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ASSESSING THE FEASIBILITY OF A SEARCH FUND IN THE NATURAL STONE INDUSTRY IN PORTUGAL

EXPLORING INDUSTRY 4.0 PROSPECTS AND INDUSTRY PROGRESS

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Abstract

This thesis explores the viability of implementing a Search Fund (SF) within Portugal's ornamental stone (OS) industry. Through a literature review, it assesses the challenges, opportunities, and advancements associated with Industry 4.0. Leveraging in-depth interviews with key industry stakeholders, it substantiates the potential efficacy of employing a Search Fund as a revitalization tool for Portugal's OS sector. The study constructs an investment memorandum aimed at securing funding and delineates a comprehensive business model outlining strategies for modernization and fostering industry growth.

Keywords: Natural Stone; Ornamental Stone; Portugal; SME; Search Fund; Industry 4.0; Business Opportunities; Industrial Design; Business Models; Stone Technology; Digital Transformation; Succession; Acquisitions.

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ATC	Average Total Cost
AVG	Average
B2B	Business to Business
BI	Business Intelligence
BIM	Building Information Modelling
BM	Business Model
BMC	Business Model Canvas
BPM	Business Process Management
CAC	Customer Acquisition Cost
CAD	Computer-Aided Design
CAE	Classificação das Atividades Económicas
CAGR	Compound Annual Growth Rate
CAM	Computer-aided manufacturing
Capex	Capital Expenditure
CENFIM	Professional Training Centre
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CNC	Computer Numerical Control
CO2	Carbon Dioxide
COO	Chief Operation Office
CRM	Customer Relation Manager
CTO	Chief Technology Officer
EA	Entrepreneurship Through Acquisition
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
EC	European Commission
ERP	Enterprise Resource Planning
ESG	Environmental, Society and Governance
ETA	Entrepreneurship Through Acquisition
ExCom	Executive Committee
GDP	Gross Domestic Product
GPS	Global Positioning System
I4.0	Industry 4.0

IOI	Indication of Interest
IoT	Internet of Things
IP	Intellectual Property
IRR	Internal Rate of Return
HGF	High Growth Firm
KPI	Key Performance Indicator
LOI	Letter of Intent
M&A	Mergers and Acquisitions
MES	Manufacturing Execution System
MVP	Minimum Viable Product
NACE	Nomenclature of Economic Activities
NS	Natural Stone
OECD	Organization for Economic Cooperation and Development
OS	Ornamental Stone
PLM	Product Lifecycle Management
PPM	Private Placement Memorandum
PPT	People, Processes and Technology
PRR	Recovery and Resilience Plan
PY	Previous Year
R&D&I	Research, Development, and Innovation
RFID	Radio Frequency Identification
ROA	Return on Assets
ROI	Return on Investment
ROS	Return on Sales
RRP	Recovery and Resilience Plan
SDG	Sustainable Development Goals
SF	Search Fund
SME	Small and Medium Enterprise
SWOT	Strengths, Weaknesses, Opportunities and Threats
YTD	Year to Date
WACC	Weighted Average Cost of Capital
WMS	Warehouse Management System

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1. Introduction

Wood and stone were the first materials to be used as shelters and continue to be one of the most durable, recyclable, and sustainable materials used by humankind. The use of Portuguese stone out of its origin can be traced back to the Romans that used marble from Estremoz as architectural and decorative materials in temples in Merida (18 B.C) (Casal Moura et al. 2007). In the XV century, with the discoveries, the use of Portuguese marble and limestone was spread to Africa, India, and Brazil to build monuments, symbolizing the power and richness of the country.

In 2020, global ornamental stone (OS) quarrying reached a record 318 million tons, marking a 40% increase from 2010. However, the trend has recently stabilized over the past five years due to factors such as the pandemic-induced construction slowdown and heightened ESG policies surrounding quarrying, (Carlo Montani 2021). OS is expected "*to be valued at $60,367.30 million by 2030, surging from $35,998.50 million in 2021, a CAGR of 5.0%* (Research Dive, 2022).

With a long history of quarrying and processing natural stone, exports valued 493M€ in 2022 (Assimagra 2021b) and a growth +13,3% in comparison with the previous year, Portuguese OS Sector is well-positioned to continue to grow, leveraging on the rising of global affinity for natural stone in interior design, the escalating need for eco-friendly construction materials, and the emergence of advanced quarrying and processing technologies. These avenues for expansion maybe limited by some hurdles that persist, including a notably fragmented market, 98% comprising small-scale firms (#1855), yielding an EBITDA under 1M€ and fewer than 10 employees. Additional challenges involve suboptimal managerial skills, modest digital proficiency, minimal R&D, and limited customer service capabilities.

In summary, the OS Portuguese Industry has big opportunities which also come with big challenges, and this brings us to our research question for this thesis: **Can a Search Fund**

effectively acquire and transform an OS company by aligning with market trends, enhancing customer value, and scaling for increased profitability, paving the way to elevate the Portuguese stone industry's global relevance?

This thesis is divided in four parts: Introduction, Literature Review, Research and Conclusions. The Literature Review involved individual contributions while the remaining parts represent collaborative efforts. The **thesis objectives are the following:**

- Analyse Portugal's Natural Stone (NS) extraction and transformation markets, studying its dynamics, challenges, and potential business prospects;
- Investigate the feasibility of utilizing Search Funds for acquiring and expediting the industry transition within the Natural Stone sector, pinpointing the suitable company profiles for acquisition;
- Explore what business model could make it work to scale.

2. Literature Review

Section A. The Portuguese Natural Stone Sector and the Industry 4.0 challenges[1]

A.1 The importance of the natural stone sector in Portugal

The natural stone sector in Portugal represents 0,45% (INE 2023) of the nation's total exports of goods, covering 553% the level of imports (Assimagra 2021b) making this one of the healthier ratios per industry in the country.

COUNTRIES	1996		2015		2016		2017		2018		2019		2020	
	000 tons	shares	000 tons	shares	000tons	shares	000 tons	shares	000 tons	shares	000 tons	shares	000 tons	shares
CHINA	7.500	16.1	45.000	32.1	46.000	31.7	49.000	32.2	48.000	31.4	50.000	32.4	52.500	33.9
INDIA	3.500	7.5	21.000	15.0	23.500	16.2	24.500	16.1	26.000	17.0	26.500	17.2	27.500	17.7
TURKEY	900	1.9	10.500	7.5	10.750	7.4	12.250	8.1	12.000	7.8	11.750	7.6	11.250	7.3
BRAZIL	1.900	4.1	8.200	5.9	8.500	5.9	8.350	5.5	8.250	5.4	8.200	5.3	8.000	5.2
IRAN	2.500	5.4	7.500	5.4	8.000	5.5	8.700	5.7	9.000	5.9	8.250	5.3	7.800	5.0
ITALY	8.250	17.7	6.500	4.6	6.250	4.3	6.300	4.1	6.000	3.9	5.850	3.8	5.250	3.4
EGYPT	1.000	2.2	5.000	3.5	5.250	3.6	5.300	3.5	5.000	3.3	5.000	3.2	5.000	3.2
SPAIN	4.250	9.1	4.750	3.4	5.000	3.4	4.900	3.2	4.950	3.2	4.850	3.1	4.500	2.9
USA	1.350	2.9	2.700	1.9	2.800	1.9	2.750	1.8	2.850	1.9	3.150	2.0	3.200	2.1
PORTUGAL	1.950	4.2	2.700	1.9	2.600	1.8	2.750	1.8	3.000	2.0	3.350	2.2	2.850	1.8
PAKISTAN	200	0.4	1.050	0.7	1.100	0.7	1.100	0.7	1.200	0.7	1.250	0.8	1.300	0.8
S. ARABIA	250	0.5	1.200	0.9	1.250	0.9	1.250	0.8	1.300	0.8	1.250	0.8	1.250	0.8
GREECE	1.800	3.9	1.250	0.9	1.200	0.8	1.500	1.0	1.450	1.0	1.400	0.9	1.200	0.8
FRANCE	1.150	2.5	1.250	0.9	1.300	0.9	1.350	0.9	1.350	0.9	1.200	0.8	1.150	0.7
SUB-TOTAL	36.500	78.5	118.600	84.3	123.500	85.0	130.000	85.4	130.350	85.2	132.000	85.4	132.750	85.6
OTHERS	10.000	21.5	21.400	15.7	21.500	15.0	22.000	14.6	22.650	14.8	22.000	14.4	22.250	35.4
WORLD	**46.500**	**100.0**	**140.000**	**100.0**	**145.000**	**100.0**	**152.000**	**100.0**	**153.000**	**100.0**	**154.500**	**100.0**	**155.000**	**100.0**

(Fonte: Elaborazione propria) *(Source: own data processing)*

N.B. - Le stime produttive non comprendono i materiali per uso strutturale. *N.B. - Current materials for structure use are not considered.*

Figure 1 Leading quarry production (Carlo Montani 2021)

In the world stone production rankings, Figure 1, Portugal occupies the 10th position, the 3rd in Europe(Carlo Montani 2021). Emerging nations like China and India are reshaping the import & export landscape of natural stone, while traditional players such as Italy are witnessing a decline in their market share. There are only 7 countries that export more than 1M tons and Portugal, despite its size, ranks 6th. Portugal only keeps 20% of its OS production for domestic

[1] Section done by Carlos Frederico Carvalho, Individual Contribution

use but has 5th highest per capita use in the World after Switzerland, Saudi Arabia, South Korea, and Belgium, respectively.

According to Carlos Montani, Portugal exports to 104 countries, 55,9% for Europe. The sector has traditionally been focused on the European market (France, Spain, Germany), see Figure 2, but there are opportunities to expand into new markets, such as Asia and the Middle East. These markets are growing rapidly, and there is a strong demand for high-quality stone. According to regional analysis, the natural stone market in Asia-pacific region generated a revenue of $19,907.20 million in 2021 and is projected to reach up to $35,170.00 million by 2030 (Research Dive 2022) .

COMERCIO INTERNACIONAL

	2023 (YTD FEB)				2022 (YTD FEB)		
MERCADO	€	Share	TON	€/TON	€	TON	€/TON
França	**14 392 096 €**	19%	52 265	275 €	**14 229 420 €**	49 709	286 €
China	**8 520 550 €**	11%	64 424	132 €	**11 918 778 €**	91 056	131 €
Espanha	**8 129 174 €**	10%	60 322	135 €	**8 742 881 €**	72 289	121 €
EUA	**5 507 014 €**	7%	3 076	1 790 €	**3 489 071 €**	3 231	1 080 €
Alemanha	**5 212 763 €**	7%	23 314	224 €	**5 700 138 €**	32 571	175 €
UK	**5 025 528 €**	6%	14 699	342 €	**4 054 261 €**	11 086	366 €
Bélgica	**2 930 949 €**	4%	5 989	489 €	**2 387 546 €**	4 137	577 €
Paises Baixos	**2 388 753 €**	3%	5 787	413 €	**2 302 695 €**	5 331	432 €
Argélia	**1 956 632 €**	3%	6 790	288 €	**102 181 €**	691	148 €
Polénia	**1 924 242 €**	2%	4 286	449 €	**1 001 198 €**	4 070	246 €
Luxemburgo	**1 863 070 €**	2%	8 439	221 €	**1 232 389 €**	5 978	206 €
Suécia	**1 655 708 €**	2%	5 155	321 €	**1 838 037 €**	11 578	159 €
india	**1 572 643 €**	2%	4 757	331 €	**880 380 €**	3 701	238 €
Irlanda	**1 327 155 €**	2%	4 316	307 €	**1 742 502 €**	5 655	308 €
Dinamarca	**1 325 148 €**	2%	6 204	214 €	**1 027 674 €**	3 831	268 €
TOTAL MUNDO	77 635 055 €						

Figure 2 Portuguese Exports YTDFEB23 (Assimagra)

Portuguese exports of raw materials are diminishing to 34% in 2021 (Assimagra 2021b) and processed products increasing, bringing more value into our exports, Figure 3 and Figure 4. In 2023 according to Assimagra the price per ton of our exports has grown 12,4% (May.23 Assimagra).

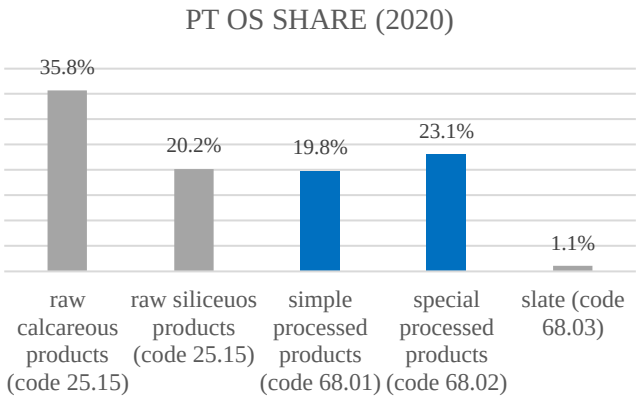

Figure 3 Portuguese Exports per Type (Carlo Montani 2021)

COUNTRIES	USD/ton					USD/sq. mt. / 2 cm.				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
ITALY	1.250,2	1.326,3	1.442,5	1.389,0	1.363,1	67,58	71,69	77,98	75,08	73,70
GERMANY	1.145,7	1.202,2	1.228,9	1.297,4	1.241,3	61,93	64,98	66,43	70,10	67,10
BELGIUM	530,3	580,5	668,8	1.137,8	1.145,4	28,67	31,38	35,15	61,50	61,91
CHINA	690,1	564,4	610,3	674,2	816,0	37,31	30,51	32,99	34,24	44,10
BRAZIL	696,4	711,6	719,0	738,1	701,8	37,65	38,47	38,87	39,90	37,94
GREECE	692,1	722,9	823,1	736,0	656,4	37,41	39,08	44,49	39,78	35,48
SPAIN	863,0	564,8	597,4	547,0	582,1	46,65	30,53	32,29	29,57	31,47
PORTUGAL	542,8	536,0	569,4	536,5	549,0	29,34	28,97	30,78	29,00	29,68
FRANCE	613,9	574,4	516,6	565,7	497,7	33,19	31,05	27,93	30,58	26,90
INDIA	510,4	508,4	470,8	470,6	455,6	27,59	27,48	25,45	25,44	24,63
MEXICO	327,6	232,8	192,2	194,4	384,0	17,70	12,60	10,40	10,50	20,75
TURKEY	451,6	419,6	401,8	470,6	363,0	24,41	22,68	21,72	25,44	19,62
TOTAL	673,5	604,2	625,0	623,0	676,1	36,65	32,96	33,78	33,68	36,55

(Fonte: Elaborazione propria) *(Source: own data processing)*

N.B. Valori riportati a dollari anche per l'export europeo *N. Average prices in USD for European export*

Figure 4 Leading countries of processed stone exports (Carlo Montani 2021)

On a less favourable aspect that Montani notes in his 2021 Report, (Carlo Montani 2021):

- The price per ton of Portuguese processed products is lower than its main competitors, led by Italian stone that extracts 148% more value per ton.
- OS Technology wise, Portugal imports (1.919 tons, 23 MUSD), much more than exports (758 tons) and imports mainly Italian technology (89,6%).
- Portugal is irrelevant in concrete and artificial stone products with 0,88% share of the World's production.

In summary, the Portuguese Ornamental Stone (OS) sector emerges as significant both on a domestic and global level, the trends are positive but there are opportunities to be taken such that more value is extracted from it.

A.2 The Industry 4.0 and 5.0 opportunities

The 1st Industrial Revolution (1784) changed the World from an agrarian and handicraft economy to one led by industry and machine manufacturing. These technological changes introduced new ways of working and living and fundamentally transformed society, (Britannica Encyclopedia n.d.). Since then, till today, two additional have happened: the **2nd Industrial Revolution (1870),** based on the invention of electricity and the combustion engine, introduced mass production, and allowed prosperity to levels never seen before; the **3rd Industrial Revolution (1969)** based on computers and the internet, brought automation, mass communications and IT globalization.

We are now in the **4.0 Industrial Revolution,** also referred as the Industry 4.0, the term was introduced in Germany in 2011 by Henning Kagermann, of the German National Academy of Science and Engineering, to describe an initiative supported by the government to modernize the industry, (Xu et al. 2021). Later, the term was also adopted by other countries, bringing the Internet of Things (IoT) and cyber-physical systems (advanced computer technologies working with and for humans) into the stage, along with a further focus on production, people, environment, and security.

The Boston Consulting Group identified nine key enabling technologies of Industry 4.0 (Rüßmann et al. 2015):

1) Big data and analytics;
2) Autonomous robots;
3) Simulation;
4) Horizontal and vertical system integration;

5) Industrial Internet of Things;
6) Cybersecurity;
7) Cloud;
8) Additive Manufacturing;
9) Augmented Reality.

Industry 4.0 aims to create **smart factories** and production systems that are more **efficient**, **fast**, **flexible**, and **interconnected to boost productivity and revenue**. The production processes can be connected and controlled by remote systems with little intervention by humans, (Xu et al. 2021).

To be a Smart Factory 4.0 several conditions need to be met, namely: **interoperability** (connectivity between systems including persons), **information transparency** (100% mapped processes that can be virtually tracked), **technical assistance** (help to decision making and human substitution in dangerous operations) and **decentralized decision processes** (the system is able to take decisions to become as autonomous as possible), (Boone 2023).

The digitalization of the business goes beyond the production site. Leading companies take significant value from data and analytics, AI, and machine learning to improve their processes, products and customer service while achieving higher employee satisfaction, and reducing their environmental impact. Others, however, remain stuck in pilot purgatory, fighting to retain the full potential of their transformation or deliver a satisfactory profit, (Gregolinska et al. 2022).

Digitalization enables to extract value for all stakeholders:

- **Manufacturers** can choose from hundreds of potential solutions and tech applications to improve their ways of working, it is common to see 40% reductions in machine downtime, 20% increases in output, 20% improvements in labour productivity, and 85% more accurate forecasting.

- **Employees** are empowered to make decisions, which allows easier talent recruitment and natural upskilling and retention.
- **Customers** benefit from a complete change in the traditional customer journey that becomes a “circular movement” where brands are discarded much easier based on the experiences stated by other customers or by the power of the digital engagement that the company can establish, (Rekettye and Rekettye 2020).

Companies that adopt an Industry 4.0 approach will: **fully digitize their operations**, **redesign their products or services**, and establish **closer interactions with their customers**. The full digitization of a company's operations involves integrating every function among all levels of the company. Another key component is linking with suppliers, partners, and distributors, and transferring data among them seamlessly. For example, a company that wants to digitize operations could implement an inventory management system, which connects retailers, distribution centres, transporters, manufacturers, and suppliers. Data can be sent across supply levels and orders can be placed and filled automatically to meet a company's needs.

A company looking to digitize should also complete a redesign of products and services to make them responsive and interactive, in addition to being able to track their own activity and results. When analysed, data received from the products can then show how well they are functioning. For example, equipment can now detect an impending mechanical breakdown and even prevent it.

Finally, companies looking to digitize and join the fourth industrial revolution should expect to have closer interaction with customers. New processes, products, and services will allow a business to reach end customers more directly and tailor their approach accordingly.

In 2017, the industry started to speak about Industry 5.0, which emerges from the need to bring the brutal technological evolution of the past few years to gain focus on our species, planet, and society limitations. The EU commission’s vision for Industry 5.0 speaks about a shift from

technology or economic growth to human progress and well-being, by reducing and changing consumption to new forms of sustainable, circular, and regenerative economic value creation, (Adel 2022).

This approach to the industry contributes to 3 of the Commission's priorities: "An economy that works for people", "European Green Deal" and "Europe fit for the digital age" (European Commission 2023).

The complexity of the technologies promised by Industry 4.0 and their emergent nature makes them feel unfamiliar and, to many, threatening.

"All industrial revolutions are ultimately driven by the individual and collective choices of people. And it is not just the choices of the researchers, inventors and designers developing the underlying technologies that matter, but even more importantly those of investors, consumers, regulators, and citizens who adopt and employ these technologies in daily life.", (Nicholas Davis 2016).

Next, we will discuss what has been done so far by the OS Portuguese sector in relation to the Industry 4.0 practices, in which phase are the companies and what are the opportunities to fast accelerate this transition, making it more efficient from both economic and anthropocentric standpoints.

A.3 The Portuguese Natural Stone Journey towards the Industry 4.0

Until 2004, natural stone companies were oriented towards standardized products like tiles, graveyard stones, simple pavements, kitchen countertops, the ceramic industry was killing the OS business, producing cheaper and easier-to-apply substitute products.

