructions on which the company is required to do.

CUSTOMIZATION

- > Customization features allow customers to adapt the online content to their own needs.
- > 3D Ways customer interface is already extremely personalized, with the possibility to review the orders’ history, the production status of each order etc. What would be suggested, in the report section, is to include a higher number of statistics so that customers could extract more useful insights from the dataset.

INTERACTIVITY

- > The purpose of engaging with the portal is at the centre of 3D Ways customer interface so that every aspect is designed in order to facilitate the client contribution, which has an active role on the remote-control management system.
- > What is not already exploited is the networking platform that will be at the base of the networking value at the centre of 3D Ways value proposition. In this sense, a section in which it is possible to visualize the location of other customers and their availability, as well as directly contact with them, can be a useful tool to encourage the interactivity with the other customers.



For customer interface screenshots, please check Appendix 16)

6. FINANCIAL ANALYSIS

- Financial Forecast
 - P&L Calculations
 - P&L Breakdown
 - P&L Statement
 - Break-even Analysis
 - Sensitivity Analysis
 - Scenario Analysis

Financial Forecast

P&L Calculations

3DWAYS' PROJECTIONS

2019	2020	2021	2022	2023
Yearly projected Revenue per Printer				
€4,800	€6,000	€7,200	€8,400	€9,600
IT Costs				
€20,000	€20,000	€40,000	€6,000	€6,000
Interest Payments				
-	€ 26,251	€ 20,213	€ 10,280	€ 7,916

- > Marketing Costs:
 - 2020: 120€000 = 40% of €300,000 from the financial round
- > Employees and Personnel Expenses in 2020, respectively 20 and €170,635

ASSUMPTIONS & CALCULATIONS

- > P&L statement is only for the UK.
- > Marketing Costs:
 - 2021, 2022, 2023: 12% from the revenue of the previous year (Deloitte 2017). Resulting in a marketing cost of € 15,840 in 2021, € 49,248 in 2022 and € 112,896 in 2023.
- > Revenue per printer in 3DWays' projections grows at CAGR (2019-2023) of 19%. This is quite similar to the global revenue for 3D printing software and services CAGR (2018-2024) which is equal to 21.68%. Therefore, it was assumed that the revenue per printer in each year is equal to the values in 3DWays' projections.
- > Penetration rate in each new region is assumed to be approximately 10%, the global SaaS penetration Rate (Various Sources, 2017). After the first year, penetration in each county should grow at 5%.
- > The number of printers per organization is assumed to be 3 printers per Big healthcare infrastructure and 1 printer per small-medium healthcare infrastructure.
- > 2 out of 5 employees are responsible for providing the service. Hence in the following years, this ratio will be taken into consideration when calculating the value for personnel expenses, since two fifths of the labour cost is a direct cost that is already englobed in the cost of revenue.
- > Depreciation was assumed to be 0 as the software is not yet finalized with all the desired features. Therefore, making it extremely difficult to evaluate its value. However, according to EY, the lifetime of a software is usually 3 years, resulting in a depreciation rate of 33%. (Worldwide Capital and Fixed Assets Guide, 2018)
- > Corporate Tax in Portugal for SMEs (IRC): 17% until €15,000, then 21%. Companies with losses in a fiscal period pay 0% corporate tax (Deloitte, 2019).

Financial Forecast

P&L Calculations

ESTIMATED TARGETED FACILITIES PER REGION

FACILITIES TARGETED PER REGION

London	South East	Midlands	North East & Yorkshire	North West
55	62	46	46	48
Trusts				
23	19	23	20	25
Total Public Hospitals				
25	25	25	22	27
Private Hospitals				
29	37	21	24	21