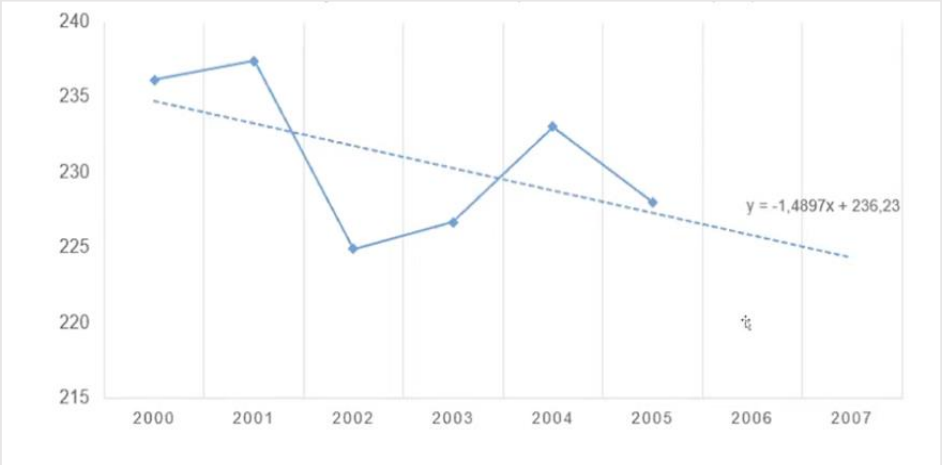

Figure 5 Portugal OS Exports 2000-2005 (M€)

The innovation pathway of the Portuguese natural stone sector began in 2004 with a first mobilizing project called JETSTONE followed every 4 to 5 years by a new one: INOVSTONE, INOVSTONE 4.0 e INOVMINERAL 4.0, in a phased approach to create renown companies that could be followed by others. The mobilizing projects were conducted through consortiums of universities, stone and machinery companies, and sector associations. Over 2 decades of projects, the LEANSTONE Master Plan was able to invert the trend of stone exports experienced until 2004, bringing momentum to this industry with product differentiation, brand recognition and higher value-added and revenue per product. (Silva 2021).

	2004-2006 **JETSTONE** 10 Entities	2009-2013 **INOVSTONE** 12 Entities	2016-2020 **INOVSTONE 4.0** 24 Entities	2020-2023 **INOVMINERAL 4.0** 20 Entities	2022-2025 **Sustainable Stone by Portugal (RRP)** 50 Entities	
OC Companies		ETMA FRAVIZEL FRAZÃO -Mármores Granitos GALRÃO Norte MOCASTONE MVC PEDRANTIQUA Plácido José Simões PRODIGINVENTA RAFAEIS SOLANCIS	FILSTONE GRANATUR GRANIALPA INOVOPEDRA URMAL MARFILPE MARMOCAZI MARMORES GALRÃO PEDRAMOCA SOLANCIS TORRE-ITM	DIMPOMAR JULIPEDRA LSI STONE MARFILPE MÁRMORES VIGÁRIO MVC POLIMAGRA SOLANCIS	A. BENTO VERMELHO AIRELIMESTONE BRITAFIEL DIMPOMAR FILSTONE GRANUMLUX GRUPO FRAZÃO JULIPEDRA LOPESTONE LSI STONE MARFILPE MARMOCAZI	MARMORES GALRÃO MOCAMAR MRF PEDRAMOCA POLIMAGRA RAFAEIS MAMORES ROCKING SOLANCIS (PROMOTOR)
Tech and Software		CEI CEVALOR INOCAM	CEI DIAPOR FRAVIZEL FRONTWAVE INOCAM ISQ ZIPOR	CEI FRAVIZEL FRONTWAVE SEVERAL WAYS STREAMVALUE	ARROW4D CEI FRAZIVEL FRONTWAVE GENOA SPARK HRV INOCAM	POSTEJO SEVERAL WAYS STREAMVALUE
Academia		Universidade de Évora	IPPORTALEGRE IST ISCTE UEVORA UTRASMONTES UNL-FCT	ISCTE FC ULISBOA FCT PORTO IST IPLEIRIA	EPRM ETPR FTC_NOVA IDMEC INECT-TEC INESC TEC INSIGNARE IPLEIRIA	IPSANTAREM ISG IST-ID ITECONS NOVA.ID.FCT UCOIMBRA UEVORA LNEG MUNIC PORTO DE MÓS
Associat.				ACPMR CLUSTER AEC	ACPMR ASSIMAGRA BUILT COLAB	
	?	4,5M€	7,0M€	5,7M€	55,8M€	
MAIN Objectives	Flexible technologies Improve Efficiencies Waste reduction	Disruptive Innovation New Tech and Digital sol. Enhance productivity	Value chain integration Industy 4.0 Focus Adopt BIM Principles	Circular economy Full digitization Colab. Processes New HR skills & careers	Accelerate I4.0 transition Safety for workers More Value added products ESG principles	

Figure 6 Leanstone PLAN projects summary

The LEANSTONE PLAN was designed by CEVALOR and ASSIMAGRA as a playbook to establish disruptive technologies and techniques that would reverse the sector's negative trend, attract skilled human resources, establish courses to train specialized workers, reduce raw material waste, and establish the STONE.PT brand.

The first phase of the LEANSTONE PLAN, called **JETSTONE**, was focused on developing flexible technologies that could produce customized products while improving its efficiency. The scope was micro-orders in the domestic and European markets.

The next phase, **INOVSTONE** (CEI 2009), a new consortium extended to new science and technology entities, aimed to develop new technological and digital solutions of disruptive

innovation (Industry 4.0) that would enhance productivity and efficiency (lower energy consumption), and create customer value through customized, differentiated products, that answered exact customer needs. The scope of this phase was the response to medium-sized commercial opportunities in a more flexible and competitive manner in international markets, (Da Silva et al. 2020).

The **INOVSTONE 4.0** (ACPMR 2020) was the next phase, with the goal of digitally integrating the complete OS value chain, connecting 24 entities from raw materials (upstream) to transformation processes (downstream). The scope was the response to customized projects of any scale, fostering collaborative, co-creative, and personalized interactions between clients and suppliers (Silva 2021).

The intention was to communicate the sector's offerings in a manner that could be seamlessly integrated into the Building Information Modelling (BIM) architect platforms. The current procurement system prevalent within the construction industry is widely regarded as a source of wastage, spanning from the building's conception to its eventual demolition, thereby attributing an entirely unsustainable carbon footprint to the process (Silva and Almeida 2020). The application of BIM technology to this supply chain, which is progressively becoming mandatory by legislation in numerous countries, facilitates a cleaner, more transparent, and sustainable approach. As posited by A. Silva, (A da Silva, Policy, and 2020 2020) within the BIM framework, standardized construction materials will openly compete in procurement processes, intensifying pricing pressures and excluding less efficient enterprises from the equation, while concurrently expanding opportunities for those that demonstrate proficiency on a global scale.

In **INOVMINERAL 4.0 (**CEI 2020), the paramount objective encompasses the co-optative digital integration of the value chain. In this novel endeavour, new partners, and clusters outside the OS Sector, such as those in architecture, engineering, and construction, are brought into the

fold for a comprehensive integration aimed at uniting the already digitized enterprises and the OS Marketplace.

The Portuguese Natural Stone sector may take the standardization pathway and compete through already mentioned BIM opportunity or can leverage on the Industry 4.0 revolution and on the intangible attributes that bring value upon a product that takes millennia to evolve, rendering its unique, irreproducible, enduring, recyclable, and sustainable characteristics (Klemm and Wiggins 2016). This serves as a countermeasure against standardization, encouraging a strategic focus on bespoke products – artistic pieces imbued with distinctive character and substantial value. To attain this objective, the digitization of customer interactions and their concomitant professionalization emerges as pivotal imperatives.

As a result of the LEANSTONE PLAN, the export trend has inverted (Silva 2021). The resulting technologies are currently implemented in over 300 OS enterprises, which engage in exports to more than 57 countries. As an integral facet of LeanStone, the Mineral Resources Academy was established, concurrently giving rise to novel vocational courses and forging interconnections between these courses and the broader higher academic trajectory.

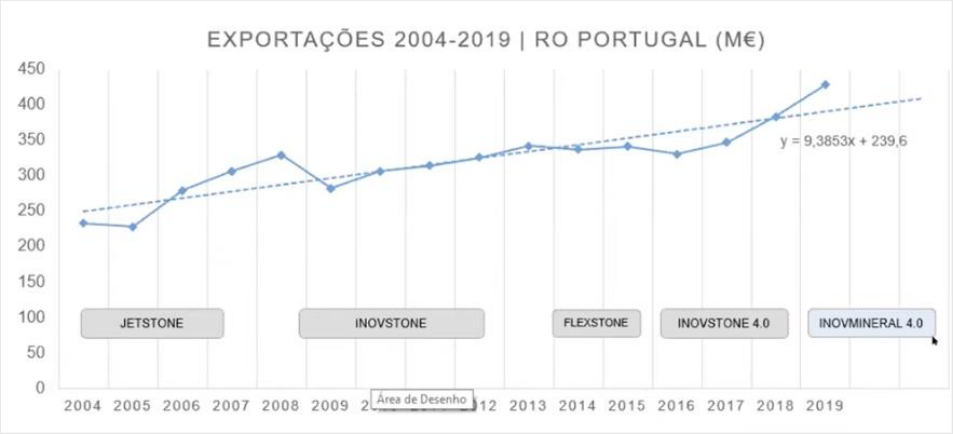

Figure 7 OS Portuguese Exports 2004 to 2019

In 2022, as part of the Recovery and Resilience Plan (RRP), a Mobilizing Agenda for Natural Stone was unveiled. Through a consortium led by the Association Cluster Portugal Mineral Resources and comprising 49 partners, this initiative, named SUSTAINABLE STONE BY

PORTUGAL, aims to truly galvanize the competitiveness and internationalization of the Natural Stone sector. According to the Mineral Resources Cluster, this ideation competition seeks to solidify and extend synergies between the business landscape and the scientific and technological framework within Portugal. This endeavour contributes to enhancing the competitiveness and resilience of the Portuguese economy through research and development (combined stone and cork products), innovation, diversification, specialization of the production structure, and the reduction of raw material waste. This program, which has already garnered 140 submissions, is currently in progress. (ACPMR 2022)

A.4 The status of the Portuguese companies in this sector

According to Carlos Rabadão in the study on digital transition on the OS Sector (Carlos Rabadão, Institute of Polytechnic of Leiria, 2019) most of the companies are at level 0 and 1 indicating very low levels of digitalization. In this study, of the 669 companies assessed (83% of the total), 414 (62%), were at level 0, no digitalization or entirely traditional/manual processes; 125 (19%), with only 1 computerized machine, were at level 1; 94 (14%) at level 2, possessing more than 2 machines with integrated management processes; 25 (2%) were at level 3, encompassing machine integration with management and industrial engineering; and 15 (2%) were at level 4, connecting to the marketplace. The study concluded that companies with higher levels of digitalization are more competitive in foreign markets and that ascending one level of digitalization yields a return of €7 for every euro invested in exports under a moderate scenario, potentially reaching €12 in an optimistic scenario.

Later in 2020/21, ASSIMAGRA (Assimagra 2021a) conducted a series of focus groups (4) within the framework of the "THE STONE 4.0 AGE, the Digital Transformation of the Stone Sector" project, aiming to assess the readiness of companies for Industry 4.0 concepts based on the model developed by the IMPULS Foundation of the German Engineering Federation

(VDMA). This model focuses on six dimensions, with particular emphasis on defining the level of Industry 4.0 maturity. Various parameters were evaluated within each dimension.

The general conclusions of this work point to:

- Strategically there is lack of well-defined goals for digitalization, innovation, and Industry 4.0, accompanied by insufficient progress tracking; there is a lack of promotion and visibility of the sector both in national and international markets; companies need capital to invest; there is a need to develop circular economy strategies in which companies and service providers stimulate the sector itself.
- There is a need for someone to oversee innovation and Industry 4.0, possibly an external consultant. Recruitment is challenging due to the sector's unattractive image, less competitive salaries, and limited career growth compared to similar industries. Upskilling current staff is also difficult, and management is concerned about losing specialized experts after transitioning to new technologies.
- The lack of communication network coverage in work areas poses as a barrier to digital transformation. Numerous companies mistake the adoption of specific IT systems with innovation and Industry 4.0.

Also in 2020, the "STONE4.0 AGE" project (Assimagra 2020) conducted a comprehensive quantitative survey among Assimagra's members. The primary objectives were to provide a characterization of the Portuguese Ornamental Stone (OS) industry, evaluate their readiness in terms of legal and HR aspects, assess the extent of digitalization in production and management, and gauge the level of available technology and digital resources. Out of the 323 companies invited to participate in the survey, only 26 responded. These respondents were predominantly from the Leiria, Santarém, and Lisboa regions, with an equal distribution between extraction and transformation activities within the ornamental stone industry. The study's findings shed light on several crucial aspects within the sector:

- 42% of the surveyed companies are highly export-oriented, with over 80% of their production destined for international markets. A majority of companies, 54%, focus on producing a single type of product, indicating a specialized niche approach. Only a limited 27% of the respondents claim to have access to a dedicated test laboratory, suggesting potential room for investment in quality control and R&D infrastructure.
- Approximately 65% of the workforce falls within the 40-49 age group, indicating a significant concentration of experienced professionals in the middle-age bracket. Less than 10% of the workers hold a high school degree, with the majority possessing educational qualifications below that level. This suggests that a significant portion of the workforce may have limited formal education. A substantial majority, exceeding 80%, of the sector's workforce comprises men, indicating a gender imbalanced industry.
- A significant 70% of companies report having production control systems. Surprisingly, 50% lack certified management systems, suggesting potential opportunities for enhancing overall business processes. Digitization levels vary across tasks, with higher adoption in customer communications but lower integration in production and quality control systems. Approximately 42% still rely on paper-based documents, primarily due to the workforce's limited information system skills.
- In extraction companies, specific software is prevalent but there's a notable issue with system integration, as 60% of different departments use systems that don't communicate effectively. While websites are common, product catalogue availability is limited to only 20%. Production sites in extraction companies often lack computers, CNC machines, and electronic production planning systems.
- In transformation companies around 50% have interconnected production management software, facilitating streamlined operations. A significant 69% have adopted CNC machines, signifying a higher degree of automation. While electronic records are not

widely adopted, website presence is strong, with 40% offering product catalogues and customer engagement features. The use of Building Information Modelling (BIM) is limited to only 5% of transformation companies.

The study also offers a comprehensive array of management KPIs, which collectively underscore the sector's heterogeneity and potential for enhancement: cost structure; stock average value; days of sales outstanding; order delivery time; machine failures and repair times. Furthermore, the study delves into ESG KPIs, revealing notable observations: a substantial percentage (23% to 38%) of the companies lack data on these metrics, indicating a need for improved data tracking. More than half (54%) of the companies report residue levels above 46%, underscoring environmental impact considerations within the sector.

These findings collectively emphasize the heterogeneous nature of the Portuguese Ornamental Stone sector and suggest areas for innovation, digitalization, efficiency improvements, and sustainability initiatives, (Assimagra 2020).

According to the special report conducted by the European Court of Auditors in 2020 on the Digitalization of European Industry, “EU companies are not fully exploiting advanced technologies for innovation. Given that 99% of EU companies are SMEs, it is particularly important to encourage them to embrace the challenge of digitalization.", (European Court of Auditors 2020).

So, all the reports are pointing in the same direction, it is urgent to overcome the hurdles poised by the technology advances, to reorganize the sector, to enhance companies with tools to scale and compete at global scale.

3. Research

3.1 Research Questions

Can a Search Fund effectively acquire and transform an OS company by aligning with market trends, enhancing customer value, and scaling for increased profitability, paving the way to elevate the stone Portuguese industry's global relevance?

To solve this question, we propose a stepwise approach that will investigate:

- How do the OS key stakeholders see themselves regarding the Industry 4.0 challenges and how do they project their future?
- What factors potential influence OS customer journey, in particular, why do they opt for a natural stone or a substitute?
- What companies meet the Search Fund KPIs for success and what business model should be used?

3.2 Methodology / Research design

Our line of research follows, according to the Research Onion method (Saunders 1997), a combination of cross-sectional data collection, mixed methods (integrating qualitative and quantitative elements), and a sequential approach involving interviews and surveys. This strategy embraced an inductive approach for theory-building and adhered to a pragmatic research philosophy, ultimately facilitating a comprehensive and practical exploration of the research topic divided in the following 3 phases and respective objectives:

- **Qualitative research, in-depth 1:1 interview**, face to face or via Microsoft Teams, with a total of at least **20 individuals** representing OS Companies and OS Machinery Factories Owners, OS Project University Professors and OS Sector Associations Representatives, *convenience* sampled from a database of Assimagra associates or following referenced companies by interviewed subjects, conducted from April to July 2023. Our objective is to identify the core values OS key stakeholders used to navigate

in this sector over the past years and to assess the challenges they feel will be critical in the foreseen future.

- **Secondary Research**, in depth review of sector reports, official websites with financial data of OS related companies to extract information according to KPIs referred in the literature that could inform us on what companies to interview on the qualitative research and lead us on the choice of the potential targets for a Search Fund. Conducted by us from February to June 2023.
- **Quantitative research phase**, completion of at least **50 web surveys.** The 15 questions survey was sent by mass email to a mailing list convenience sampled from Orbis© by Moodis of national and international architects, to identify the profile of the end customers understanding their criteria when choosing natural stone materials. Conducted in July 2023.

3.3 Research results

Section B. Qualitative research

Below we describe the Qualitative Questionnaire used to interview the companies' stakeholders.

1. **Company** name?
2. **Interviewed name** and position?
3. What type of **supplies** are used? How and from where do they select them?
4. What **production processes** are used (level of automation)? What type of technology is used, type and number of machines? What is the level of machine interconnectivity?
5. What **type of products** do they do? Who develops them? Do they have IP or other authorial protection? Do they sign/brand their products? How do they innovate?
6. Who are their main **customers**? Buying frequency? Level of exports? Is there a customer acquisition/retention policy?
7. HR, how many **employees** do they have? How are they organized? How are they recruited and maintained? What type of benefits do they give them?
8. What are the **main challenges they face**? How do they prepare for them?
9. What is the **company organogram**? What's the company's CEO succession plan?
10. Can you provide a name of a company we should interview to have a different perspective on the sector?
11. Type of collaboration we got from the interview.

Figure 8 Qualitative Questionnaire

Sample method

We began by validating our 1:1 Interview Questionnaire with local OS companies in Pêro Pinheiro and seeking referrals for additional interviews. Later we added to the list, companies referenced by Assimagra that we met remotely. More names were added after our participation in the Global Stone Congress 2023 (https://globalstone2023.stonebyportugal.com) and in the Stone Expo 2023, in June, where we met several OS experts and scholars that gave us new perspectives on Stone trends and uses in other parts of the world. If initially our difficulty was to get to the OS Stone CEOs for lack of references in the end, we lacked the time to conduct more interviews that we ended up loving for the richness of the conversations. We chose from

a pool of over 72 key stakeholders and companies, prioritizing diversity in backgrounds, product specialization, size, and positioning, Figure 9.

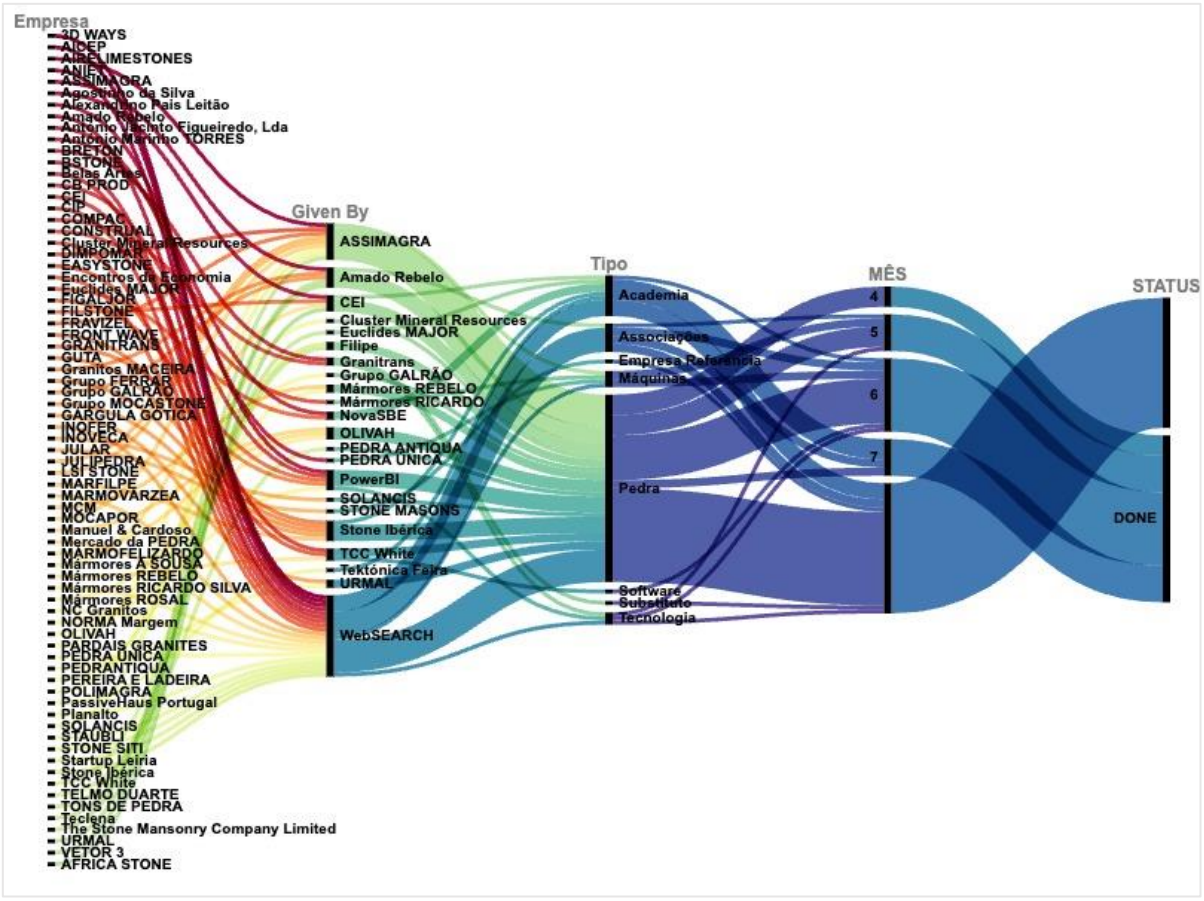

Figure 9 Alluvial Diagram of the Interviewed Companies

We were able to collect 37 contributions that we categorized in clusters depending on insights gathered: positioning in the OS Value Chain, raw material used, types of products offered, number of employees, type of machinery, level of customer service, I4.0 maturity, management type, generation, EBITDA, operating revenue and revenue per employee, see Figure 10. The different combinations of these attributes generated 7 homogeneous clusters: (i) small businesses (not specialized: do it all type of businesses), (ii) medium businesses (specialized: retailers of slabs or sellers of raw blocks of stone), (iii) small to medium size differentiated offer of products including co-creation and personal brand (iv) large companies covering all steps of the value chain (v) producers of machinery and software (vi) institutional players (vii) others (academia, congresses, experts).

Company Initials Code	Industry	Interview			Line of Work	Size	Business Type Cluster	Value Chain Position	Industrial Design	Tenure Cluster	Management	CEO Generation
		DATE	TYPE	Role								
IIM	NOS	11/jul	F2F	NA	A	NA	6	1/2	NA	NA	NA	
EEE	NOS	12/jul	Online	NA	A	NA	7	4	NA	NA	NA	
AG	NOS	17/jul	F2F	NA	A	NA	7	2/4	NA	NA	NA	
AMT	NOS	18/jul	Online	NA	A	NA	7	4	NA	NA	NA	
GU	OS	22/jun	F2F	Employee	E	Small	2	1	N	2	Prof	
FJ	OS	24/abr	F2F	Employee	ET	Medium	2	1/2	N	2	Family	3
DPC	OS	12/mai	Online	Employee	ET	Medium	4	1/2/3	Y	3	Family	2
EMEVN	OS	5/jun	Online	Owner	ET	Medium	4	1/2/3/4	Y	3	Family	3
UR	OS	9/jun	Online	Owner	ET	Medium	4	1/2/3	N	3	Family	3
APL	OS	13/jun	F2F	Owner	ET	Medium	2	1/2	N	1	Family	3
PA	OS	16/jun	F2F	Owner	ET	Medium	3	2/3/4	N	2	Mixed	2
GF	OS	22/jun	F2F	Owner	ET	Medium	1	1/2	Y	2	Family	1
SC	OS	3/jul	F2F	Owner	ET	Medium	4	1/2/3/4	Y	3	Family	2
GT	OS	4/jul	Online	Owner	ET	Medium	2	1/2	N	2	Family	1
CGS	NOS	22/jun	F2F		I	NA	6	1/2	NA	NA	NA	
ASS	NOS	24/mai	Online	Vice President	I	NA	6	1/2/4	NA	NA	NA	
CMR	NOS	30/jun	Online	President	I	NA	6	1/2	NA	NA	NA	
SSL	NOS	5/jul	Online	President	I	NA	7	4	NA	NA	NA	
AI	NOS	20/jul	Online	Employee	I	NA	6	1/2	NA	NA	NA	
ES	NOS	9/jun	Online	Employee	M	NA	5	2	NA	NA	Prof	
ST	NOS	13/jun	Online	Employee	M	NA	5	2	Y	NA	NA	
AJ	NOS	26/mai	F2F	Owner	M	Small	5	2	N	2	Family	3
CT	NOS	26/mai	F2F	Owner	M	Small	5	2	N	2	Family	2
FV	NOS	16/jun	F2F	Owner	M	Medium	5	1	Y	3	Family	1
C	NOS	22/jun	F2F	Employee	M	Small	5	2	Y	3	Prof	
PU	OS	24/abr	F2F	Employee	T	Micro	1	2	N	0	Family	2
RSM	OS	24/abr	F2F	Owner	T	Micro	1	2	N	0	Family	2
CP	OS	24/abr	F2F	Employee	T	Small	2	2	Y	2	Prof	
NM	OS	3/mai	Online	Employee	T	Small	1	2	N	2	Family	1
AR	OS	10/mai	F2F	Owner	T	Micro	1	3	N	0	Family	1
TW	OS	11/mai	Online	Owner	T	Small	3	2/3/4	Y	3	Family	1
3DW	NOS	23/mai	F2F	Employee	T	Micro	7	3	Y	0	NA	
PL	OS	10/jun	Phone	Owner	T	Medium	2	2/3	Y	3	Mixed	1
OH	OS	14/jun	Online	Owner	T	Micro	3	3/4	Y	2	Prof	
GGG	OS	22/jun	F2F	Owner	T	Micro	3	3/4	N	1	Prof	
MPF	OS	23/mai	Online	Owner	T	Micro	1	2/3	N	3	Family	2
TSM	OS	28/jun	Online	Owner	T	Small	3	3/4	Y	3	Prof	

Line of work: E(Extraction); T(Transformation); M(Machines); I(Institutional); A(Academia)
Value Chain: 1 (Quarry); 2 (Simple Transformation); 3 (Bespoke Products); 4 (Co-Creation)
Tenure: 0(<5Years);1(<20Years);2(>20Years)
Industry: ornamental stone industry (OS); non-ornamental stone industry (NOS)

Figure 10 Example of the interviews processing clusters

Cluster	Number of Companies in the Cluster	Number of Companies with Info	Avg. Cluster Employees	Avg. Cluster EBITDA	Avg. Cluster Op. Revenue	Avg. Cluster Revenue per Employee
1	6	4	11	92.515	700.417	71.338
2	6	6	63	1.411.934	10.198.270	438.042
3	5	2	29	203.211	1.715.035	72.211
4	4	4	90	1.037.694	6.914.743	76.501
Subtotal	**21**	**16**				
5	6					
6	5					
7	5					
Total	**37**					

Figure 11 The 7 homogenous CLUSTERs summary

The 37 interviews took place in 5 different formats, 15 were in person, 14 online via Microsoft Teams, 4 in person during the congress and stone fair, 3 were online but after a personal approach on-site and 1 by telephone. Out of all the interviews, the majority, 21, were with OS businesses, with 14 being family-managed, 5 having professional managers, and 2 transitioning towards professional management. Regarding family-type businesses, out of the 14 in total, 5

are currently managed by the founders, 5 belong to the second generation, and 4 are under the management of the third generation of the family.

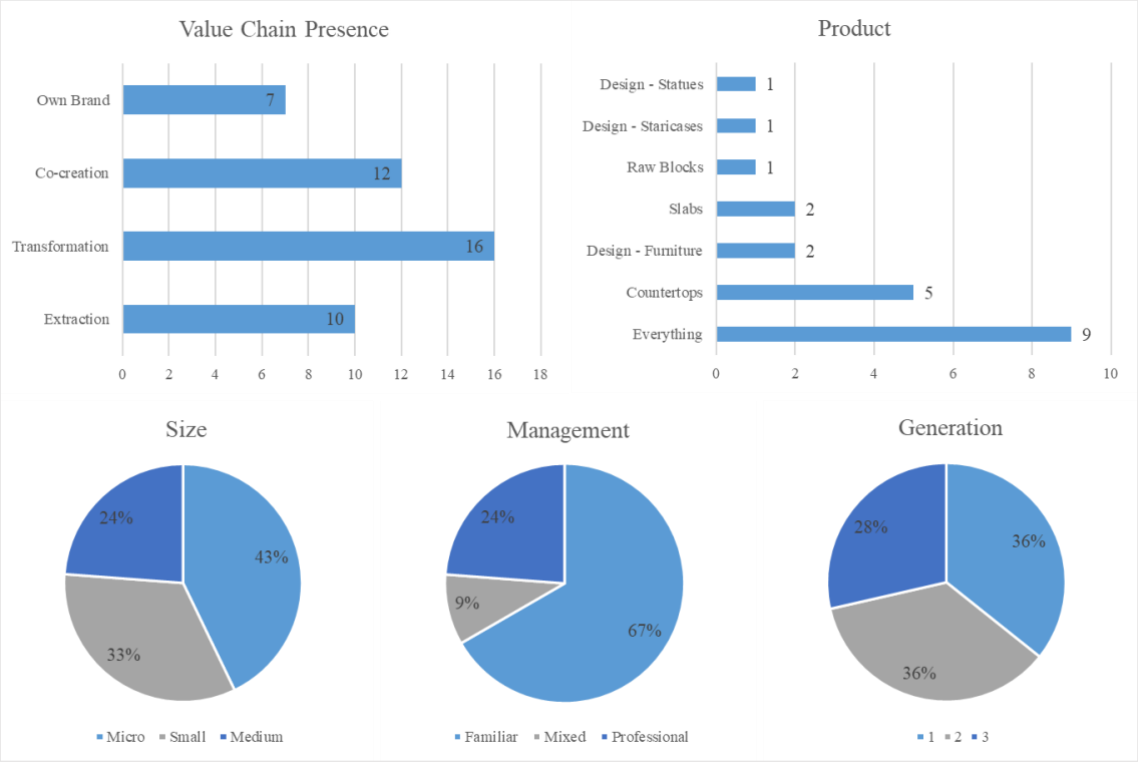

Figure 12 Summary of company's main characteristics.

In classifying the maturity level of adopted technologies, we obtained the following distribution: 0 indicating no technology use in daily operations or customer engagement, and 3 indicating system interoperability and a certain level of customer-centricity.

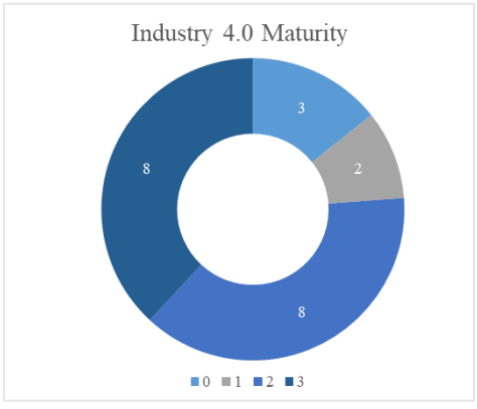

Figure 13 Interviewed Companies I4.0 maturity (own classification)

Findings

We attained a collaboration level of 4.3 out of 5 in the interviews conducted, yielding valuable key insights that we detailed over the next paragraphs.

The OS Portuguese companies have evolved to be specialized by stone type and product types. Some work primarily with limestone, others with granite, others with marble and others may even work with substitute products but that does not mean that they do not commission or work with other materials upon customers' specific requests. Regarding product types, most companies manufacture facades, flooring, surfaces, countertops, exterior pavements, fireplaces, or cemetery stones. There are some, more specialized that produce bathtubs, washbasins, pre or post-tensioned staircases, blocks as structural elements in buildings or employ artistic handwork to create replicas of statues or design pieces, see Figure 14.

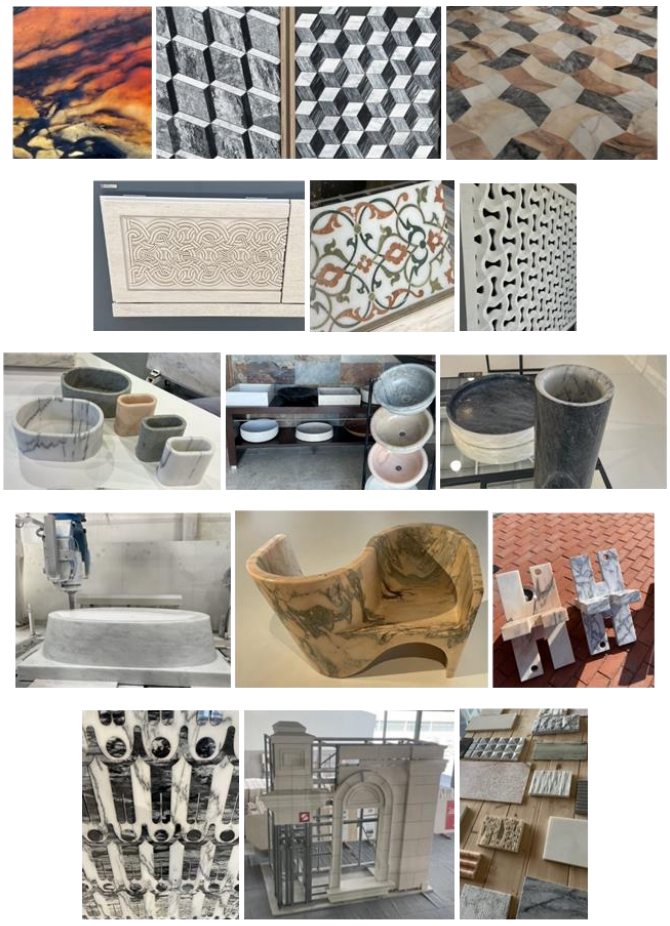

Figure 14 Products viewed during visits, photos Nuno Castanheira

- **A highly resilient sector with powerful sector associations.**

Our interviews encompassed stakeholders from various stone generations and diverse backgrounds, including those from academia, consultancy firms, and quarry operations. Across this spectrum, a common thread was evident - resilience and a steadfast commitment to the path ahead. There was also a profound respect expressed for industry associations (Assimagra, Aniet, Cluster Mineral Resources) and for the pioneering efforts of top companies in charting the industry's future course.

The past years financial crisis, the changes in trends regarding the natural stone export market value, the new emerging competitors (ceramics, Dekton©, Silestone©…), the Industry 4.0 acceleration together with the difficulty to retain and gain new international customers made surviving an objective for many OS companies. Only some show a clear view of their situation and of the challenges ahead, the majority seems to be focus on their day-to-day business.

- ***"The OS Industry has a culture of competition instead of cooperation."***

Portuguese OS companies often struggle with size limitations that hinder their competitiveness on a global scale. While there are exceptions, the formation of consortiums to secure procurement processes for significant international projects, which require large quantities of stone, a wide range of product categories, and stringent timelines, remains infrequent. This is primarily due to the structural constraints that individual OS companies face in meeting such demands. Many times, OS companies run against each other, **crushing prices** to stay ahead, **owning quarries**, in an environment of immense difficulties to get new extraction licenses, to control accesses to raw materials, **betting on the latest technology** to gain efficiency. The competitive advantage of quarrying licenses and heavy capital investment in factories and machinery create strong barriers to entry, limiting new business and scale-up opportunities. Additionally, most of the value for the OS customer comes from intangible characteristics like the uniqueness of the product stone or design, the quality of the sales and post sales service, the

respect for the delivery times, areas in which much of the OS sector is not focused on. Businesses keep copying each other in terms of products and technology used so any advantage they may have been time limited. The industry is "*commonly focused on what is easier*", as one of the CEOs said, "*they lack the skills, curiosity, and creativity to do more*".

Although there have been several public supported projects (JETSTONE, INOVSTONE, INOVSTONE 4.0, INOVMINERAL 4.0 and mobilizing agendas of RRP) to promote innovation in this industry, digitalization and interoperability between different technologies is still a mirage for most companies. The interconnection between production plants (upstream-downstream and downstream-downstream) is the future and only few are ready to tackle it.

- ***"It's impossible to get licenses..."***

Portugal has 4 main areas of quarrying: granite, in the north, that shows a growing trend in volume and value, evolving from block to processed products; lioz, a marble-type stone, in the Lisbon Area, declining due its low export market value; limestone, in the centre, growing supported by Assimagra projects and Government programs, and with high export market value, and Estremoz marble, trending down due to difficulties related with quarrying laws & licensing.

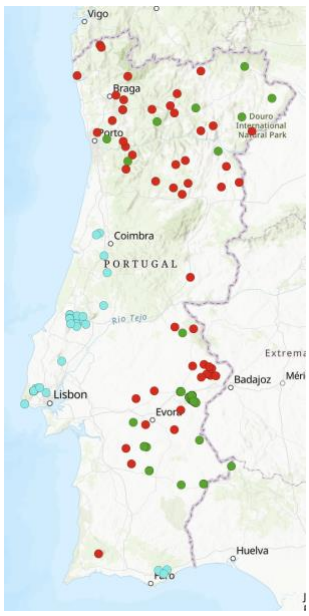

Figure 15 Portuguese Natural Stone Quarries (LNEG 2023)

Irrespective of the quarrying area or the location of the processing factories, to get an OS business permit shows to be a daunting and complex process. The accident in Borba in November 2017, that killed 2 workers, brought extra difficulties on the quarrying activity, and made the public perception of this industry worse than before making it hard to get endorsement from municipalities to approve new projects or extensions of the current licences. Politicians take ages to develop and apply new laws that, like Italy did, give to the country's natural resources the correct framework to make it sustainable and profitable. The execution of the law number 54/2015 ("Lei n. º 54/2015 | DR" n.d.) is still being discussed and its content being widely disputed by the sector as it limits opportunities and closes businesses.

- ***"I can't afford to have R&D."***

We found many different forms of innovation but when making investment decisions, money, or FTEs, most of the companies do not choose R&D, that they consider to be a luxury, "*we do not have the size to do it*". OS innovation comes mainly from **heavy investment in technology** and its frequent renovation cycle, **hand finishing** of the products, by adapting, in a typical Portuguese way, **practices from other sectors** (e.g., shoes industry) or by **tweaking the business models** (e.g., using the vacant containers to ship back block of stones to China, signature brands, pieces booklet with the story from block to final product). **Industrial design** is rare, usually the projects come in drawings that just need some small adjustments to be produced and that is the only thing they do.

- "***Environmental, Social and Governance" could be the next big thing.***

Regarding ESG, OS companies need to take more advantage of working with a durable, recyclable, sustainable natural product offsetting the impact traditional business operates to downplay potential substitutes.

Environmental

Product height, width, length, price, packaging, production time, waste use, energy production/consumption balance, overall CO2 footprint, air, water, and visual pollution are all aspects that need to improve moving forward. OS companies use only **3% of what is extracted** from quarries and for each raw piece extracted 5x its volume goes to waste.

Technology already allows low quality blocks, stone leftovers, and muds to give way to new business opportunities cleaning the stone region landscapes. Recent technology machinery strips dust, noise, and muds out of the working areas but it needs to be more widely used since innovation pace is high and once cutting-edge technology become obsolete in less than a decade. There are also opportunities to explore more the machinery in place in % of working time or in technical features. Additionally, there is value to be captured in repurposing recycled OS stone.

CO2 emissions of concrete fabrication process is a drawback in the construction sector giving stone as a structural **element** for the buildings an opportunity. Latest trends for nearshoring might be an opportunity for the stone industry to sell products at a fair price with production close to the consumption site.

Social

OS companies are frequently the heart and soul of the small villages nearby, different family generations, complete households, side business depend on them. In the good examples recruitment, training and retaining policies can be found. Some CEOs call the teens in their communities to promise them jobs after their graduation and plan to distribute production prizes amongst their best employees. These actions might help overcome the challenges of recruiting and retaining employees, even though tech enhanced, and exports focused companies have less problems with recruitment since they provide a cleaner environment to work and better salaries. The same progressive thinking cannot be found in terms of Inclusion & Diversion, many of the

workers are men, women can be found often in quality control or administrative areas. Also, regarding the visual *impact caused by the* OS activities, with some exceptions, companies live peacefully with it, not worrying about the feelings of nearby populations which later affects them when trying to get new licenses.

Governance

Industry associations are actively engaged in formulating strategic workstreams aimed at steering the sector towards greater alignment with governance principles, however factors such as the small size of the businesses, family-based management structures, intense market competition, the prevalence of tax informality, and a culture of confidentiality collectively contribute to creating formidable barriers for the elevation of this ESG pillar.

- **BIM, a friend, and an enemy**

BIM may shape the future of certain Portuguese firms, particularly those focused on robotic mass production and cost-efficient units. Such ventures rely on standardized quality stone, which is increasingly scarce due to challenging quarry operations. Potential threats for these businesses encompass competition from cheaper materials, imitation stone ceramics, and yearly launched products. An alternative, as advocated by Agostinho da Silva (da Silva and Almeida 2020) is escaping the BIM trap, a strategic approach involves leveraging stone's imperfections as unique features to co-create distinctive highly valued pieces, engaging directly with architects and contractors. This bypasses BIM but adheres to its principles of transparency, ESG concerns, and more.

We have identified three paradigms that could dictate the future of this sector:

I. “Bloco é ouro, Chapa é prata, Ladrilho é lata “

Despite significant investments in technology and a strong customer-centric approach driven by Industry 4.0 principles, a prevalent sentiment in the industry remains, encapsulated in the saying, "Bloco é ouro, Chapa é prata, Ladrilho é lata" (stone blocks are

gold, slabs are silver, and standardized pieces are loose change). This adage underscores the enduring importance of tradition within the sector. It highlights that there is still considerable revenue to be generated from traditional, non-future-proof, low-value-per-ton, and non-strategic products. In essence, while the industry embraces technological advancements, it also cherishes its heritage and recognizes the continued significance of conventional stone products in generating revenue and sustaining the sector.