Following the marketing analysis, the targeted institutions for 2020 will be Big Public and Small-Medium Private infrastructures, in the London and South East counties. With 25 Big Public infrastructures in both counties, 37 Small-Medium Private institutions in South East and 29 in London, the total number of infrastructures to target in 2020 amounts to 116. Since the core of 3DWays' business model centres around a network of clients, the strategy for internationalizing should focus on a rapid expansion into new regions and organizations. After London and South East, the most promising areas in terms of number of organizations are North West, North East & Yorkshire and the Midlands. **Expanding into a further county each year, and since the number of infrastructures in the remaining areas is very similar, the priority for 2021 was chosen based on geographical proximity of the first two counties.** Therefore, the region to target in 2021 is the Midlands county, with a total of 46 infrastructures, 25 of which are public and 21 private. For 2022, 3DWays should expand into the North East & Yorkshire and North West counties, where both share borders. This would translate into a total of 46 infrastructures in the North East & Yorkshire (24 are private and 22 are public), and a total of 48 infrastructures in the North West (27 public and 21 private). Finally, the company's main focus should be to grow the number of infrastructures and printers in each area. **This expansion plan will allow 3DWays to spread its network to cover just about the full territory of Great Britain.**

Nº FACILITIES AND RESPECTIVE PRINTERS

NUMBER OF PRINTERS

	London & South East	Midlands	North East & Yorkshire	North West	Facilities Penetrated	Total Nº Printers
2020	12	-	-	-	12	22
2021	25	5	-	-	29	57
2022	37	10	5	5	57	112
2023	50	16	10	10	85	168

After estimating the number of targeted infrastructures in each county, the number of infrastructures that 3DWays could penetrate and the respective number of printers was estimated. First, the **penetration rate was assumed to be 10%, since this is the worldwide rate of penetration for SaaS** (Various Sources, 2017). For the following years, it was assumed that the **number of penetrated infrastructures increases by 5% per year**, as 3DWays' customers confidence in the service increased, leading to an increase in the demand for its service and a higher usage rate of each printer. Moreover, as the company increases its presence in the first two counties during the first year, **it needs to expand geographically to scale its network fast**, as previously explained. Therefore, this **expansion will result in 12 infrastructures reached by 3DWays in 2020, 29 in 2021, 57 in 2022 and 85 in 2023.** Using 3DWays' benchmark case of José de Mello Saúde in Portugal which has requested the company to install 1 printer per healthcare facility in its organization (small to medium in facility size); plus the fact that in 2017, the average number of hospital beds in the United Kingdom is approximately 4.5 times greater than in Portugal (OECD, 2019); it was assumed that each big public infrastructure in the UK would require three printers (since the company main target are big public infrastructures). While, targeted private infrastructures being small to medium clinics and hospitals will require one printer per facility. Henceforth, **resulting in a total number of printers of 22 in 2020, 57 in 2021, 101 in 2022 and finally 157 in 2023.**

REVENUE CALCULATIONS

Years	3DWays' PROJECTIONS	CALCULATIONS	
	Revenue per Printer	Number of Printers	Projected Revenue
2020	€ 6,000	22	€ 132,000
2021	€ 7,200	57	€ 414,400
2022	€ 8,400	112	€ 940,800
2023	€ 9,600	168	€ 1,612,800

To calculate the projected revenue for each year, it was multiplied by the estimated number of printers by the respective estimated yearly revenue per printer. As previously explained, the revenue per printer was assumed to be the same as 3DWays' projections, as the CAGR of the projections (19%) is almost identical to the global revenue for 3D printing software and services CAGR (21.68%).

Therefore, resulting in a **projected revenue of €132,000 in 2020, €414,400 in 2021, €940,800 in 2022 and €1,621,800 in 2023.**

Financial Forecast

P&L Calculations

COST OF REVENUE CALCULATIONS

Correlation Analysis using 3DWays' Projections

3DWays' Projections	
Number of Printers	COS per printer
9	€ 4075
30	€ 2200
180	€ 542
1080	€ 314
Intercept	2524.19
Number of Printers	-2.28
R²	0.45

Estimated Cost of Revenue (COR) per printer, using the correlation analysis

	2020	2021	2022	2023
Number of Printers	22	57	112	168
COR per printer	€ 2,474	€ 2,394	€ 2,268	€ 2,140
COR Growth Rate		-3%	-5%	-6%

EMPLOYEES CALCULATIONS

Estimated nº of Employees and Personnel Expenses

	2020	2021	2022	2023
Nº Employees	10	15	23	35
Personnel Expenses	€ 170,635	€ 255,952	€ 392,460	€ 597,221
Personnel Expenses (adjusted)	€ 102,381	€ 153,571	€ 235,476	€ 358,333