Figure 16 Examples of low-quality raw blocks, photos Nuno Castanheira

Low quality blocks of stone or stone leftovers can be found everywhere in the OS Industry regions. Superior quality blocks are sold in Portugal or sold to Europe, lower quality blocks are sent to China while medium quality blocks are transformed and sold as slabs, the remaining stay stockpiled in the confines of the quarry or the vicinity of the processing factory. The work Italians are doing in educating their customers of how *defects* give personality and uniqueness to the stone pieces is still to be done amongst us and it is felt by many of the interviewed CEOs as a critical step moving forward for economic and ESG reasons.

II. They say they must focus on the customer but…

Most of the companies tailor their processes and/or products to meet their customers' needs, their execution is flawless, but they are closed in august, they give scarce information on the

status of the order or its time for completion, they lack the post sales service and that makes it exceedingly difficult to compete against more reassuring/standardized products.

Businesses lack commercial strategy, they have passive sales processes, and they lack orientation for innovation. When selling to foreign countries it is most often done using the services of local agents. Many business contacts are still made in international or national sector fairs Global Stone (Batalha, Portugal), Marmomac (Verona, Italy); Xiamen Stone Fair (Xiamen, China); Vitória Stone Fair (Vitória, Espírito Santo, Brazil) or using showrooms. Websites are mainly used as business cards with no other value in terms of budgeting, product tracking or customer support.

Photographing the piece encompassing the transformational journey from raw material to the final product and giving a booklet to customers so that they utterly understand what they have bought could be essential to establish higher value, "... ***to buy OS is an experience full of sensation and emotions".*** Only a handful of companies have a brand they imprint in the work they do or number their pieces.

Embracing a paradigm of co-creation in collaboration with customers and architects emerges as the transformative trajectory for the evolution of this industry. To allow designers and architects to breathe life into their projects by using premium stones, incorporating its inherent imperfections as unique features it is necessary to bypass the challenges posed by alternative materials' prices & standard looks competition.

Design pieces and partnerships with renown artists, designers, architects could be a way to add extra value like the Primeira Pedra Project by Assimagra showed (https://www.primeirapedra.com/en/). Only four of the companies we have talked to demonstrated evidence of possessing intellectual property safeguards for their proprietary processes and machinery or have sought protection through authorship mechanisms.

III. OS Company's trade worldwide *but they die where they were born.*

OS companies import machines from Italy, blocks or slacks from Europe, Africa or Asia, export worldwide, yet an intriguing phenomenon emerges: a propensity to remain entrenched in their geographic origins, notwithstanding the advantages that lie 50 kilometres away. This vantage point offers more favourable access to specialized fiscal incentives, European Union financial backing, and enhanced logistical infrastructures. Paradoxically, all interviewed companies steadfastly uphold their founding places, evincing a pronounced affinity for sharing their success with their communities. They do not care that out of the Lisbon region or out of their small village, motorways and ports are closer, governmental programs available to support them and municipalities that gladly would license expansion projects they cannot approve in their current environs.

When asked about their immediate challenges, most of the CEO's points to the scarcity of skilful workers. They face problems in recruiting and retaining the talents they desperately need to operate increasingly sophisticated technologies. This sector contends with more lucrative options in cleaner industries, emphasizing the urgency to communicate the significance, potential, and future of the stone industry to prospective young employees. CEOs don't seem to be focus on their succession, they don't anticipate their children entering the sector, but they remain vigilant and somehow hopeful. A minority has already embraced external investments, and a subset has definite plans for complete divestment.

In summary, in the Portuguese OS industry tradition, opportunities and difficulties live side by side. Some of the companies seem to lack the investment, capacity, and technology to survive, others are adapting for the future, supported by the industry associations, unsure if what they are doing is enough. We've met some of these latter companies but do we have a solution that could made them bigger and stronger to compete? Can we find out what the customers are truly looking for? That's what we will try to find out in the next research section.

Section C. Macroeconomic and Financial Characterization of OS Industry

Sources

Dataset	Type of Data	Date of Extraction	Observations	Last Period Available	Type of Data
ORBIS, BUREAU VAN DIJK					
PT OS companies from Extraction and Transformation	Integer, Currency, Text	31-05-2023	1.892	2022	Microdata
International OS companies Extraction	Integer, Currency, Text	18-06-2023	55.939	2022	Microdata
International OS companies Transformation	Integer, Currency, Text	18-06-2023	70.192	2022	Microdata
INE – Instituto Nacional de Estatística					
Exports	Currency	13-08-2023	5.220 (5 var.)	2022	Aggregated
Number of Employees	Integer, Currency	08-06-2023	770 (24 var.)	2021	Aggregated
Legal Form	Integer, Currency	08-06-2023	126 (28 var.)	2021	Aggregated

We've developed a Power BI analysis of the sector which can be accessed with this link.

Findings

The international distribution of companies in the ornamental stone industry, Brazil is the country with more companies (45k), followed by the USA (12k), China (11k), India (9k) and Portugal (2k) in 14th place. If one ranks these companies by EBITDA, Portugal takes the relevant 8th place, by operational revenue 13th, while by number of employees 15th.

Regarding the OS PT Industry, exports more than doubled since the beginning of the century, however, its contribution to the country total exports is orbits around 1% over the observed horizon. This increased value exported is related to an increased importance of transformed products.

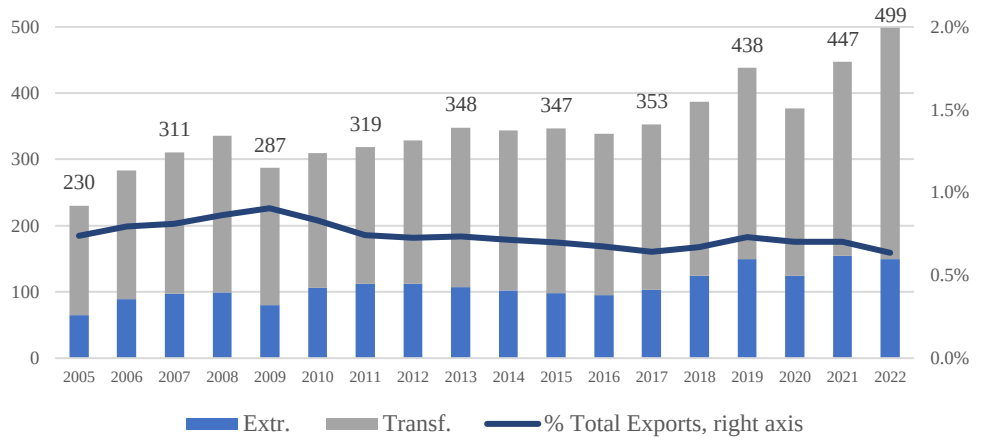

Figure 17 OS Industry PT Exports

The graph below shows the slow decay of marble exports while limestone and granite exports gain importance since 2005.

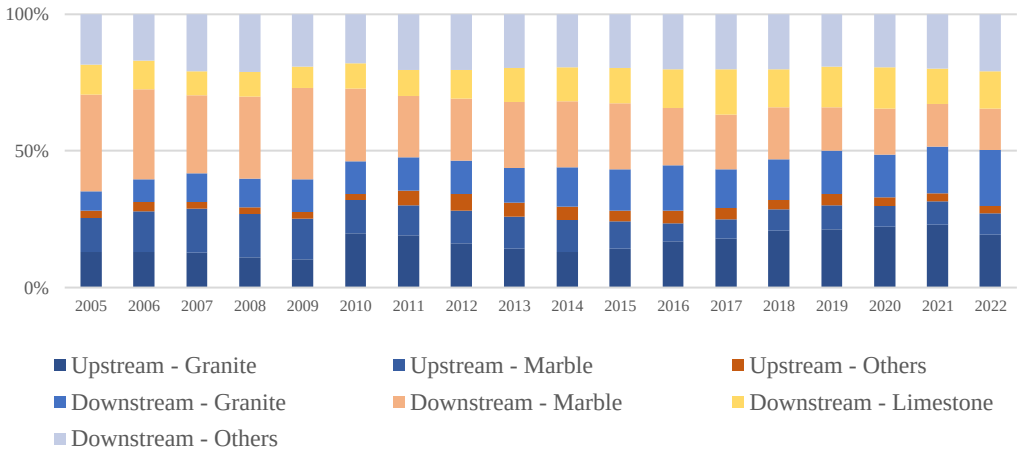

Figure 18 Products Exported

	Exports 2022 (millions of euros)	2022-2012 % Variation	Contributions
Granite	96	81%	25%
Marble	39	-2%	0%
Others	14	-30%	-4%
Subtotal Extraction	149	32%	21%
Granite	103	154%	37%
Marble	75	2%	1%
Limestone	68	96%	20%
Others	104	55%	22%
Subtotal Transformation	350	62%	79%
Total	**499**	**52%**	**100%**

Figure 19 Evolution of PT exports by type of product

Acquiring a company through the search fund model requires an exhaustive investigation, including macroeconomic context, ornamental stone industry particularities and identify the best financial criteria for benchmarking companies and reaching a short-list of potential targets. The strategy for identifying the target company was analysing enormous amounts of data, starting at a macroeconomic perspective, and making a drill-down toward a micro perspective with the analysis of the unit economics of the targeted company. We started by mapping opportunities with industry-wide information from (Gabinete de Estratégia e Estudos, 2022 and Instituto Nacional de Estatística, 2023) where indicators by NACE[2] 0811[3] and 2370[4] were analysed, such as number of companies, turnover, legal form, gross value added, net income, returnonequity (ROE), number of employees, within others. Using Orbis from (Moody's 2023) database, microdata was analysed bringing a clearer vision of potential targets, from this dataset, information about shareholders, employees, location, legal form, foundation, VAT number, contacts, operating revenue, EBITDA, assets, solvency, cash flows, stocks, liquidity, cash, and long-term debt was retrieved. Afterwards some calculations were made to complement the information such as the 5-year or 3-year average of important financial variables and the revenue per employee. Complementarily, information from IAPMEI and AICEP was also looked at where information about exporting companies and type of products produced. This search phase was supported by the development of a dashboard in Microsoft Power BI (see link above and print screens in appendix) to help draw conclusions from the data and share our conclusions in an appealing visual format. This analysis was the starting point for giving an intelligible format to numbers and allow a clear photograph of the Portuguese

[2] Statistical Classification of Economic Activities in the European Community

[3] Upstream/Extraction of raw stone blocks

[4] Downstream/Transformation of stone blocks into slabs

ornamental stone industry and used for preparing interviews with the owners of the potential acquirable companies.

According to INE, in 2021, there were over 2200 companies in the ornamental stone industry in Portugal, around ¼ in the extraction and ¾ in the transformation. These companies translate into an operating revenue of 1.2 billion euros, 35% extraction and 65% transformation while the gross value added achieved 450 million euros, distributed 40%-60% between upstream and downstream. Since 2012, both variables moved in an upward trajectory (>50%) whereas the number of companies keeping decreasing (-300) showing some consolidation in this industry. On average, the financial statement of these companies improved decreasing the ratio of liabilities to assets. Over the same period, employee costs increased 30% to 261 million euros (around 20% of operating revenue) while the number of employees decreased (-700 to 14,8 k) and minimum wage rose 37% (from 485 to 665 euros per month). This industry is also characterized by a proliferation of small enterprises, >80% have less than 10 employees, only 161 companies have medium size (>50 employees). These 161 companies (7,3% of total) take 57% of operating revenue and 59% of gross value added. If one also adds the companies with more than 10 employees, 388 companies (17,5% of total), capture 76% of operating revenue and 79% of gross value added.

While INE considers two types of companies, individual companies (655) and societies (1556) summing a total of 2211 in 2021, Orbis, which provide disaggregated individual microdata, shows only 1890 companies in both sub-industries (upstream and downstream). According to Orbis data, these companies employ a total of 15k employees, an operating revenue of 1.3 billion euros and an EBITDA c. 0.2 billion euros. The maturity of the companies of this sector has the following distribution:

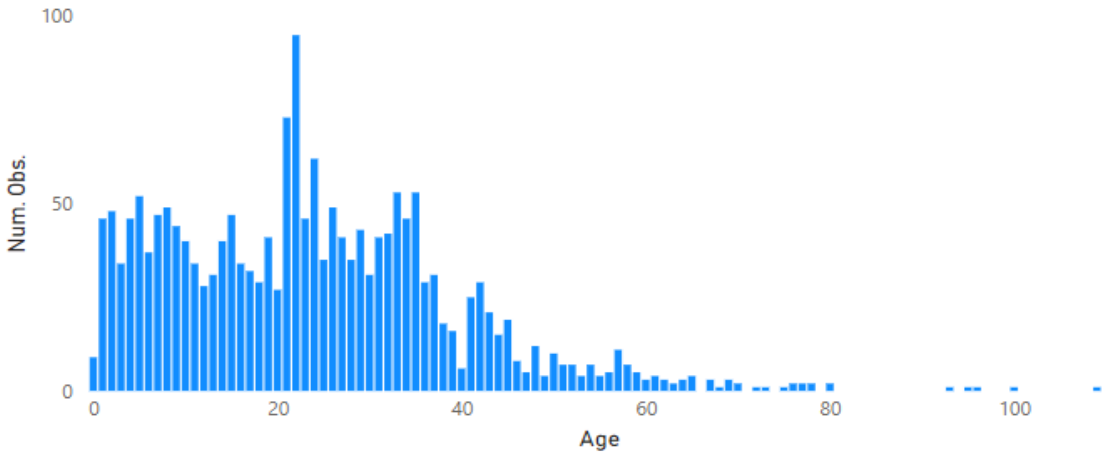

Figure 20 Distribution of Companies per Tenure

Over 70% of the companies have 1 or 2 shareholders and 94% take the form of a limited liability company while 5% are public limited companies (94). From the 1890 companies in the disaggregated dataset, 67 have an EBITDA over 0.5 million and 162 have operating revenue over 1.5 million. The Power BI dashboard allows making several comparisons easily, testing several intervals and combinations of restrictions.

Another example of what is possible to do in this dashboard is a scatterplot with the average EBITDA and the revenue per employee, where the size of the dots is governed by the operating revenue. One can immediately see different profiles of companies which one can cluster in subgroups.

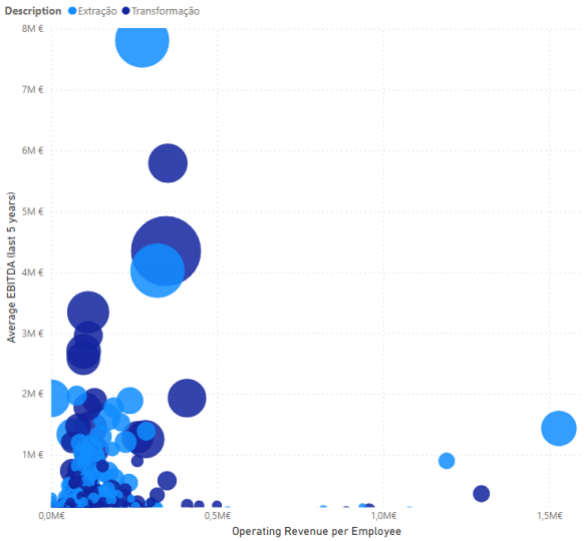

Figure 21 EBITDA vs Operating Revenue per Employee

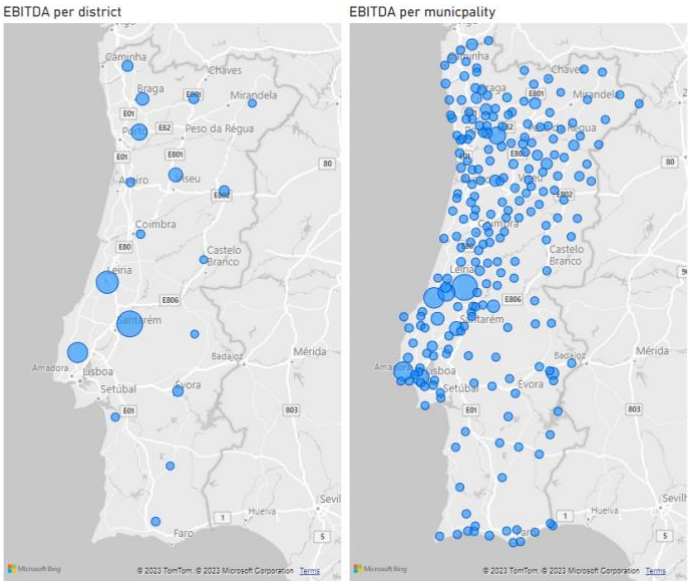

Figure 22 EBITDA per District & Municipality

The national distribution of EBITDA per district and municipality can be seen in the next map where one can see bigger bubbles in centre region (Leiria and Santarém) showing the importance of Serras de Aire e dos Candeeiros (Ourém, Alcobaça and Porto de Mós). In a smaller dimension, per municipality it is also possible to see the importance of the companies registered in Sintra, Lisboa, Marco de Canaveses and Vila Viçosa.

In a more interactive format, the remaining pages of the Power BI desktop pretend to complement this macro information with a deeper view into a dozen companies view with filters by region (district or municipality) to compare several at the same time, interval of financial indicators (EBITDA or operational revenue), firm specific with the selection of the name of the company from a drop-down list. The power BI also allows to see multiple dimensions plotted all together, Figure 23, showing a bird's eye view of the 1890 companies and their positioning vs. the measure's averages represented by the blue dotted lines.

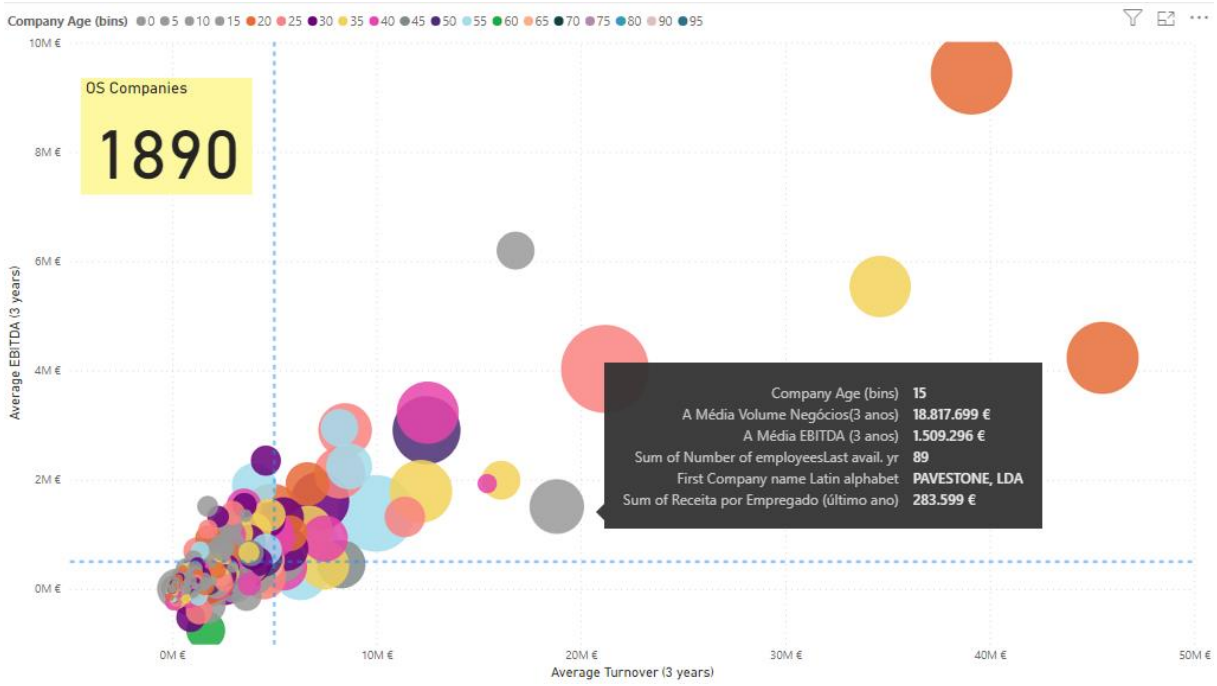

Figure 23 EBITDA vs Turnover vs # Employees for the OS ALL

The 1,890 companies and the parameters defined in the Power BI dashboard serve as the foundational dataset for identifying potential targets within the Search Fund context, a step to be explored further in this thesis. In the forthcoming research section, our focus will shift towards characterizing the needs and requirements of customers/prescribers within the OS sector. This exploration is aimed at uncovering insights and opportunities that can inform the development of future business models in the industry.

Section D. Quantitative research

1. **In which city or town do you currently live?** Open text
2. **What do you do for living?** Open text
3. **To which age group do you belong?** 25-34; 35-44; 45-54; 55-64; Other
4. **When you think of marble what country of origin do you think of?** Italy; Spain, Turkey; Portugal; Greece; China; Other
5. **Can you say why?** Open text
6. **Are you aware of Portuguese marble?** Y/N
7. **What's your experience with marble as a material?** Open text
8. **When was the last time you bought a marble piece / furniture?** This month; Last 6; Last 12; More than 12
9. **What was it? Why have you bought it?** Open text
10. **From who have you bought it?** Store; Architects; Designers; Did it myself
11. **Please rank the following reasons as to aspects you value the most when selecting a marble piece**: Design; Country of Origin; Marble Type; …
12. **Who helps you to decide what to purchase?** Open text
13. **Please describe the marble piece that you have bought that you are most proud of and why?** Open text
14. **What are the main difficulties you have encountered when ordering a new custom-made marble piece/furniture?** Open text
15. Could you please provide us with a name and email of a friend / colleague that is also a buyer of marble design pieces that could help us and answer this survey? Open text

Figure 24 Architects & Designers questionnaire

Sample Method

The quantitative research phase was conducted by an online survey of 15 questions (Figure 24 Architects & Designers questionnaire) sent via email to 3.609 national and 1.290 international architects obtained from Orbis on 12.06.2023, by filtering the Portuguese database with CAE 741 and 711 (similar to NACE), with email registered and with data updated after 2019 and the International database with CAE's 4120, 7022, 7111 and 7410[5] and positive total sales revenue.

Findings

The survey yielded a total of 167 valid responses, constituting approximately 3.4% of the total sample. These responses met the criteria of having at least 75% of the questions answered. On average, respondents took approximately 16 minutes and 56 seconds to complete the survey.

Demographically, the majority of respondents (93%) hail from Portugal, indicating a strong representation from the local context. Among the respondents, 74% identified themselves as architects, while 12% identified as designers, reflecting a predominant professional background

[5] 4120 – Construction of residential and non-residential buildings; 7022 – Business and other management consultancy activities; 7111 – Architectural activities; 7410 – Specialised design activities

in the architecture field. In terms of age distribution, 72% fall within the age groups ranging from 35 to 54 years old.

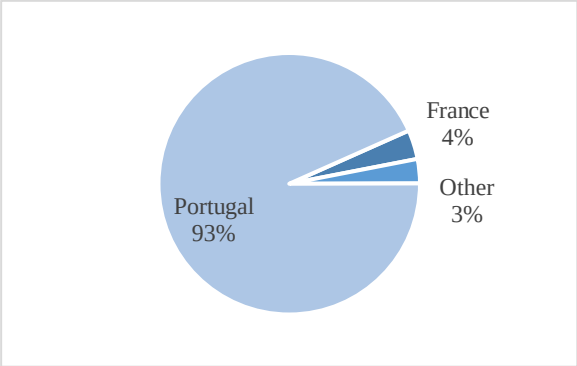

Figure 26 Q:In which "country" do you currently live?

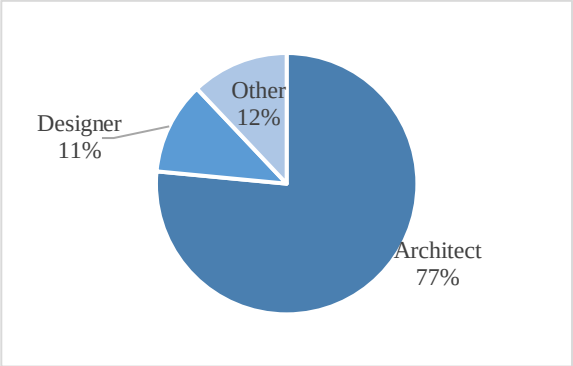

Figure 26 Q:What do you do for living?

When asked about what country they associate with marble, 70% responded Portugal and 23% Italy. 100% of the respondents outside Portugal answered Italy, none of which were Italian.

When probed about their reasons for these associations: Portuguese respondents primarily linked marble to their home country due to national pride, but also attributed it to factors such as quality, competitive pricing, and transportation cost advantages. Foreign respondents favoured Italian marble due to its enduring legacy, excellent reputation, and globally recognized quality.

Impressively, 94% of the survey participants demonstrated familiarity with Portuguese marble, emphasizing its recognition within the industry.

The survey findings reveal that a substantial portion of respondents have a well-established history of using marble in their projects. They overwhelmingly characterize marble as a "beautiful", "durable", "strong and timeless", and "sustainable" material. Their overall experience with marble is described as excellent, underlining its positive attributes.

While the majority of respondents hold a highly favourable view of marble, a minor percentage (1.2%) expressed concerns about stone maintenance, and a slightly larger fraction (5.4%) mentioned price considerations. Nevertheless, even those who noted price concerns still

regarded marble as "expensive but good," indicating an acknowledgment of its quality despite cost considerations.

The survey results reveal that a significant 68% of respondents have made stone-related purchases in the past 12 months. These purchases were primarily centered around various applications: **Kitchen, Bathroom, Flooring, or Walls**, approximately 54% of respondents acquired stone pieces for these functional areas within construction and interior design projects; **Furniture Pieces**, a notable 25% of respondents invested in stone pieces for furniture applications; **Design Pieces**, the remaining purchases involved stone pieces for various design-oriented applications.

Moreover, the survey indicates that architects and designers are actively involved in the development and procurement of stone pieces. In 55% of the cases, these professionals design pieces themselves and either directly engage with stone factories or utilize agents to have them produced. In the remaining 45% of instances, architects and designers incorporate pre-designed stone pieces into their projects, showcasing the diverse approaches taken within the industry.

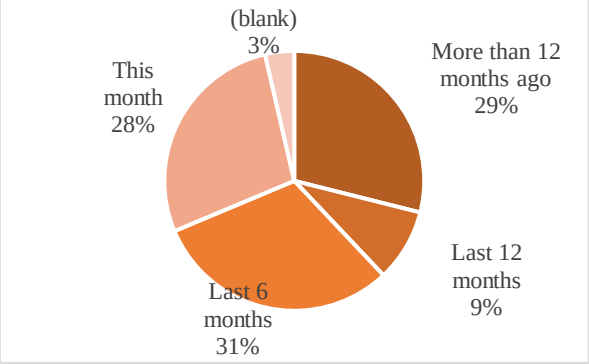

Figure 28 Q:When was the last time you bought....?

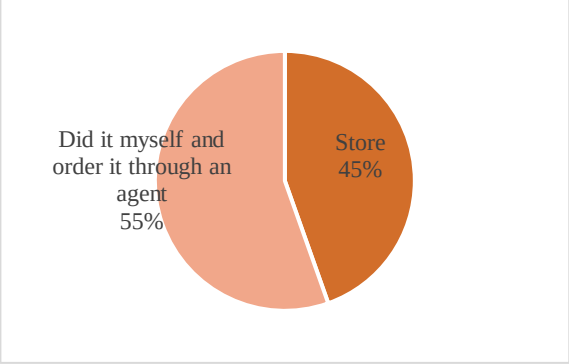

Figure 28 Q:From who have you bought it?

The decision-making process for choosing stone design/pieces within the surveyed population is notably influenced by several key factors:

- Architect's Influence: In a majority of cases (58%), the architect's input significantly guides the decision on the type of design or piece to select.
- Agent/Supplier Influence: In approximately 22% of instances, the agent or supplier plays a pivotal role in influencing the choice.
- End Customer Consultation: Surprisingly, end customer consultation is relatively rare, with only 10% of cases involving direct input from the customer.

In terms of the most influential factors guiding the choice of stone design/pieces:

- Stone Type: The type of stone itself is a primary consideration, underscoring its significance in decision-making.
- Design: Design elements strongly influence the decision, emphasizing the importance of aesthetics.
- Color: Color is another pivotal factor that plays a significant role in shaping choices.
- Quality: Quality considerations, along with the country of origin, also hold considerable sway in the decision-making process.
- Conversely, factors such as "price," "agent," and "author" are deemed to be less critical in the decision-making process, highlighting the dominance of stone type, design, and colour in guiding choices within the ornamental stone sector.

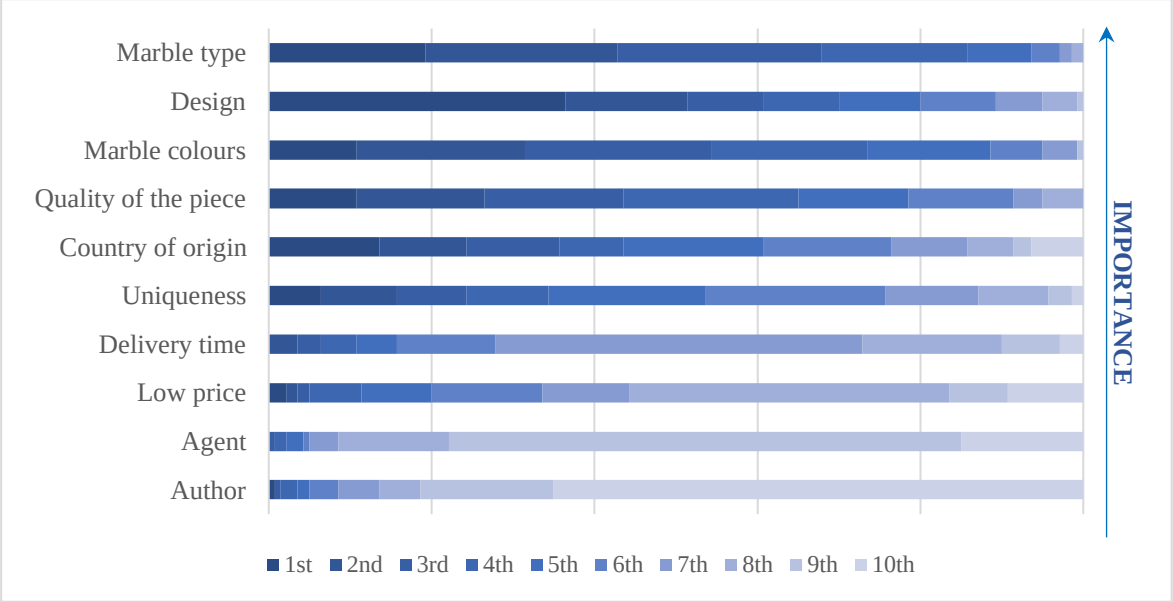

Figure 29 Q:Please rank the following reasons as to aspects you value the most when selecting a marble piece.

When asked on the features they most appreciate in the last stone piece they bought, 51% of the interviewed replied “uniqueness” and “beauty” while 28% refered cited convenience-related factors, such as practicality, affordability, familiarity, and proximity to the quarry, as influential in their choices.

These insights underscore the importance of aesthetics and uniqueness in stone piece selection, as well as the consideration of practical and convenient attributes for a portion of buyers.

A notable finding from the survey is that only 13% of respondents reported never encountering difficulties when purchasing natural stone pieces. For the majority of respondents, difficulties were encountered in several key areas: Timely Delivery, a significant number of respondents faced challenges related to the timely delivery of their orders; Price Transparency, transparency regarding the final price of the stone pieces was a common issue for many respondents; Logistics, challenges related to transport and logistics during the procurement process were reported; Quality Control/Assurance, issues regarding quality control and assurance of the purchased marble pieces were also mentioned by respondents.

These findings highlight the real-world complexities and challenges that buyers within the ornamental stone sector may encounter during the procurement process.

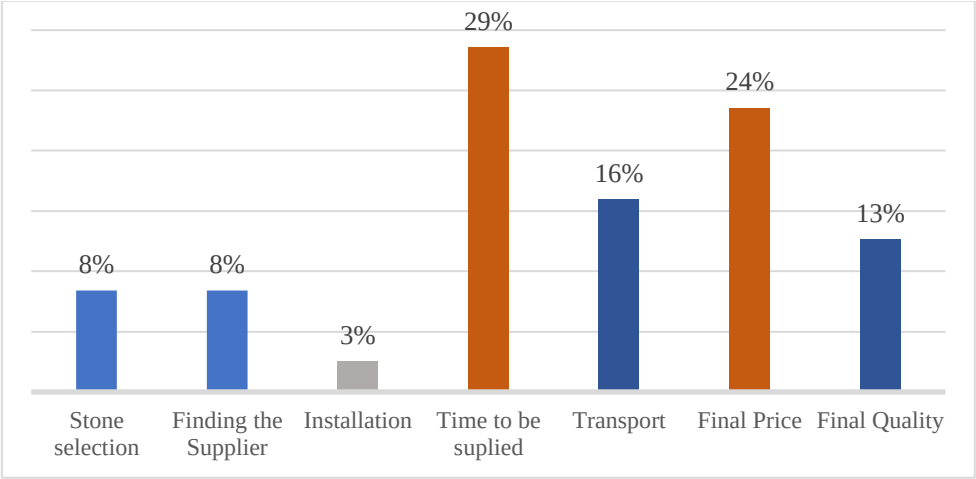

Figure 30 What are the main difficulties you have encountered when ordering a new custom-made marble piece/furniture?

Supported on this survey, we can summarize the following:

- Architects and Designers are strong influencers in the OS Industry, as prescribers and designers, but on half of their projects they buy industrial design pieces.
- Stone products are valued for their uniqueness, sustainability, and durability and they are frequently part of Architects projects.
- "Portuguese Marble and Natural Stone" is known and valued but the brand needs to be scaled up to.
- "price", "author" and "agent" are the least valued attributes when looking for a stone product where "type", "design" and "appearance" are kings.
- "delivery time" is not a critical decision factor but is seen as one of the biggest hurdles when ordering for stone works.

Hurdles and decision factors coincide on the need to listen to customer's needs. A superb omnichannel customer service can solve the transparency and communications issues identified and be a big swing success factor for a company that wants to uplift its sales.

4. Conclusion

The Portuguese marble industry has a favourable outlook: the appetite for Natural Stone is growing internationally, the sector has done some solid steps towards modernizations and there are clear pathways established by the leading companies and sector associations on what to do next. The opportunities that lay ahead are:

- **Search for capital** to: (**i**) Opt for consolidation to bolster company size by gaining scale to become more competitive; (**ii**) Ramp up investments in existing technology and digitization, spanning both upstream and downstream operations, as well as fostering stronger customer connectivity; (**iii**) Allocate resources to robust R&D initiatives to introduce innovative products and expanded offerings.
- **Expand into new markets**, such as Asia, the Middle East and USA.
- Develop **new business models** harnessing ESG principles, natural stone by-products, structural natural stone, and rejuvenated quarry utilization. Cultivate strong advocacy for Portuguese natural stone brands within domestic and global spheres.

From the interviews conducted, the surveys collected, and the literature reviewed we found at least 4 possible configurations for an OS business to thrive:

1. **Volume**: Export of standardized/optimized products leveraging on BIM; a high-volume, cost-competitive venture set to rival other products such as ceramics.
2. **Customization**: Export of client-customized stone (Amazon model) – catering to small-scale customers who engage in self-design added by state-of-the-art web interface to guide them through the planning and production cycles.
3. **Co-creation**: Offer architect-co-created stone solutions offering the professional customers state of the art support and extended customer service that allows full integration with BIM software.

4. **Structural**: Take advantage of lower artistic quality blocks of stones to create a Structural Stone Business.

Considering both the opportunities and the potential business models that we studied we can conclude that a Search Fund can be the right tool to capitalize on the promising Natural Stone Sector, offering a pathway for strategic growth and value optimization. If we apply the discussed criteria in section **Error! Reference source not found.** above (latest 3 years average Turnover and average EBITDA, revenue per employee, number of employees and company maturity) and filter the power BI using the targets in Figure 31 Search Fund acquisition metrics, we find **25 potential companies** to deepen the possibility of an acquisition, see Figure 32 Table of the TOP 25 OS Companies and with 2 additional criteria, see Figure 33.

- Average Turnover of the last 3 years: > 5 million euros
- Average EBITDA of the last 3 years: > 0.5 million euros
- Number of employees: >= 30
- Company Age: >= 15 years
- Revenue per employee in the last year: > 0.08 million euros

Figure 31 Search Fund acquisition metrics

District	Maturity (years)	Shareholders	Employees	Revenue per Employee	Margin %	EBITDA (5 years avg.)	% EBITDA (5 years)	Turnover (5 years avg.)	% Turnover (5 years)	Assets (5 years avg.)	Debt (5 years avg.)	EBITDA (3 years avg.)	% EBITDA 3 years vs. 5	Turnover (3 years avg.)	% Turnover 3 years vs. 5
Santarém	41	1	35	148.717 €	26%	1.299.225 €	-16%	4.914.731 €	28%	14.306.185 €	875.823 €	1.077.812 €	-17%	5.065.113 €	3%
Leiria	41	2	37	170.289 €	16%	709.808 €	245%	4.562.259 €	82%	5.089.003 €	966.448 €	923.508 €	30%	5.142.225 €	13%
Faro	16	2	64	105.796 €	12%	569.133 €	20%	4.734.084 €	93%	4.108.663 €	602.512 €	549.532 €	-3%	5.344.516 €	13%
Vila Real	34	2	49	110.686 €	21%	1.074.917 €	79%	5.039.115 €	34%	6.792.896 €	1.389.838 €	1.305.358 €	21%	5.449.522 €	8%
Vila Real	30	2	59	112.798 €	12%	584.767 €	228%	4.916.441 €	90%	3.716.165 €	780.211 €	739.444 €	26%	5.574.094 €	13%
Leiria	24	2	37	103.824 €	20%	968.901 €	-48%	4.939.077 €	7%	9.599.038 €	3.672.850 €	1.020.960 €	5%	5.760.505 €	17%
Leiria	23	1	56	130.584 €	31%	1.893.711 €	1%	6.125.876 €	30%	19.034.260 €	4.756.602 €	1.922.076 €	1%	6.618.116 €	8%
Viana do Castelo	35	1	64	121.895 €	16%	1.001.652 €	51%	6.157.271 €	47%	8.516.102 €	1.029.260 €	1.101.971 €	10%	6.702.805 €	9%
Porto	31	3	103	80.618 €	23%	1.469.787 €	64%	6.402.996 €	85%	6.903.247 €	115.642 €	1.611.806 €	10%	7.230.674 €	13%
Lisboa	43	4	63	132.645 €	15%	1.075.079 €	-40%	7.371.413 €	19%	10.420.771 €	3.926.423 €	923.003 €	-14%	7.471.076 €	1%
Lisboa	57	1	41	236.967 €	26%	1.890.706 €	1466%	7.159.936 €	60%	21.911.117 €	11.167.279 €	2.950.866 €	56%	8.187.909 €	14%
Viseu	27	1	78	108.578 €	24%	1.786.452 €	100%	7.583.005 €	35%	8.419.133 €	123.909 €	2.125.577 €	19%	8.195.870 €	8%
Santarém	29	0	86	111.858 €	35%	2.960.412 €	32%	8.385.003 €	21%	22.106.560 €	8.061.357 €	2.909.789 €	-2%	8.461.775 €	1%
Braga	57	5	62	166.539 €	21%	1.618.168 €	439%	7.683.747 €	80%	11.687.535 €	1.614.860 €	2.244.151 €	39%	8.662.021 €	13%
Lisboa	29	4	48	260.224 €	12%	1.290.701 €	-17%	10.485.749 €	36%	10.483.155 €	1.271.979 €	1.318.784 €	2%	11.386.089 €	9%
Porto	38	5	118	117.953 €	13%	1.438.629 €	100%	11.434.863 €	33%	16.384.201 €	3.384.501 €	1.787.675 €	24%	12.168.502 €	6%
Leiria	54	0	139	97.676 €	22%	2.699.946 €	69%	12.229.811 €	23%	24.971.500 €	9.142.384 €	2.906.788 €	8%	12.446.538 €	2%
Viseu	44	6	116	96.907 €	23%	2.586.739 €	204%	11.431.482 €	33%	21.931.189 €	845.637 €	3.227.512 €	25%	12.501.714 €	9%
Lisboa	36	2	44	409.028 €	13%	1.931.875 €	6%	15.186.722 €	34%	18.808.686 €	1.124.172 €	1.990.901 €	3%	16.090.595 €	6%
Santarém	19	1	42	351.479 €	37%	5.790.731 €	18%	15.829.331 €	20%	31.200.973 €	5.322.023 €	6.195.590 €	7%	16.801.519 €	6%
Viana do Castelo	17	2	89	283.599 €	8%	1.256.803 €	626%	14.879.633 €	307%	15.566.709 €	2.970.968 €	1.509.296 €	20%	18.817.699 €	26%
Viseu	26	3	234	111.298 €	18%	3.342.977 €	131%	18.219.811 €	102%	21.871.113 €	7.146.225 €	4.029.684 €	21%	21.171.711 €	16%
Lisboa	37	2	113	320.095 €	13%	4.026.026 €	213%	30.806.471 €	41%	30.169.161 €	4.989.678 €	5.538.859 €	38%	34.635.775 €	12%
Santarém	21	1	202	273.951 €	26%	7.807.022 €	232%	30.500.567 €	340%	42.539.032 €	12.443.430 €	9.435.721 €	21%	39.102.416 €	28%

Turnover (3 years avg.): 5.000.000 € – 45.515.481 €

EBITDA (3 years avg.): 500.000 € – 9.435.721 €

Employees: 30 – 234

Company Age: 15 – 57

Revenue per Employee: 80.000 € – 409.028 €

Number of Companies: 25

Figure 32 Table of the TOP 25 OS Companies

From these 25 potential targets, to keep the investment in a more modest interval, 2 additional restrictions were included, namely, a superior limit concerning EBITDA (<5.000.000 euros) and operating revenue (<25.000.000 euros). With these we end up with 21 potential targets.