Using 3DWays' projections for the number of printers and the respective cost of revenue (or cost of sales), a **regression analysis was made to estimate the cost of revenue according to the projected activate printers in the UK for the next years**. Thus, resulting in a **cost of revenue per printer of €2,474 in 2020, €2,394 in 2021, €2,268 in 2022 and €2,140 in 2023**. There is a decreasing trend in the cost of revenue, ranging from -6% to -3%, with the biggest reduction predicted to happen in 2023, when there is a considerable number of printers. This decreasing trend in the cost of revenue can be explained by the fact that as the number of printers increases sustained by the customers' demand, the costs of software development and labour are more spread, resulting in a lower cost of revenue per printer.

To estimate the number of employees 3DWays' projections, the number of employees, 10 and the respective personnel expenses of €170,635 for 2020 were applied. Then, the average value of employee growth in SaaS start-ups was added, which accounted for 56% (RedPoint, 2019) of growth rate with respect to personnel expenses for the company during 2021, 2022, 2023 in the UK. Resulting in 15 employees in 2021, 23 in 2022 and 35 in 2023, with respective personnel expenses of **€255,952 in 2021, €392,460 in 2022 and €597,221 in 2023**. Currently **2 out of 5 employees are involved directly in providing the service to customers, this cost is already contemplated in the cost of revenue**. Therefore, personnel expenses were adjusted by a ratio of three fifths, the remaining portion was not included in the cost of revenue. Subsequently, resulting in **personnel expenses of €102,381 in 2020, €153,571 in 2021, €235,476 in 2022 and €358,333 in 2023**.

FINANCIAL FORECAST

P&L Breakdown

REVENUE				
	2020	2021	2022	2023
Active Printers	22	57	112	168
Revenue per Printer	€ 6,000	€ 7,200	€ 8,400	€ 9,600
Revenue	€ 132,000	€ 410,400	€ 940,800	€ 1,612,800

To estimate the revenue, it was first estimated the number of targeted infrastructures across the United Kingdom. 3DWays' plan is to target big public hospitals and clinics, and small to medium private clinics and hospitals. Big infrastructures require three printers, while small to medium infrastructures will require one printer. In 2020, the first two counties that 3DWays will expand to are London and South East. Then, in 2021, it will expand to the Midlands county and finally in 2022, it will expand to the North East & Yorkshire and North East counties. This plan will allow the company to spread its geographic presence, totalling almost the entirety of the Great Britain territory. The number of infrastructures penetrated in the first year in each region will be 10% of the total number of facilities targeted. This rate is assumed to be the same as the global SaaS penetration rate (10%). In the following years, the number of infrastructures reached will increase by 5%. This will result in the number of printers presented above, totalling 168 printers by 2023. **Then, the number of printers was multiplied by the revenue per printer for the respective year, resulting in the final projected revenue of each year. The final values for the revenue are illustrated above: €132,000 in 2020, €410,400 in 2021, €940,800 in 2022 and €1,612,800 in 2023.**

The estimations of the revenue per printer was provided by 3DWays', with the **revenue per printer growing at CAGR of 19% in the next four years**. This value is roughly the same as the revenue for 3D printing software and services CAGR of 21.68%. The **internationalization process is backed by a significant investment in marketing, partnerships with industrial and medical associations and certification agencies**. Also, as the level of the development of the software increases (especially the automation factors) eliminating factory effort by the business structure, increasing the customers' confidence on the service. Finally, the company is looking to certify its 3D remotely printing service, which will lead to the standardization of the process for customers. Hence presumably, **all these factors will lead to a rise in the demand for 3DWays' service, respectively increasing the sales of the service, resulting in a growing revenue per printer and number of printers, consequently leading to an increase in revenue in the following years.**