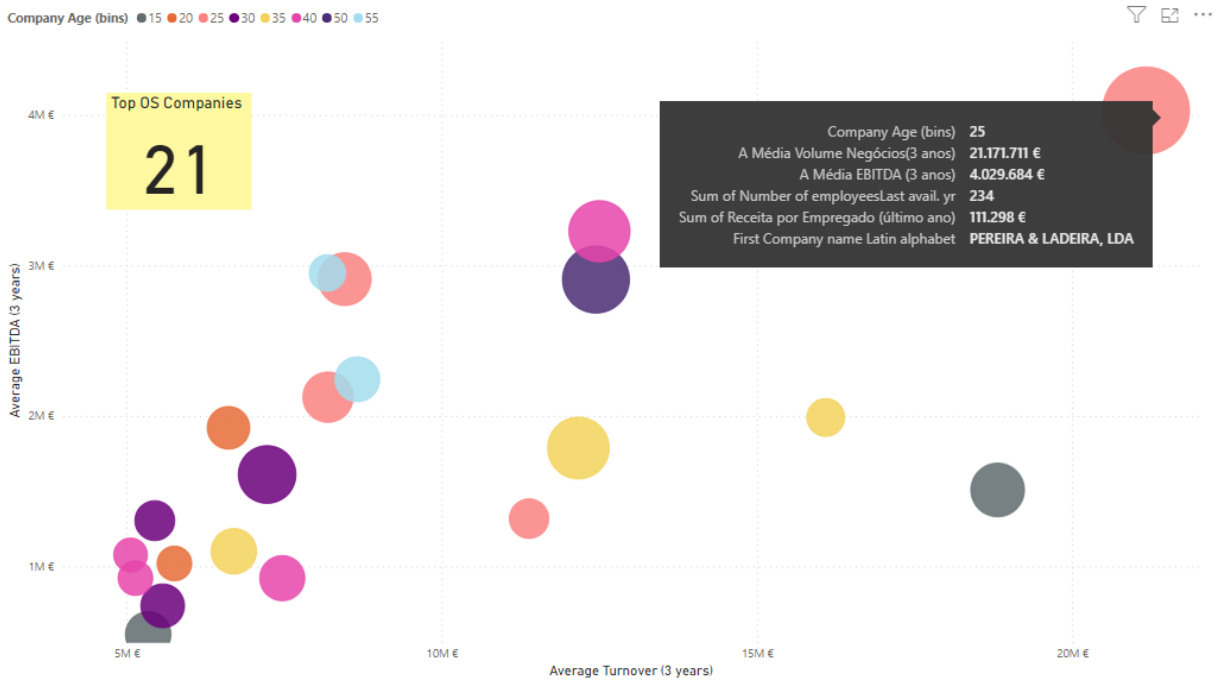

Figure 33 OS Companies Final Shortlist

If one follows the investment multiples identified for SF, the following indicative table (Figure 34 Search Fund investment intervals) is obtained, namely considering multiples between 1 to 1.5x if compared with sales or 3.5 to 5x in regard with EBITDA. Following the 21 short-listed companies, the average sales is 9.4 M€ and the average EBITDA is 1.8 M€, which points towards an investment close to 10 M€. This investment value is obtained with a combination of the 4 metrics, i.e., using the limits multipliers interval for sales and EBITDA one obtains 4 indicative acquisition prices and then a simple average is done since any of these criteria is considered preferred.

Multiples and Investment				
Multiples		Min.	Max.	
Sales		1	1,5	
EBITDA		3,5	5	
Ratios		29%	30%	
Investment Estimation	N+0	Min.	Max.	Invest.
Sales	9,4 M€	9,4 M€	14,2 M€	
EBITDA	1,8 M€	6,4 M€	9,1 M€	
Average = Investment Value	19%			**9,8 M€**

Figure 34 Search Fund investment intervals

To convince investor we propose the memorandum presented below.

Industry

- **OS industry in Portugal:**
  - Enterprises: >2 k, 90% micro and small companies;
  - Turnover: 1.2 bi euros and net profit: 0.1 bi euros;
  - CAGR 2012-2022: >50% in sales and exports;
  - Exports: c. 0.5 bi euros (30% raw, 70% transformed).
- **Problems:**
  - Low access to capital to expand production capacity;
  - Technological and product obsolescence;
  - Lack of managerial skills and stone masons;
  - Shortage of vision and unplanned successions;
  - Threat of substitute products.

Economics

- **Search phase:** 250 k euros for two years (sunk cost)
- **Investment:** up to 10 million euros (up to 2.4 million from investors %)
- **Structure:** 70% debt, 25% investors and 5% searchers
- **Incentives :**
  - Vesting: 20% (3 parts: acquisition, 4 years and 20-35% IRR);
  - Performance: 4% of equity (employees);
  - Earn out period: seller works with new ExCom 1 year after acquisition.
- **Expected return (10-year horizon):**
  - ROI 495%;
  - IRR: 34.2%.
- **Risks:**
  - Inability to find a target or to close the acquisition;
  - Unattractive investment conditions (investors have the right of refusal);
  - Inability to sell, low liquidity shortage of market depth;
  - Performance and management;
  - Unknown risks (pandemic, war, political, taxes).

Investment

- **Solution:** one year SF to deepen this thesis and close an acquisition
- **Search Criteria:**
  - Turnover: 5-25 million euros:
  - Revenue pc: > 80 k euros;
  - EBITDA: 0.5-5 million euros;
  - Company tenure: >15 years;
  - Employees: > 30.
- **Roadmap to revamp the OS business model:**
  - Modernize infrastructure (machinery, IT);
  - Implement a proactive sales strategy;
  - Product development with ESG and intellectual property focus;
  - Design lab with co-creation of solutions with customers;
  - Transparent processes from quarry to end customer;
  - Customer experience and satisfaction (predictability of deliveries);
  - Sustained competitive advantages through high barriers to entry (heavy investment and quarry licenses).

Team

- **Advisory Board:**
  - Investor representative;
  - Experts in SF or M&A;
  - OS industry *connaisseurs*.
- **Executive Committee:**
  - CEO – Carlos: Chemistry, >20y scientific strategy in pharma
  - CFO – Nuno: Economics, >10y finance in government & energy
  - CTO – Hugo: Computer Science, >20y IT experience
  - COO – Filipe: Economics, >24y of growth and sales worldwide.
- **Hirings:** sales consultants, designers, artists, architects (3D experts), IP experts, engineers

Figure 35 Investment Memorandum

A 10-year horizon financial model covering the 5 phases of the search fund model and a calendar was drawn: (i) raise the search capital – 6 months, (ii) search and acquire a promising company – 18 months, (iii) operate, grow, and value generation – 120 months, and (iv) exit – 6 months. To simulate the results of this venture, a financial model was built which considered

the assumptions in Figure 36. To root the model on real data, most of the financial indicators come from observed data in the industry, using sources such as Instituto Nacional de Estatística, Orbis or Bank of Portugal. Additionally, other ad-hoc but still realistic assumptions about macroeconomic variables were made, namely concerning growth rates, prices evolution, taxes (were considered 10x the observed proportion of taxes/sales in INE data). The assumptions used in the financial model were based on industry aggregated data, namely INE[6] which was also used in the Power BI which the references can be seen in

Appendix 19. One of the most important assumptions regards the pace of growth of sales which is assumed to be 1/10 of the last decade growth of exports, i.e., 5.2%, and the assumption of increasing value generation (either through efficiency gains driven by better technology use and higher prices per ton sold), namely that cost of goods sold grow at 2/3 the growth rate of sales. In a further investigation these assumptions could be calibrated with specific ratios for the 21 selected companies or the selected company to make more robust premises by retrieving from Orbis the necessary financial data to calculate each ratio.

The debt is assumed to be reimbursed uniformly, 10% of the initial value per year and the interest payment is assumed to reach 3.5% of the stock of debt in each period.

Another key component of the SF model is the acquisition and selling prices which affect the return to investors and then the indicators IRR and ROI. With this respect, an important decision for the model is the calculation of the acquisition price which is assumed to sum 9.8 million euros and the exit price, which is assumed to follow the same estimation method as the acquisition price, obtaining a value of 15.3 million euros. The return for investors is expected to achieve 34,2% of IRR and the discounted cash-flows to the present day generate a return on investment of 495%.

[6] INE, Sistema de contas integradas das empresas, atividade económica (Subclasse - CAE Rev. 3)

Financial Model

Phases and Duration	Months
1. Raise Search Capital	6
2. Search and Acquire	18
3. Operation and Value Creation	120
4. Exit	6

Assumptions	Source	Value
Industry		
Exports Growth - 2012-2022	INE	51,8%
Sales Growth	Assumption	5,2%
Average Salary	INE	1.000 €
Revenue / Employee	Orbis	95.215 €
Revenue / Employee	INE 2021	87.191 €
Salaries Growth	Assumption	5,0%
Inflation - Operational Expenses	Assumption	2,5%
Cost of Goods Sold (COGS) Growth	Assumption	3,5%
Social Security (%Salary)	Assumption	23,75%
Other Employee Costs (%Salary)	Assumption	10,0%
Income Statment Ratios		
Sales Composition	INE	100,0%
Products (transformed)		74,3%
Goods (non-transformed)		15,8%
Services		9,9%
COGS (%Sales)	INE	34,4%
Operating Expenses/FSE (%Sales)	INE	31,2%
Capex (%Sales)	INE	10,0%
Employee Cost (%Sales)	INE	21,5%
Net Income (%Sales)	INE	7,5%
Production (%Sales)	INE	94,0%
GVA (%Sales)	INE	37,0%
Gross Margin (EBITDA/Oper. Rev.)	Orbis	13,2%
Balance Ratios		
Equity/Assets	INE	46%
Liabilities/Assets	INE	54%
Debt/Assets (Solvency Ratio)	Orbis	44%
Financing Costs		
WACC	Calculation	7,0%
Cost of Equity	Assumption	10,0%
Cost of Debt	BdP	3,5%
Taxes		
Indirect Taxes	Assumption	5,0%
Direct Taxes	Assumption	10,0%

Figure 36 Financial Model Assumptions

To show how the search fund model works, a financial model was developed to highlight the main components of this model which produces high returns to investors and an alignment of incentives of shareholders with managers (founders) and employees. However, while the model is being calibrated, the adjustment of each variable also allows a better understanding of the sensitivity of the model and show how the managers need to keep expenses as low as possible to achieve the desired goal of an internal rate of return (IRR) over 30%, essential unlock the vesting goal.

N	N+0	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10	TOTAL
Período	0	1	2	3	4	5	6	7	8	9	10	
Operation Phase	Invest.										Exit	

Investment Structure		
Investment	%	€
Founders	5,0%	0,5 M€
Investors	25,0%	2,4 M€
Debt	70,0%	6,8 M€
TOTAL	**100,0%**	**9,8 M€**

Incentives	N+0	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10	TOTAL
Vesting	7%					1%	1%	1%	1%	1%	7%	20%
Performance		0,25%	0,25%	0,25%	0,25%	0,33%	0,33%	0,33%	0,50%	0,50%	1%	4%

Cap Table/Balance	N+0	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10	TOTAL
Founders	12%	12%	12%	12%	12%	13%	14%	16%	17%	18%	25%	
Investors	18%	25%	32%	39%	45%	51%	56%	61%	67%	72%	71%	
Employees	0%	0%	1%	1%	1%	1%	2%	2%	3%	3%	4%	
Debt	70%	63%	56%	49%	42%	35%	28%	21%	14%	7%	0%	
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	

Income Statement (millions of euros)	N+0	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10	TOTAL
Revenue	11,8	12,4	13,1	13,7	14,5	15,2	16,0	16,8	17,7	18,6	19,6	
Cost of Goods Sold (COGS)	4,1	4,2	4,3	4,5	4,6	4,8	5,0	5,1	5,3	5,5	5,7	
Gross Profit	**7,8**	**8,2**	**8,7**	**9,3**	**9,8**	**10,4**	**11,0**	**11,7**	**12,4**	**13,1**	**13,9**	
Operating Expenses	3,7	3,8	3,9	4,0	4,1	4,2	4,3	4,4	4,5	4,6	4,7	
Indirect Taxes	0,6	0,6	0,7	0,7	0,7	0,8	0,8	0,8	0,9	0,9	1,0	
Cost of Employees	2,3	2,4	2,6	2,7	2,8	3,0	3,1	3,3	3,4	3,6	3,8	
EBITDA / Operating Profit	**1,1**	**1,4**	**1,6**	**1,9**	**2,2**	**2,5**	**2,8**	**3,2**	**3,6**	**4,0**	**4,4**	
Interest Expense	0,2	0,2	0,2	0,2	0,1	0,1	0,1	0,1	0,0	0,0	0,0	
Direct Taxes	0,1	0,1	0,2	0,2	0,2	0,2	0,3	0,3	0,4	0,4	0,4	
Depreciation & Amortization		0,1	0,2	0,4	0,5	0,7	0,8	1,0	1,2	1,4	1,6	
Net Income	**0,8**	**0,9**	**1,0**	**1,2**	**1,3**	**1,4**	**1,6**	**1,8**	**2,0**	**2,2**	**2,4**	

Financial Ratios	N+0	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10	TOTAL
COGS (% Sales)	34%	34%	33%	33%	32%	32%	31%	31%	30%	30%	29%	
Operating Expenses (% Sales)	31%	30%	30%	29%	28%	27%	27%	26%	25%	25%	24%	
Employee Costs (% Sales)	20%	20%	20%	20%	20%	19%	19%	19%	19%	19%	19%	
EBITDA/Operating Profit (% Sales)	10%	11%	12%	14%	15%	16%	18%	19%	20%	21%	22%	
Net Income (% Sales)	6,7%	7,3%	7,9%	8,4%	8,9%	9,5%	10,0%	10,6%	11,1%	11,6%	12,2%	
Implicit # of Employees	124	130	137	144	152	160	168	177	186	195	206	

Dinvestment/Exit	N+0	Min.	Max.	Invest.	Multiples
Sales	19,6 M€	19,6 M€	29,4 M€		110%
EBITDA	4,4 M€	15,4 M€	21,9 M€		491%
Average = Dinvestment Value	22%	78%	75%	**21,6 M€**	

IRR and ROI	N+0	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10	TOTAL
IRR (investors)	**34,2%**											
Search Capital	0,25											
Investment	-2,44											
Net Income		0,23	0,33	0,45	0,59	0,73	0,90	1,09	1,31	1,55	1,69	
Exit											15,30	
ROI (investors)	**495%**											
Search Capital	0,25											
Investment	2,44											
Current Value of Investment		0,21	0,29	0,36	0,45	0,52	0,60	0,68	0,76	0,84	0,86	
Divestment/Exit											7,77	

Debt	N+0	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10	TOTAL
Debt	6,84	6,15	5,47	4,79	4,10	3,42	2,74	2,05	1,37	0,68	0,00	
Var. Debt	0,00	-0,68	-0,68	-0,68	-0,68	-0,68	-0,68	-0,68	-0,68	-0,68	-0,68	
Stock of initial Debt	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%	

Capex and Cash-Flow	N+0	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10	TOTAL
Capex	1,18	1,24	1,31	1,37	1,45	1,52	1,60	1,68	1,77	1,86	1,96	15,76
Cash Flow		0,34	0,59	0,86	1,14	1,44	1,76	2,10	2,47	2,85	3,26	16,83
FCF (PV of CF)		0,32	0,52	0,70	0,87	1,03	1,17	1,31	1,43	1,55	1,66	10,56

Figure 37 Financial Model Returns

Another important aspect revolves around the financial leverage of this investment which is 70% financed through bank debt, 25% from investors and 5% from the founders. The SF model also includes two types of incentives, the vesting of equity to the founders (20%) and shares for employees (4%). The value generated to investors and founders come from the assumption of

increased value added of each OS sold. This is the aim of this model and is seen in the model by sales value growing at a higher pace than costs (raw materials, employees, and services).

To deliver the targets expressed in the investment memorandum some tweaks should be done on the traditional business models that we saw in our research. Our proposal, for the hypothetical company that could emerge from this exercise, would be:

Customer Value Proposition	Go-To-Market
Customer: Architects and interior designers seeking premium features for their projects. **Problem:** Architects and interior designers struggle to materialize their projects in natural stone. **Solution:** A reliable, price transparent platform that connects architects and interior designers with natural stones from around the world and with the best technology to transform it, ESG & BIM certified. **Price:** Free access to DRAFT estimates. Premium pricing for the projects executed.	**Distribution Channels:** Website; Direct Sales to Contractors and Builders; Architects and Designers; B2B Contracts **Conversion funnel:** Architects browse for solutions in the web > Architects ask for a quote for their projects **Demand Generation:** Content Marketing; Social Media Engagement: Associations Partnerships; Influencer Collaborations; Email Campaign/ Newsletters
Technology & Operations	**Profit Formula**
Value Chain: R&D; UX; Customer Acquisition (Marketing); Hosting **Key Activities:** Curating and updating the collection of natural stones; Products / technologies / processes R&D; Marketing and promotion to attract architects, interior designers, and stone suppliers. **Vertical Integration:** Raw Stone, Web Platform (outsourced); Transformation, R&D, marketing (in-house) **Business Type:** Product Innovation | Customer Management **Intellectual Property (IP):** Web algorithm; R&D products	**Monetization Model:** Cost of co-creation and project execution or Commission on successful transactions between architects/designers and 3rd parties. **Market Size: 528**M€ (PT), growing 4% (Assimagra May23) **Cost Structure:** Platform development and maintenance; Marketing and advertising costs; Raw Materials and Machinery; HR; R&D **Profit Drivers:** number of architects and designers registered on the platform; Average project value per customer; Customer satisfaction scores from architects/designers

Figure 38 Business Model adapted from Lean Startup

In the 1:1 interviews we conducted on our research we had the opportunity to meet 5 of the above listed companies. We found deeply passionate CEOs, managing, in 4 out 5, family-run enterprises, inherited, with a clear view on the Industry 4.0 opportunities and concerned with its challenges. For many, the journey undertaken thus far has not been easy. Companies rely heavily on them, and they are unsure if they will have the energy to take them further: the technological barrier is substantial, clients are widely dispersed, and competition from substitute products is uncomfortably close. Remarkably, none of these companies has concrete succession plans. One CEO, however, exhibited a resolute intention to sell once age precludes effective management. This CEO leads a highly profitable, technologically advanced, customer

focused, impeccably structured, financially solid company and conveniently situated making it the prime contender to move for the next level of the Search process.

These 5 companies are the ones we saw better prepared, if we extend the foreseen OS challenges for the universe of the enterprises, we know that many will fail to adapt, and many would suffer a lot to survive in the coming years.

We studied the OS Sector, finding its challenges and opportunities, we´ve met a fair number of its key stakeholders, we found an investment instrument that could transform the way these family-run, small size companies sector operates. We build an investment memorandum to start the Search Fund, we proposed a business model to make it thrive. Finally, we list below a set of principles the hypothetical company should follow:

- Be Customer-Centric by focusing on delivering value that meets their needs.
- Bring innovative (disruptive if possible) ideas and solutions to market.
- Adopt a lean methodology, efficiency, and resource optimization.
- Be agile and adaptable, act on feedback and changing market conditions.
- Plan for growth and scalability.
- Build the right team: high expertise, creativity, motivation, and resilience.
- Building strong networks: advisors, investors, and industry peers.
- Apply the startup principles: build a strong viral brand; fast escalation of ideas, MVP testing, IP, internationalization.

5. Contribution to Knowledge

This thesis enhances understanding of the Portuguese marble sector by identifying growth opportunities within the industry. The analysis of company strategies, market trends, and technological advancements offers insights that can guide industry stakeholders and potential investors in fostering sustainable growth, strategic innovation, and global market positioning.

6. Limitations

This thesis on the Portuguese Ornamental Stone Sector acknowledges limitations due to a condensed timeline that encompassed literature review, extensive face-to-face interviews, group coordination, and individual full-time jobs. The compressed schedule has constrained the number of companies that we could speak to, the possibility to study competing or complementary sectors (like the ceramic, stone by-products, timber, and cement industries) and even other OS exporting countries, the depth of analysis and comprehensive data collection. These constraints are intrinsic to the project's timeline and circumstances.

7. Future Research

To implement a Search Fund more companies, need to be identified, so the next research phase should be focus on a comprehensive study on the remaining TOP OS Companies gathering insights into their resilience, evolution, and plans, including HR and succession issues. Secondly, the 4 business models and the investment memorandum proposed should be tested with OS Companies, Architects, and potential Investors. Lastly, a comparative analysis of international ornamental (Italy, France, Turkey) stone sectors might yield valuable benchmarking insights, aiding in identifying Portugal's unique strengths and opportunities for global competitiveness.

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Appendix

Reference Documents & Events

Appendix 1 Global Stone Congress Batalha 2023

#	Tipo	Empresa	STATUS	Website	Telefone
1	Academia	Belas Artes			
2	Academia	GUTA		guta@gutamg.com	
3	Academia	MME			
4	Academia	Univ LEIRIA	DONE	https://www.ipleiria.pt	
5	Academia	Glauco MADEIRA			
6	Academia	António Marinho TORRES	DONE		
7	Academia	Euclides MAJOR	DONE		
8	Academia	Teclena		https://teclena.pt	
9	Academia	Planalto			
10	Academia	PassiveHaus Portugal	DONE	https://www.passivehouse.es	
11	Associações	AICEP	DONE	https://www.portugalglobal.pt/EN/Pages/Index.aspx	
12	Associações	ANIET		http://aniet.pt/pt	
13	Associações	ASSIMAGRA	DONE	www.primeirapedra.com	244 491 803
14	Associações	Cluster Mineral Resources	DONE	https://www.clustermineralresources.pt	
15	Associações	STONE SITI		https://www.stoneciti.com/	217 121 930
16	Associações	CIP	DONE	https://cip.org.pt/en/	
17	Empresa Referência	JULAR		https://www.jular.pt	
18	Máquinas	CONSTRUAL	DONE	https://www.construal.pt	
19	Máquinas	FRAVIZEL	DONE	https://www.fravizel.com	
20	Máquinas	STAUBLI	DONE	https://www.staubli.com/fr/en/corp.html	+34 636 953 736
21	Máquinas	António Jacinto Figueiredo,	DONE	https://www.ajfigueiredo.pt	
22	Pedra	Mercado da PEDRA		https://mercadodapedra.com/en/home/	
23	Pedra	ÁFRICA STONE		http://www.africa-stone.com/	
24	Pedra	AIRELIMESTONES		https://www.airelimestones.com/	244 098 438
25	Pedra	Amado Rebelo	DONE	Not Available	
26	Pedra	BSTONE		https://www.bstone.pt	268 848 030
27	Pedra	CB PROD	DONE	https://cbprod.pt/home	968 701 193
28	Pedra	CEI	DONE	http://www.ceigroup.net	919 982 264
29	Pedra	DIMPOMAR	DONE	https://www.dimpomar.com/pt	
30	Pedra	FIDALJOR	DONE	https://figaljor.pt	
31	Pedra	FILSTONE		https://www.filstone.com	938 988 007
32	Pedra	FRONT WAVE		https://frontwave.pt/em	
33	Pedra	GARGULA GÓTICA	DONE	https://gargulagotica.pt	966 423 047
34	Pedra	GRANITRANS	DONE	https://www.granitrans.com	
35	Pedra	Grupo FERRAR	DONE	https://grupoferrar.pt	
36	Pedra	Grupo MOCASTONE	DONE	https://www.mocastone.pt	
37	Pedra	INOFER	DONE	https://www.facebook.com/metalinofer	934 801 737
38	Pedra	INOVECA		http://www.incoveca.pt/pt/index.php	232 857 500
39	Pedra	JULIPEDRA		https://www.julipedra.com/en/home	262 929 766
40	Pedra	LSI STONE		https://lsi-stone.com	244 403 673
41	Pedra	Manuel & Cardoso		https://pedrasmc.com	933 603 653
42	Pedra	MARFILPE		https://www.marfilpe.pt/em	915 976 669
43	Pedra	MÁRMOFELIZARDO		https://www.marmofelizardo.pt	965 140 307
44	Pedra	Mármores A SOUSA		https://www.facebook.com/people/Mármores-e-Granitos-A-Sousa-Lda/100045006858735	917 530 860
45	Pedra	Grupo GALRÃO	DONE	https://www.galrao.com	
46	Pedra	Mármores REBELO	DONE	https://marmoresrebelo.pai.pt	917 552 961
47	Pedra	Mármores RICARDO	DONE	https://www.facebook.com/ricardosilvamg82	918 323 707
48	Pedra	Mármores ROSAL		https://marmoresrosal.com	243 406 213
49	Pedra	MCM		https://www.mcmstonetailors.com	917 221 136
50	Pedra	MOCAPOR		https://www.mocapor.com/pt	268 881 415
51	Pedra	NC Granitos		https://www.ncgranitos.com	255 880 060
52	Pedra	NORMA Margem	DONE	https://www.normamargem.pt	919 361 325
53	Pedra	OLIVAH	DONE	https://www.olivah.pt	
54	Pedra	PARDAIS GRANITES		https://pardais.com	255 611 682
55	Pedra	PEDRA ANTIQUA	DONE	https://www.pedrantiqua.pt	919 557 106
56	Pedra	PEDRA ÚNICA	DONE	https://pedraunica.net	965 057 056
57	Pedra	PEREIRA E LADEIRA	DONE	https://pereiraladeira.pt	232 763 855
58	Pedra	SOLANCIS	DONE	http://www.solancis.com	262 925 080
59	Pedra	STONE MASONS	DONE	https://www.thestonemasonrycompany.co.uk	+44 77720980330
60	Pedra	TCC White	DONE	https://www.tccwhitestone.com	912 980 468
61	Pedra	TELMO DUARTE		http://www.telmoduarte.com/welcome.php	927 165 094
62	Pedra	TONS DE PEDRA	DONE	https://www.tonsdepedra.com/em	917 585 454
63	Pedra	URMAL	DONE	https://www.urmal.pt/index.html	968 520 303
64	Pedra	VETOR 3		https://www.vetor3.pt	219 674 198
65	Pedra	Granitos MACEIRA		https://www.granitos-maceira.com	219 678 600
66	Pedra	MARMOVÁRZEA		Not Available	219 230 242
67	Pedra	POLIMAGRA		https://polimagra.pt	254 584 186
68	Software	EASYSTONE	DONE	https://www.ddxgroup.com/stone-working-software/easystone	+39 0356 21093
69	Substituto	COMPAC		https://www.compac.es/	+34 962 954 053
70	Tecnologia	3D WAY	DONE		
71	Tecnologia	Alexandrino Pais Leitão	DONE	https://www.apleitao.com/	262 508 907
72	Tecnologia	BRETON		https://breton.it/products/machines-and-lines	+39 042 37691

Appendix 2 List of Contacts Used

Appendix 3 Pero Pinheiro's Quarries visited, Blocks and Slates examples

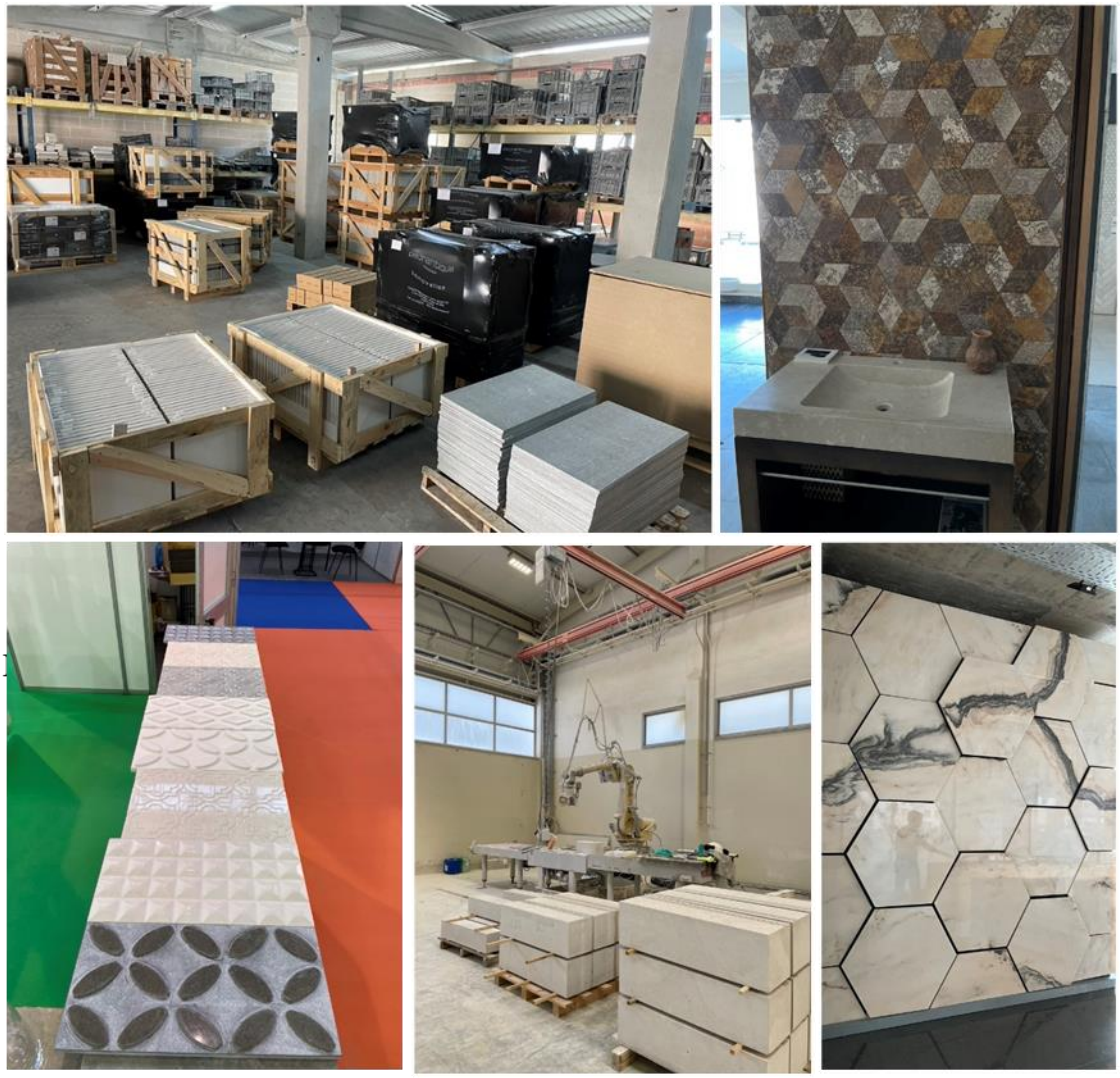
Examples of Design Pieces and Customized Products

Appendix 4 Design Pieces

Appendix 5 Mormon Temple Facade (Limestone)

Appendix 6 The First Stone Project Exhibition

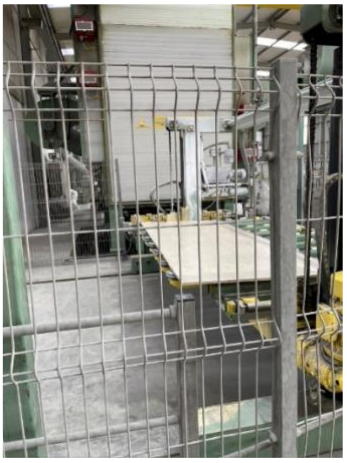
Examples of Mass Production Materials (tiles)



Appendix 7 Tiles mass production

Examples of Machinery Used

Appendix 8 Cutting disks



Appendix 9 Work zone protection

Appendix 10 Diamond Stone Cutting Wire

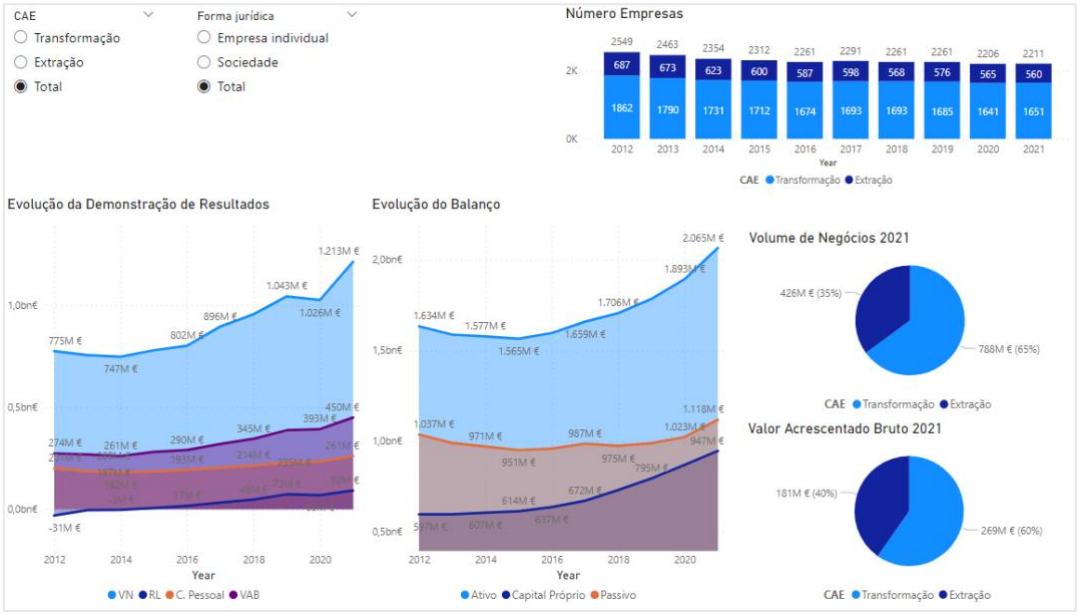
Appendix 11 CNC Machine

Appendix 12 One slate block cutting machine

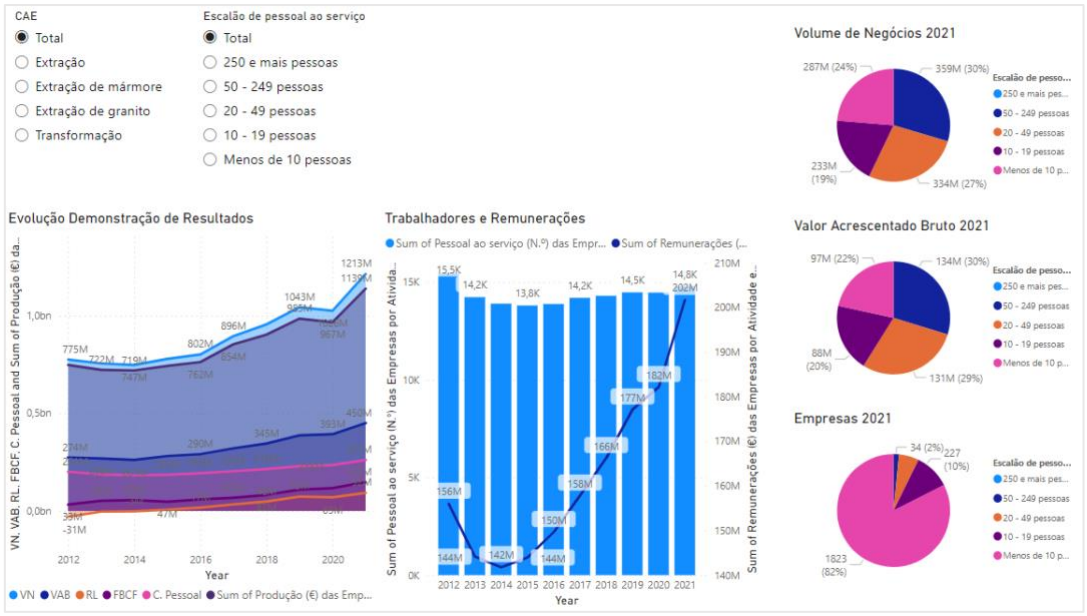
Appendix 13 Waste Recycling

Appendix 14 Block Cutting Machine

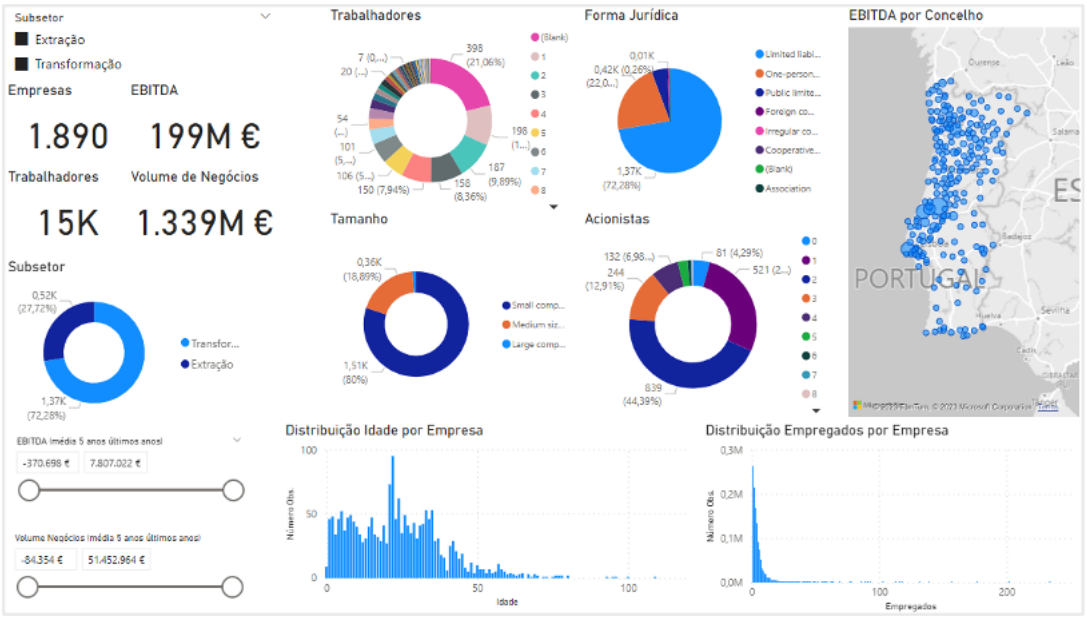
PowerBi Main Tables



Appendix 9 OS Companies Financial Characterisation



Appendix 10 OS Companies Characterisation by Employees

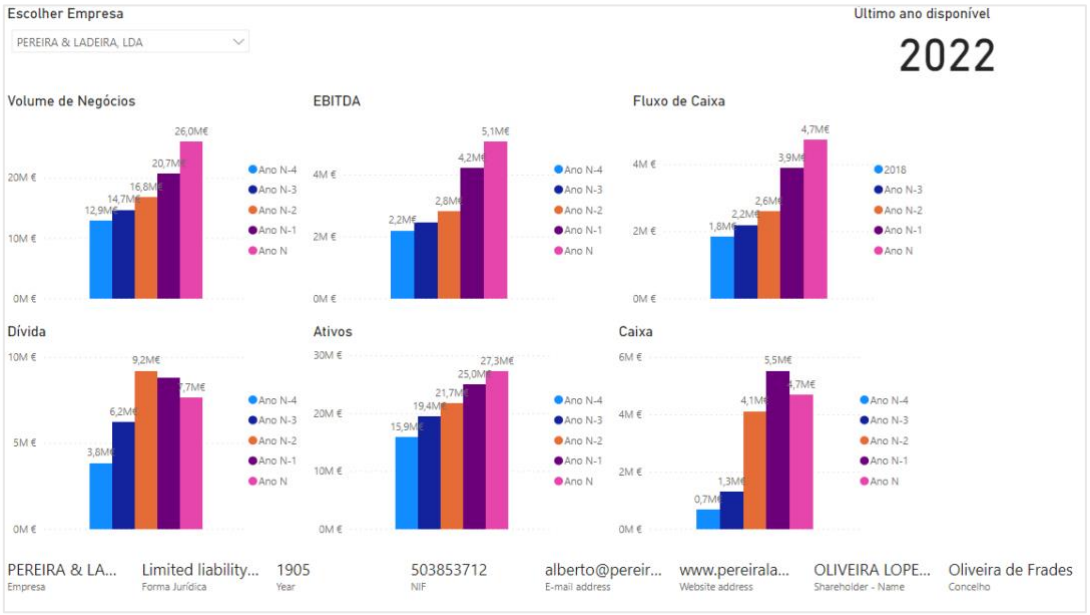


Appendix 11 OS Companies General Characterisation

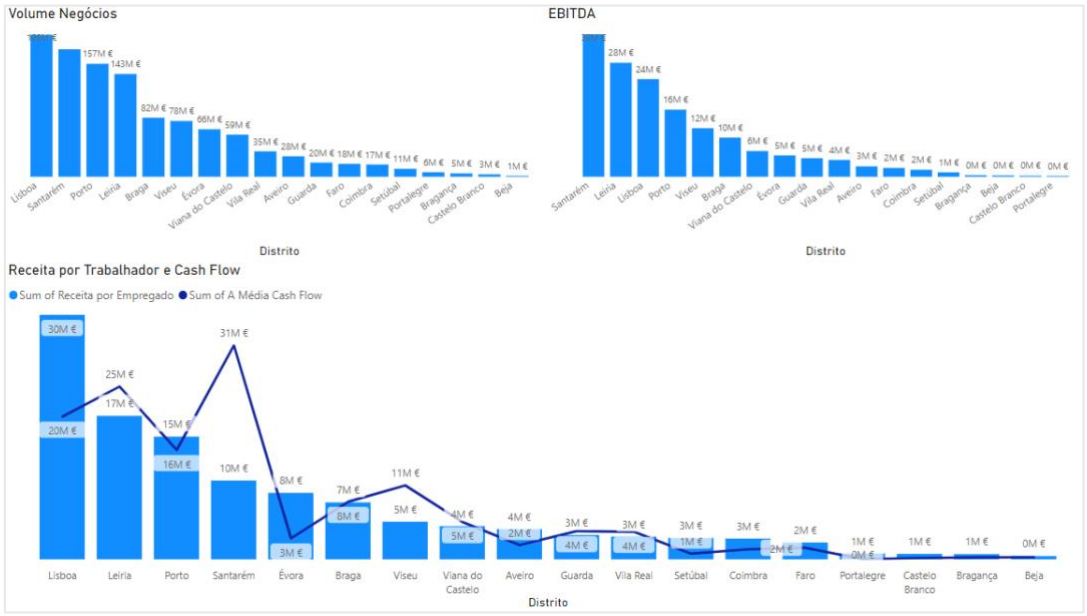
Appendix 12 OS Companies Financial Characterisation