COSTS				
	2020	2021	2022	2023
Active Printers	22	57	112	168
Number of Employees	10	15	23	35
COR per Printer	€ 2,474	€ 2,394	€ 2,268	€ 2,140
COR Growth per Printer	-	-3%	-5%	-6%
Cost of Revenue	€ 54,426	€ 136,455	€ 254,051	€ 359,586
Marketing	€ 120,000	€ 15,840	€ 49,248	€ 112,896
IT	€ 20,000	€ 40,000	€ 6,000	€ 6,000
Personnel Expenses	€ 102,381	€ 153,571	€ 235,476	€ 358,333
Total Costs	€ 296,807	€ 345,866	€ 544,775	€ 836,814

For the cost of revenue, using the company's projections, it was **performed a correlation analysis to estimate the values, which were then adjusted to the number of projected printers activated in the UK**. The biggest decrease happens in 2023 when the absolute number of printers increases the most. As the number of printers increases pushed by the customers' demand, the costs of software development and labour costs are more spread, resulting in a lower cost of revenue per printer.

For the number of employees and the respective personnel expenses, it was assumed that the number of employees was 10 and the respective expenses €170,635, according to the company projections for 2020. Then for the following years, the growth in the number of employees and expenses was estimated using the growth rate of employment growth in SaaS start-ups (RedPoint, 2019) of 56%. In 2019, two of the five employees were directly involved in delivering the service to the customers. Thus, for two-fifths of the personnel expenses were eliminated since that cost is already reflected in the cost of revenue.

Moreover, it is worth mentioning that 3DWays has financed itself with €300,000, through a financial round in the third semester of the current year. With this financial round, the company intends to invest 40% of it in marketing to increase its customer base in 2020, the same year it starts its internationalization process. For the following years, it was decided to allocate 12.2% to marketing from the previous year's revenue. This share was chosen in accordance with the CMO Survey by Deloitte (2017), which states the average marketing spending for tech and software companies as percent of company revenues. Thus in 2020, the company will allocate €120,000 to Marketing, the biggest portion spent in the next four years, which will allow the company to define most of its marketing base. From the company's projections for the next years, IT certification costs were assumed to be the same. Also, the company provided the values for their interest payments throughout the following years.

Financial Analysis

P&L Statement

P&L STATEMENT

3DWAYS' Network Business Model in the UK

	2020	2021	2022	2023
Active Printers	22	57	112	168
Number of Employees	10	15	23	35
Revenue per Printer	€ 6,000	€ 7,200	€ 8,400	€ 9,600
Cost of Revenue per Printer	€ 2,474	€ 2,394	€ 2,268	€ 2,140
COR Growth per Printer		-3%	-5%	-6%
Gross Margin per Printer	€ 3,526	€ 4,806	€ 6,132	€ 7,460
Revenue	€ 132,000	€ 410,400	€ 940,800	€ 1,612,800
Cost of Revenue	€ 54,426	€ 136,455	€ 254,051	€ 359,586
Marketing	€ 120,000	€ 15,840	€ 49,248	€ 112,896
IT	€ 20,000	€ 40,000	€ 6,000	€ 6,000
Personnel Expenses	€ 102,381	€ 153,571	€ 235,476	€ 358,333
Total Costs	€ 296,807	€ 345,866	€ 544,775	€ 836,814
EBITDA	(€ 164,807)	€ 64,534	€ 396,025	€ 775,986
Depreciation and Amortizations	-	-	-	-
EBIT	(€ 164,807)	€ 64,534	€ 396,025	€ 775,986
Interest	€ 26,251	€ 20,213	€ 10,280	€ 7,916
EBT	(€ 191,058)	€ 44,321	€ 385,745	€ 768,070
Taxes	-	€ 8,707	€ 80,406	€ 160,695
Net Income (or Net Profit)	(€ 191,058)	€ 35,614	€ 305,338	€ 607,375

CONCLUSION OF THE BREAKDOWN

Subtracting the Revenue by the Total Costs lead to an EBITDA of (€164,807) in 2020, €64,534 in 2021, €396,025 in 2022 and €775,986 in 2023. Depreciation was assumed to be 0 in each year as the software is not yet fully developed, making it hard to estimate its value and consequently the associated depreciation. For the interest rubric, 3DWAYS has provided the values of its interest payments for the next years.

In Portugal, SMEs belong to a special taxation regime. For the first €15,000 companies pay a 17% corporate tax and the remainder is subject to a 21% corporate tax rate. Companies that present losses in a tax period do not pay any corporate tax (Deloitte, 2019). The company provided the values for the interest payments for the next years.

To conclude, this analysis resulted in a **Net Profit of (€191,058) in 2020, €35,614 in 2021, €305,338 in 2022, and €607,385 in 2023.**

FINANCIAL RATIOS

	2020	2021	2022	2023	Average
Revenue (CAGR)			130%		
Gross Profit (CAGR)			153%		
ROS	(125%)	16%	42%	48%	(5%)
DFL	0.86	1.46	1.03	1.01	1.09
DOL	(0.47)	4.24	1.73	1.61	2.02

The fact that the average ROS is negative is explained by the negative ROS in the first year. Which, in turn, is explained by the high investment in marketing compared to the revenue generated in that year. In the following years, the **ROS is expected to increase reaching its highest value in 2023**, meaning that 48% of the revenue generated is converted into operating profits. **DFL remains roughly around the same range of values**, close to 1, meaning that the **company is becoming less susceptible to changes in operating income**. The DOL shows **decreasing trends on these next four years, meaning that the company's earnings are becoming less susceptible to changes in sales**. The negative value in 2020 is due to the negative value of the EBIT. In 2021, the value is quite high because the gross margin will not grow sufficiently to balance the increase in costs, resulting in a positive but low value of EBITDA (when compared to the revenue generated). The **Revenue CAGR for these 4 years is 130% and the Gross Profit CAGR is 153%.**

Financial Analysis

Break-even Analysis & Sensitivity Analysis



For the analysis of other years, please check Appendix 18) & 19)

BREAK-EVEN ANALYSIS

Year	2020	2021	2022	2023
Net Income (or Net Profit)	(€ 191,058)	€ 35,614	€ 305,338	€ 607,375
Cumulative Net Income	(€ 191,058)	(€ 155,444)	€ 149,894	€ 757,269

	Years	Months	Days	Exact Date
Break-Even Point	2.51	2	7	5 th July 2022

Formerly to calculate the break-even point, it was first calculated the cumulative net income. Then, the absolute value of the last negative cumulative net income was divided by the net income of the following year. Finally, to obtain this value, the number of years that have passed was summed before generating a positive cumulative net income; in this case, there were two that resulted in the value of 2.51. This translates into the **exact date of the break-even point, the 5th of July 2022**.

To perform a sensitivity analysis, it was **measured the medium-term sensitivity of the Net Profit**, in this case in 2023, to changes in specific variables. The **first analysis** studies the reaction of Net Profit to **cumulative changes of 5% in revenue per printer and an increasing 1% printer penetration**, converted into the number of active printers. The **second analysis tests changes the Net Profit if both revenues per printer and personnel costs change at an increasing rate of 5%**.

In the first test, during the worst-case scenario, Net Profit decreases to 81,2%, reaching a value of €114,395 (with the lowest number of printers being 107, which corresponds to a 7% penetration rate combined with the lowest level of revenue per printer, €8,160). On the contrary, the best-case scenario with the highest value for both these variables (206 printers, corresponding to a penetration rate of 13% and €11,040 in revenue per printer), Net Profit reaches €1,079,785, corresponding to a positive shift of 77,8% from the regular scenario. **On the second test**, Net Profit decreases to 49,2% in the worst-case scenario, reaching a value of €308,311 (with a level of €494,947 in personnel costs and €8,160 in revenue per printer). In the best-case scenario, Net Profit can increase up to 38,5%, reaching a value of €840,954 (with a level of €304,583 in personnel costs and € 11,040 in revenue per printer).