Empresa	Margem %	EBITDA	VN	VN pc	Trabalhadores	Acionistas
SILICALIA PORTUGAL - INDUSTRIA E COMERCIO DE AGLOMERADOS DE PEDRA, S.A.	8%	4.347.514 €	51.452.964 €	345.716 €	157	1
AGREPOR AGREGADOS - EXTRACCAO DE INERTES, S.A.	13%	4.026.026 €	30.806.471 €	320.095 €	113	2
FILSTONE - COMERCIO DE ROCHAS, S.A.	26%	7.807.022 €	30.500.567 €	273.951 €	202	1
PEREIRA & LADEIRA, LDA	18%	3.342.977 €	18.219.811 €	111.298 €	234	3
TELMO DUARTE - COMERCIO DE PEDRAS NATURAIS, S.A.	37%	5.790.731 €	15.829.331 €	351.479 €	42	1
GRANITRANS - TRANSFORMACAO DE GRANITOS, LDA	13%	1.931.875 €	15.186.722 €	409.028 €	44	2
PAVESTONE, LDA	8%	1.256.803 €	14.879.633 €	283.599 €	89	2
SOLUBEMA - SOCIEDADE LUSO-BELGA DE MARMORES, S.A.	13%	1.927.572 €	14.495.765 €			19
MOCA STONE, S.A.	11%	1.433.811 €	12.786.578 €	1.529.318 €	10	1
SOLANCIS - SOCIEDADE EXPLORADORA DE PEDREIRAS, S.A.	22%	2.699.946 €	12.229.811 €	97.676 €	139	0
FERNANDO ALMEIDA & FILHOS, LDA	13%	1.438.629 €	11.434.863 €	117.953 €	118	5
INCOVECA - GRANITOS, S.A.	23%	2.586.739 €	11.431.482 €	96.907 €	116	6
ALEXANDRINO PAIS LEITAO, LDA	12%	1.290.701 €	10.485.749 €	260.224 €	48	4
CUNHA DUARTE, S.A.	13%	1.336.740 €	10.437.738 €	64.155 €	177	5
ETMA - EMPRESA TRANSFORMADORA DE MARMORES DO ALENTEJO, S.A.	8%	719.527 €	9.224.745 €	105.587 €	69	1
RUIPEDRA - WORLD OF NATURAL STONE, S.A.	35%	2.960.412 €	8.385.003 €	111.858 €	86	0
NICOLAU DE MACEDO, S.A.	21%	1.618.168 €	7.683.747 €	166.539 €	62	5
POLIMAGRA - GRANITOS, S.A.	24%	1.786.452 €	7.583.005 €	108.578 €	78	1
ANTONIO GALEGO & FILHOS - MARMORES, S.A.	15%	1.075.079 €	7.371.413 €	132.645 €	63	4
CALBRITA - SOCIEDADE DE BRITAS, S.A.	26%	1.890.706 €	7.159.936 €	236.967 €	41	1
RG ROGRANIT GRANTAX - GRANITOS, LDA	4%	258.111 €	7.145.697 €	58.709 €	93	3
IRMAOS SILVA & TEIXEIRA, LDA	6%	370.090 €	6.718.559 €	118.596 €	69	4
CONSTRUCOES PARDAIS - IRMAOS MONTEIROS, LDA	23%	1.469.787 €	6.402.996 €	80.618 €	103	3
CUPA PEDRAS, LDA	16%	1.001.652 €	6.157.271 €	121.895 €	64	1
MARFILPE - MARMORES E GRANITOS, S.A.	31%	1.893.711 €	6.125.876 €	130.584 €	56	1
DIMPOMAR - ROCHAS PORTUGUESAS, LDA	6%	370.148 €	5.828.910 €	82.305 €	64	3
SOCIEDADE DAS PEDREIRAS DO MARCO, LDA	13%	733.689 €	5.798.626 €	62.829 €	132	2
TRANSGRANITOS - MARMORES E GRANITOS DO ALTO TAMEGA, LDA	21%	1.074.917 €	5.039.115 €	110.686 €	49	2
Total	**-2170546%**	**153.383.014 €**	**1.111.967.747 €**	**114.433.638 €**	**14821**	**3881**

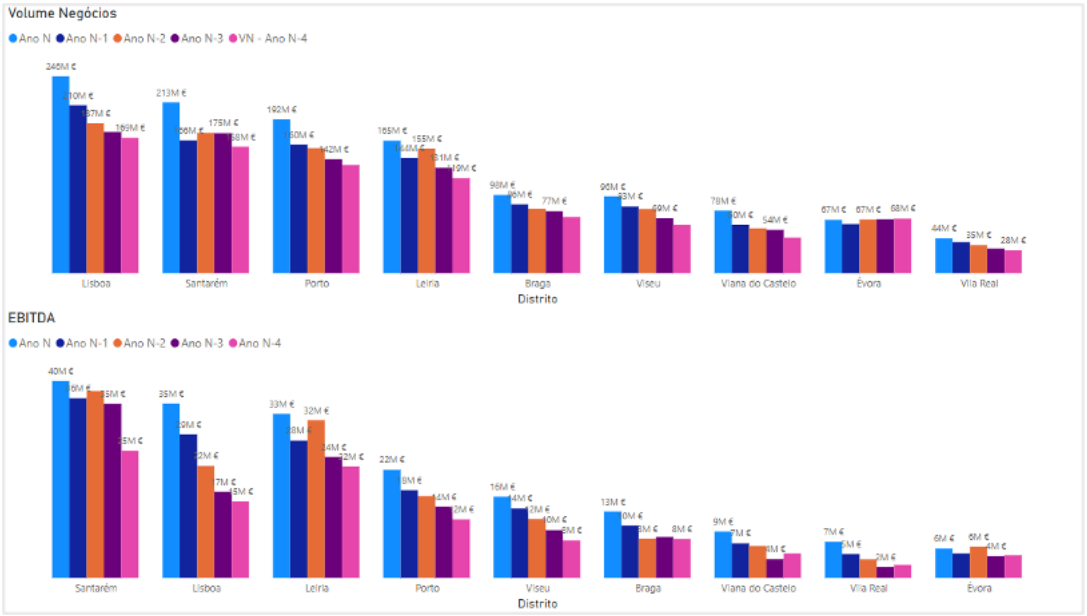
Appendix 13 Example of a PowerBI Matrix showing the main financial variables



Appendix 14 Example of one OS Top 25 companies' main financial indicators

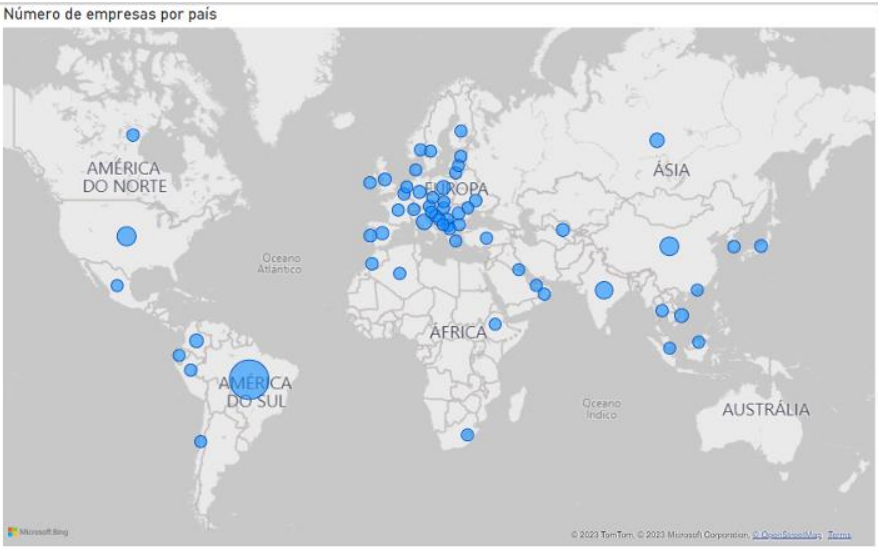


Appendix 15 Portuguese Revenue, EBITDA distribution per district



Appendix 16 Portuguese Revenue and EBITDA distribution per district per year

Country	811	2370	Total
Brazil	18266	26779	45045
United States of America	3137	8383	11520
China	9450	1456	10906
India	6491	2505	8996
Italy	765	5363	6128
Russian Federation	1987	1893	3880
Poland	309	3071	3380
Vietnam	2624	579	3203
Colombia	2357	539	2896
Spain	626	1529	2155
Germany	412	1412	1824
Uzbekistan	763	1003	1766
United Kingdom	390	1199	1589
Portugal	410	1124	1534
Japan	304	968	1272
Romania	347	889	1236
Ukraine	704	488	1192
Morocco	821	64	885
Taiwan, China		796	796
Belgium	170	594	764
Kosovo	295	444	739
Republic of Korea	233	459	692
Canada	283	384	667
Thailand	485	155	640
Algeria	595		595
Peru	458	119	577
Switzerland	72	486	558
Total	55821	68460	124281



Appendix 17 World Distribution of Extraction and Transformation OS Companies

Country	Count of ID	Sum of Number of employeesLast avail. yr	Sum of Operating revenue (Turnover)EUR Last avail. yr	Sum of EBITDAEUR Last avail. yr	Sum of Cash flowEUR Last avail. yr	Sum of Long term debtEUR Last avail. yr
United States of America	11520	133.219	€ 41.691.292.400	3.040.654.134 €	€ 2.499.253.657	€ 8.012.764.701
China	10906	181.050	€ 32.017.804.770	2.443.894.458 €	€ 1.924.164.531	€ 1.919.663.264
Brazil	45045	419.105	€ 27.203.241.373	16.275.525 €	€ 10.952.653	€ 14.996.992
United Kingdom	1589	23.691	€ 8.799.329.676	963.186.775 €	€ 1.059.858.920	€ 1.900.962.447
Italy	6128	28.434	€ 6.126.165.922	738.555.024 €	€ 647.381.149	€ 925.781.294
Russian Federation	3880	57.953	€ 3.686.299.300		€ 203.937.914	€ 2.535.040.369
Japan	1272	14.291	€ 3.409.815.926	194.072.210 €	€ 117.874.987	€ 416.091.910
Vietnam	3203	53.108	€ 2.858.441.804	104.388.890 €	€ 88.106.571	€ 255.098.860
Spain	2155	18.509	€ 2.738.569.073	296.559.438 €	€ 235.409.403	€ 797.961.023
Republic of Korea	692	2.567	€ 2.723.470.270	191.431.491 €	€ 131.217.071	€ 577.630.147
India	8996	47.174	€ 2.191.237.795	225.194.083 €	€ 125.531.874	€ 455.433.160
Belgium	764	5.632	€ 1.530.505.994	303.312.453 €	€ 334.054.253	€ 894.152.588
Portugal	1534	13.706	€ 1.264.362.557	196.633.261 €	€ 176.821.109	€ 384.706.283
Poland	3380	21.976	€ 1.189.932.994	181.985.227 €	€ 122.657.909	€ 62.909.564
Germany	1824	25.115	€ 966.808.090	129.030.165 €	€ 109.990.935	€ 504.876.238
Thailand	640		€ 940.737.199	7.652.054 €	€ 6.413.222	€ 437.009.845
France	544	2.138	€ 925.726.549	74.534.629 €	€ 61.497.461	€ 88.130.693
Ukraine	1192	19.373	€ 855.723.714	93.155.845 €	€ 90.845.556	€ 66.144.791
Morocco	885		€ 752.598.333	103.597.020 €	€ 71.976.330	€ 188.772.715
Malaysia	295	100	€ 712.327.444	17.187.398 €	€ 14.893.821	€ 51.527.493
Turkey	357	15.487	€ 624.466.589			€ 136.796.437
Canada	667	4.254	€ 550.320.274			€ 130.797
Greece	176	2.394	€ 540.168.383	155.040.070 €	€ 120.572.435	€ 254.153.471
Norway	326	1.842	€ 519.064.186			€ 66.085.916
Czech Republic	266	1.170	€ 438.120.713	37.902.661 €	€ 30.926.276	€ 18.557.609
Finland	352	1.692	€ 435.118.043	36.487.037 €	€ 32.019.198	€ 34.403.432
Romania	1236	6.581	€ 411.169.318	63.742.272 €	€ 33.288	€ 4.146.696
Sweden	360	1.573	€ 325.218.113	27.178.553 €	€ 23.623.122	€ 16.352.030
Croatia	419	3.403	€ 315.399.560	54.687.791 €	€ 50.688.116	€ 58.798.880
Mexico	200	6.414	€ 314.616.961			€ 1.649.351
Netherlands	246	1.395	€ 272.856.141	39.172.674 €	€ 31.811.957	€ 22.034.349
Ireland	212	1.845	€ 249.090.933	44.209.229 €	€ 33.092.229	€ 61.089.290
Total	124281	1.157.117	€ 149.540.908.997	10.035.626.442 €	€ 8.560.076.684	€ 22.165.912.148

Appendix 18 World distribution of OS Companies

Dataset	Type of Data	Date of Extraction	Observations	Last Period Available	Type of Data
ORBIS, BUREAU VAN DIJK					
PT OS companies from Extraction and Transformation	Integer, Currency, Text	31-05-2023	1.892	2022	Microdata
International OS companies Extraction	Integer, Currency, Text	18-06-2023	55.939	2022	Microdata
International OS companies Transformation	Integer, Currency, Text	18-06-2023	70.192	2022	Microdata
Each of these 3 microdata subsets has the following data:					
Company name Latin alphabet	Text		Original Field		Microdata
Inactive	Text		Original Field		Microdata
Quoted	Text		Original Field		Microdata
Branch	Text		Original Field		Microdata
OwnData	Text		Original Field		Microdata
Woco	Text		Original Field		Microdata
Country ISO code	Text		Original Field		Microdata
NACE Rev. 2, core code (4 digits)	Text		Original Field		Microdata
Consolidation code	Text		Original Field		Microdata
Last avail. year	Integer		Original Field		Microdata
Operating revenue (Turnover) EUR Last avail. yr	Currency		Original Field		Microdata
Number of employees Last avail. yr	Integer		Original Field		Microdata
Postcode Latin Alphabet	Integer		Original Field		Microdata
Latitude	Integer		Original Field		Microdata
Longitude	Integer		Original Field		Microdata
E-mail address	Text		Original Field		Microdata
Website address	Text		Original Field		Microdata
Products & services	Text		Original Field		Microdata
VAT/Tax number	Integer		Original Field		Microdata
LEI (Legal Entity Identifier)	Integer		Original Field		Microdata
Total assets EUR Last avail. yr	Currency		Original Field		Microdata
Total assets EUR Year - 1	Currency		Original Field		Microdata
Total assets EUR Year - 2	Currency		Original Field		Microdata
Total assets EUR Year - 3	Currency		Original Field		Microdata
Total assets EUR Year - 4	Currency		Original Field		Microdata
Operating revenue (Turnover) EUR Last avail. yr	Currency		Original Field		Microdata
Operating revenue (Turnover) EUR Year – 1	Currency		Original Field		Microdata
Operating revenue (Turnover) EUR Year – 2	Currency		Original Field		Microdata
Operating revenue (Turnover) EUR Year – 3	Currency		Original Field		Microdata
Operating revenue (Turnover) EUR Year – 4	Currency		Original Field		Microdata
EBITDA EUR Last avail. yr	Currency		Original Field		Microdata
EBITDA EUR Year - 1	Currency		Original Field		Microdata
EBITDA EUR Year - 2	Currency		Original Field		Microdata
EBITDA EUR Year - 3	Currency		Original Field		Microdata

Dataset	Type of Data	Date of Extraction	Observations	Last Period Available	Type of Data
EBITDA EUR Year - 4	Currency		Original Field		Microdata
No of shareholders	Integer		Original Field		Microdata
Date of incorporation	Date		Original Field		Microdata
NUTS3	Text		Original Field		Microdata
Standardised legal form	Text		Original Field		Microdata
Type of entity	Text		Original Field		Microdata
National legal form	Text		Original Field		Microdata
Size classification	Text		Original Field		Microdata
Shareholder - Name	Text		Original Field		Microdata
CSH – Name	Text		Original Field		Microdata
Solvency ratio (Asset based) Last avail. Yr	Currency		Original Field		Microdata
Solvency ratio (Asset based) Year - 1	Currency		Original Field		Microdata
Solvency ratio (Asset based) Year - 2	Currency		Original Field		Microdata
Solvency ratio (Asset based) Year - 3	Currency		Original Field		Microdata
Solvency ratio (Asset based) Year - 4	Currency		Original Field		Microdata
Stock EUR Last avail. yr	Currency		Original Field		Microdata
Stock EUR Year - 1	Currency		Original Field		Microdata
Stock EUR Year - 2	Currency		Original Field		Microdata
Stock EUR Year - 3	Currency		Original Field		Microdata
Stock EUR Year - 4	Currency		Original Field		Microdata
Cash flow EUR Last avail. yr	Currency		Original Field		Microdata
Cash flow EUR Year - 1	Currency		Original Field		Microdata
Cash flow EUR Year - 2	Currency		Original Field		Microdata
Cash flow EUR Year - 3	Currency		Original Field		Microdata
Cash flow EUR Year - 4	Currency		Original Field		Microdata
Cash & cash equivalent EUR Last avail. Yr	Currency		Original Field		Microdata
Cash & cash equivalent EUR Year - 1	Currency		Original Field		Microdata
Cash & cash equivalent EUR Year - 2	Currency		Original Field		Microdata
Cash & cash equivalent EUR Year - 3	Currency		Original Field		Microdata
Cash & cash equivalent EUR Year - 4	Currency		Original Field		Microdata
Subsidiary - Name	Text		Original Field		Microdata
Headquarters Name	Text		Original Field		Microdata
Branch - Name	Text		Original Field		Microdata
No of branches	Text		Original Field		Microdata
BvD sectors	Text		Original Field		Microdata
Long term debt EUR Last avail. yr	Currency		Original Field		Microdata
Long term debt EUR Year - 1	Currency		Original Field		Microdata
Long term debt EUR Year - 2	Currency		Original Field		Microdata
Long term debt EUR Year - 3	Currency		Original Field		Microdata
Long term debt EUR Year - 4	Currency		Original Field		Microdata
Freguesia	Text		Calculated Field		Microdata

Dataset	Type of Data	Date of Extraction	Observations	Last Period Available	Type of Data
Concelho	Text		Calculated Field		Microdata
Distrito	Text		Calculated Field		Microdata
NACE Description PT	Text		Calculated Field		Microdata
A Média EBITDA (5 anos)	Currency		Calculated Field		Microdata
A Média Volume Negócios (5 anos)	Currency		Calculated Field		Microdata
A Margem Operação (5 anos)	Currency		Calculated Field		Microdata
A Média Ativos (5 anos)	Currency		Calculated Field		Microdata
A Média Dívida (5 anos)	Currency		Calculated Field		Microdata
A Média Inventários (5 anos)	Currency		Calculated Field		Microdata
A Média Caixa e Equivalentes	Currency		Calculated Field		Microdata
A Média Cash Flow	Currency		Calculated Field		Microdata
A Média Rácio de Solvência	Currency		Calculated Field		Microdata
Receita por Empregado (último ano)	Currency		Calculated Field		Microdata
A Var. % EBITDA (5 anos)	Percentage		Calculated Field		Microdata
A Var. % Volume Negócios (5 anos)	Percentage		Calculated Field		Microdata
A Média EBITDA (3 anos)	Currency		Calculated Field		Microdata
A Média Volume Negócios (3 anos)	Currency		Calculated Field		Microdata
A Var. EBITDA 3 anos vs. 5	Currency		Calculated Field		Microdata
A Var. Volume Negócios 3 anos vs. 5	Currency		Calculated Field		Microdata
INE					
Exports					
Exports by type of product	Currency	13-08-2023	All industry data	2022	Aggregated
Number of Employees					
Enterprises	Integer	08-06-2023	All industry data	2008-2021	Aggregated
Cost of goods sold	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Cost of raw materials incorporated	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Supplies and external services	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Cost of employees	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Other employee costs	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Taxes	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Corporate Income Tax (CIT)	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Gross Operating Surplus	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Gross Fixed Capital Formation	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Employees	Integer	08-06-2023	All industry data	2008-2021	Aggregated
Salaries	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Net Profit	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Sales of services	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Internal Sales	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Employees Supplements	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Subsidies	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Production	Currency	08-06-2023	All industry data	2008-2021	Aggregated
GVA	Currency	08-06-2023	All industry data	2008-2021	Aggregated

Dataset	Type of Data	Date of Extraction	Observations	Last Period Available	Type of Data
Employees	Integer	08-06-2023	All industry data	2008-2021	Aggregated
Sales of goods	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Sales of products and raw materials	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Stocks	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Turnover	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Legal Form					
Enterprises	Integer	08-06-2023	All industry data	2008-2021	Aggregated
Sales of goods	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Sales of products and raw materials	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Stocks	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Internal Sales	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Turnover	Currency	08-06-2023	All industry data	2008-2021	Aggregated
GVA	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Employees	Integer	08-06-2023	All industry data	2008-2021	Aggregated
Other employee costs	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Taxes	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Corporate Income Tax (CIT)	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Sales of services	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Liabilities	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Paid Employees	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Cost of employees	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Net Profit	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Employees Supplements	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Subsidies	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Production	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Cost of goods sold	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Cost of raw materials incorporated	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Supplies and external services	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Cost of employees	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Gross Operating Surplus	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Gross Fixed Capital Formation	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Assets	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Current Assets	Currency	08-06-2023	All industry data	2008-2021	Aggregated
Equity	Currency	08-06-2023	All industry data	2008-2021	Aggregated

Appendix 19 List of Variables Extracted and Manipulated in PowerBI