SENSITIVITY ANALYSIS

Nº of Printers	2023 NET PROFIT						
	Revenue Per Printer						
	€ 8,160	€ 8,640	€ 9,120	€ 9,600	€ 10,080	€ 10,560	€ 11,040
107	€ 114,395	€ 154,969	€ 195,543	€ 236,118	€ 276,692	€ 317,267	€ 357,841
129	€ 221,715	€ 270,632	€ 319,549	€ 368,466	€ 417,382	€ 466,299	€ 515,216
145	€ 300,864	€ 355,848	€ 410,832	€ 465,816	€ 520,800	€ 575,784	€ 630,768
168	€ 416,258	€ 479,964	€ 543,670	€ 607,375	€ 671,081	€ 734,786	€ 798,492
175	€ 451,757	€ 518,117	€ 584,477	€ 650,837	€ 717,197	€ 783,557	€ 849,917
198	€ 569,643	€ 644,724	€ 719,806	€ 794,887	€ 869,969	€ 945,051	€1,020,132
206	€ 611,094	€ 689,209	€ 767,324	€ 845,439	€ 923,554	€1,001,670	€1,079,785

Personnel Costs	2023 NET PROFIT						
	Revenue Per Printer						
	€ 8,160	€ 8,640	€ 9,120	€ 9,600	€ 10,080	€ 10,560	€ 11,040
€ 304,583	€ 458,721	€ 522,426	€ 586,132	€ 649,838	€ 713,543	€ 777,249	€ 840,954
€ 322,499	€ 444,567	€ 508,272	€ 571,978	€ 635,683	€ 699,389	€ 763,095	€ 826,800
€ 340,416	€ 430,412	€ 494,118	€ 557,824	€ 621,529	€ 685,235	€ 748,940	€ 812,646
€ 358,333	€ 416,258	€ 479,964	€ 543,670	€ 607,375	€ 671,081	€ 734,786	€ 798,492
€ 376,249	€ 402,104	€ 465,810	€ 529,515	€ 593,221	€ 656,927	€ 720,632	€ 784,338
€ 394,166	€ 387,950	€ 451,656	€ 515,361	€ 579,067	€ 642,772	€ 706,478	€ 770,184
€ 494,974	€ 308,311	€ 372,017	€ 435,723	€ 499,428	€ 563,134	€ 626,839	€ 690,545

Financial Forecast

Scenario Analysis

SCENARIO #1 - PESSIMISTIC

	2020	2021	2022	2023
Active Printers	15	37	71	105
Revenue per Printer	€ 5,400	€ 6,000	€ 6,600	€ 7,200
Cost of Revenue	€ 2,490	€ 2,440	€ 2,362	€ 2,284
Gross Margin	€ 2,910	€ 3,560	€ 4,238	€ 4,916
Revenue	€ 81,000	€ 222,000	€ 468,600	€ 756,000
Cost of Revenue	€ 37,348	€ 90,267	€ 167,700	€ 239,852
Marketing	€ 120,000	€ 9,720	€ 26,640	€ 56,232
Total Costs	€ 279,729	€ 293,558	€ 435,816	€ 660,417
Net Profit	(€224,980)	(€ 91,770)	€ 18,378	€ 69,857

Break-Even Point 5.12 12th February 2025

For the scenario analysis, **revenue per month and the market penetration rate were the variables chosen to be analyzed.** In the pessimistic scenario, monthly revenue per printer only increases €50, translating into a **smaller yearly increase of €600.** Therefore, the revenue per printer in 2020 would be €5,400 instead of €6,000. The **initial market penetration is assumed to be 3% less than the normal scenario**, thus a rate of 7% (yearly increase in penetrated infrastructures in each county of 5% suffers a 2% reduction, resulting in a 3% rate). Leading to a decrease in the number of infrastructures reached, and consequently a decrease in the number of active printers in each new county, with only 15 printers activated in 2020. In this scenario, **Revenue decreases when compared with the normal situation by 38,6% in 2020, 45,9% in 2021, 50,2% in 2022 and 53,1% in 2023.** Total costs slightly decrease as well, as fewer printers result in less cost of revenue, but not enough to balance the significant reduction in **Net Profit.** In 2020, it **decreases 17,8%, reaching (€ 224,980).** **Even more noteworthy is the impact in 2021, of -158%, changing the Net Profit from a positive value to (€91,770).** The last two years also suffer sharp reductions, of 94% for 2022 and 88,5% for 2023.

SCENARIO #2 - NORMAL

	2020	2021	2022	2023
Active Printers	22	57	112	168
Revenue per Printer	€ 6,000	€ 7,200	€ 8,400	€ 9,600
Cost of Revenue	€ 2,474	€ 2,394	€ 2,268	€ 2,140
Gross Margin	€ 3,526	€ 4,806	€ 6,132	€ 7,460
Revenue	€ 132,000	€ 410,400	€ 940,800	€ 1,612,800
Cost of Revenue	€ 54,426	€ 136,455	€ 254,051	€ 359,586
Marketing	€ 120,000	€ 15,840	€ 49,248	€ 112,896
Total Costs	€ 296,807	€ 345,866	€ 544,775	€ 836,814
Net Profit	(€191,058)	€ 35,614	€ 305,338	€ 607,375

Break-Even Point 2.51 5th July 2022

For the normal scenario, monthly revenue per printer increases by €100 on a monthly basis, amounting to a € 1,200 total increase per year. As such, the value for 2020 is € 6,000, as previously reported. Moreover, initial market penetration is assumed to be 10%, and the yearly increase in penetrated facilities in each region is 5%, translating in 22 printers in 2020.

As described earlier, Revenue in this scenario is €132,000 in 2020, €410,400 in 2021, € 940,800 in 2022 and € 1,612,800 in 2023. **Net Profit amounts to (€ 191,058) in 2020, €35,614 in 2021, €305,338 in 2022 and €607,375 in 2023.**

SCENARIO #3 - OPTIMISTIC

	2020	2021	2022	2023
Active Printers	28	70	138	207
Revenue per Printer	€ 6,600	€ 8,400	€ 10,200	€ 12,000
Cost of Revenue	€ 2,460	€ 2,364	€ 2,209	€ 2,051
Gross Margin	€ 4,140	€ 6,036	€ 7,991	€ 9,949
Revenue	€ 184,800	€ 588,000	€ 1,407,600	€ 2,484,000
Cost of Revenue	€ 68,886	€ 165,498	€ 304,831	€ 424,620
Marketing	€ 120,000	€ 22,176	€ 70,560	€ 168,912
Total Costs	€ 311,266	€ 381,245	€ 616,867	€ 957,864
Net Profit	(€152,718)	€ 147,968	€ 617,158	€ 1,199,994

Break-Even Point 2.01 3rd January 2022

In the optimistic scenario, **monthly revenue per printer** increases €150 each year, resulting in a **€1,800 yearly increase.** Henceforth, revenue per printer in 2020 rises to €6,600. **Initial market penetration is 13%, 3% more than in the normal scenario** (yearly increase in penetrated infrastructures in each county of 5% suffers a 2% increase, resulting in a 7% rate). Meaning that, besides the increase in infrastructures reached and consequently a rise in the number of printers activated, the number of new printers activated added with each regional expansion increases. Thus, the **company's presence in each region is deeper than in the normal scenario.** As such, the **number of active printers in 2020 increases to 28.** In this scenario, **Revenue increases on average 46,7% when compared with the normal situation (40% in 2020, 43,3% in 2021, 49,6% in 2022 and 54% in 2023).** Total costs slightly increase (10% on average) pushed by the increase in the cost of revenue. However, overall **Net Profit rises considerably.** In 2020, even though the Net Profit is still negative, it **increases by 20,1%, reaching (€152,718).** The **biggest difference happens in 2021, with a 315,5% increase in value, reaching €147,968.** Likewise, the two final years also entail significant improvements in Net Profit, with a **102,1% rise in 2022 and 97,6% in 2023.**

7. CONCLUSION AND RECOMMENDATIONS

Conclusions & Recommendations

3DWays International Expansion: Risk Factors and Preventive Actions

Although 3DWays does not appear to have a specific home-country advantage, nor a current firm-advantage, based on the future value-network business model that the company is developing, an international expansion is recommended due to the characteristics of both the company and the industry in which 3DWays operates. In fact, *Born Global* theory suggests that companies falling in this category should not necessarily follow the traditional *Uppsala Model*, which requires a graduate foreign expansion. On the contrary, *Born Global* firms, such as 3DWays, should rapidly proceed direct exporting, without the need of having a financially strong and stable business activity in the home-country. After analysing in-deep detail five potential countries, the United Kingdom was chosen as the most attractive country (as a result of both its high market potential and moderate competitive landscape). Then, 3DWays should proceed to target different segments, Big Public and Small-Medium Private healthcare infrastructures. Starting first by the area of Great London and South East of England, which potentially provide interesting growth opportunities for 3DWays. In fact, as proven by the outcomes of the detailed financial analysis for 3DWays in the next five years, the company would be able to achieve its marketing goal by increasing every year its revenue at a rate of more than 50% over the next five years. However, additional operative risk factors, related to the internationalization of SMEs, should be ultimately considered in order to allow 3DWays to adequately prepare itself for its expansion strategy. According to a study conducted by Kubičková and Toulová (2013), there are several barriers preventing the success of international expansion, which differ for companies which are not yet operating on any foreign market, compared to those that have already a limited/extended experience abroad. Since 3DWays has not established yet any significant commercial operations in any foreign market, the first scenario is the one that can be applied to the case. In particular, the following factors are those that typically represent the most relevant constraints to the international expansion of SMEs, which might apply to the 3DWays case.

Since there is not yet any established network, due to the fact the 3DWays only has one client within the remote-control management business, initiating the value network business model will be crucial to the success of its internationalization. Being conceived with the same logic of a multi-sided platform, where the two sides are the two different types of segments, characterized by different needs and benefits, 3DWays will need to persuade its potential customers to enter the network, without initially benefitting of the networking effects during the earliest stage.

	Relevancy to 3DWays	Suggested Preventive Actions
Difficulty in finding foreign business opportunities		
Difficulty in establishing contacts with customers on foreign markets		Establishing contacts with healthcare providers might be extremely complex, due to the long decisional and operative mechanisms in place for providing patient care. The unclear structure of OBCs and their procedures might represent a significant barrier for successfully establish an effective contact within the healthcare organizations. Therefore, while hiring the sales team, 3DWays should necessarily consider to locally select Sales' personnel, placed in UK, and with extensive experience in procurement for healthcare suppliers.
Difficulty in obtaining a reliable foreign representation		As a result of the selected entry mode, based on direct exporting which does not imply the use of a local intermediary, 3DWays is responsible for its own marketing and commercial operations. However, due to 3DWays low brand awareness and reputation, the company might be not considered as a reliable supplier/partner from its potential customers. Therefore, in addition to obtaining industry-related certifications, 3DWays should try to establish collaboration with local research and innovation institutes. In fact, being associated with academic environment would provide higher credibility to the company.
Lack of staff (inadequately trained staff) to enter the foreign market		3DWays current staff does not have any previous experience in steadily managing foreign customers. Due to the transformation at the base of its international expansion, requiring a significant switch from manufacturing services to remote management services, 3DWays should promptly provide its personnel with clear and integrated guidelines to guarantee a high-quality service to its new clients.
Lack of information for foreign market analysis		While information on the 3DP industry is often uncertain, with different resources contradicting each other, it was quite difficult to find updated reports assessing advancements and opportunities for the healthcare system, in a quantitative way. While it could be suggested to conduct researches to assess the profitability of the industry and the selected market segments, 3DWays should proceed with a rapid internationalization plan of action, for the company to take advantage of first mover advantages in the country.
Lack of manager's time for searching and analysing the options of foreign markets		
Lack of support (financial or other type) from state		
Lack of capital to finance export		The €300,000 received as funds through the EU program Lisboa2020, half of which will be invested in marketing, will be sufficient to cover the costs needed for its internationalization plan, as projected in the financial analysis. However, in order to expand its operational and marketing plans, such as improving the current software and/or better targeting the selected segments to increase the penetration rate, more resources need to be invested. Therefore, 3DWays should consider to apply for new innovative programs, specifically dedicated to MedTech companies.
Difficulty in penetrating foreign distribution channels.		
Lack of language skills of key staff		
Technical, health and safety standards in foreign market		3DWays technology and its applications, 3DP products for medical devices, require high demanding quality certifications.

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