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MALTA COUNCIL FOR ECONOMIC & SOCIAL DEVELOPMENT

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Provision of Evidence-Based Research and Delivery of Training: Expansion of Investments in R&D in new economy

Final Research Report

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Acronyms

3D – Three dimensional

AI – Artificial Intelligence

EC – European Commission

EPO – European Patent Office

EU – European Union

GDP – Gross Domestic Product

GII – Global Innovation Index

HEI – Higher Education Institution

I4.0 – Industry 4.0

MCESD – Malta Council for Economic and Social Development

MCST – Malta Council for Science and Technology

ME – Malta Enterprise

NSO – National Statistics Office

OECD – Organization for Economic and Development

PRIMA – Partnership for Research and Innovation in the Mediterranean

PSF – Policy Support Facility

R&D Research and Development

R&I Research and Innovation

STEM – Science, Technology, Engineering and Mathematics

WWI – World War I

Executive Summary

The level of investment in research and development in Malta remains very low and well below the target set by Malta for 2020, which was 2% and even lower than the target of 3% of GDP set by the EU. The level of investment for 2020 for Malta was only 0.67% of GDP, meaning €87.188 million, ranking Malta 26th out of 27 EU member states.

The expectations of increased investment in research and innovation in the world continues to grow, with a 5.43% increase expected for 2022 over the figure for 2021. The figure for 2022 is expected to reach $2.476 trillion. More than 80% of that investment will be spent by the top ten countries of R&D. There is global consensus that R&D is the surest way for future growth.

The aim of this report is to analyse the current situation in Malta, not only by presenting relevant data but also to understand the supporting policies and structures already in place. The methodology used relies on published and unpublished secondary data, and on interviews, focus groups and a questionnaire.

Preliminary research findings show that although the economy has witnessed significant economic growth, nonetheless the amount of R&D investment has not been able to keep up or more importantly while there has been an increase in volume, this has not translated into a corresponding increase of R&D as a percentage of GDP. There are other worrying trends that include, the number of engineers and graduates in STEM are decreasing, some R&D activities have been moved abroad, an R&D mentality is not part of the business culture in Malta, funding programmes are available but are not seen as being enough or are believed to be too complicated and lengthy as a process, there appears to be lack of publicity on the importance of R&D for society and the economy, the number of students following science topics is not increasing, there is a steady fall in employment in knowledge-intensive activities, the number of enterprises involved in innovation activities remains low, and there has been a drop in R&D investment by the foreign private sector in comparison with local business.

The report presents data on the level, source, type, and focus of investment engaged in by industry, higher education institutions and government. It provides comparisons with other small countries and offers insight from different international indices as to the situation of

R&I in Malta, showing the country's strengths and weaknesses. Several recent studies, by the Chamber of Engineers and the European Commission's Peer Review of Malta's R&I situation provide a picture of a country which needs to do much more to encourage investment in research and innovation. The National R&D Monitoring Report 2019-2020 by MCST gauges the targets and achievements of the 2014-2020 R&I Strategy.

The term 'new economy' "describes aspects or sectors of an economy that are producing or intensely using innovative or new technologies" (OECD 2021). The range of economic activity this term encompasses has changed and expanded over the past decades. It is thus more complicated to adequately measure their role in the economy. However, certain indicators can be used to provide information regarding the type of resources being used in the form of inputs and their subsequent outputs.

Desk research shows that there are several policies and structures in place which should support more investment in R&I, the latest of which is Malta's Research and Innovation Smart Specialization Strategy (RIS3) 2021-2027. The next innovation strategy currently awaits Cabinet approval. Other supporting policies need updating. Results from the interviews and focus groups show that those interviewed appreciate that Malta needs to do much more to increase interest and funding for R&I investments. Although there are several success stories, investment in R&I remains marginal to Maltese business, with issues arising over size of enterprises, complicated funding programmes, an undeveloped eco-system, fragmentation of entities and programmes, lack of interest in STEM subjects by students, lack of expertise and human resources, and the need for better coordination amongst the different service providers. The low number of responses to the questionnaire was disappointing, even though several entities helped to disseminate the online survey. The limited responses are thus not representative but only indicative of the disinterest in this type of investment which is seen as long-term and risky.

Overall results shows that whilst the appetite for R&D&I is slowly increasing with local businesses, the Maltese traditional business model does not rely on research and innovation. There are several factors which are influencing and impacting on the level of R&D. There are different types of barriers which may be more complicated to remove, particularly in the short to medium term. These can be divided into four types of barriers: institutional, market, business model and external factors.

The economies of the future, the new economy in its multitude of variations, will create a divide between those who merely embrace technological changes and those who create them, between the followers and the leaders. A country needs to understand and acknowledge the full implications associated with such fast-paced technological change. Being ranked 26th out of 27 countries does not show that Malta is fully understanding the importance of focusing more on R&D&I and on fresh areas of the new economy. However, the 2019 Peer Review was undertaken in the knowledge that this would feed into the R&I Strategic Plan for 2022-2025, and thus policy-makers appear to be aware of its importance.

The report provides seven recommendations including: strengthening the eco-system; increasing and showcasing funding schemes; creating incentives for R&D&I; capacity-building and networking; focusing on a wider market; the need for a new direction for the local business model; and the provision of different working permits for high-value human capital.

Whilst there has been progress in recent years, a complete and cohesive R&D eco-system would bear more benefits to the Maltese economy. Malta needs to continue to build up its capacities, its networks, it needs to introduce new and powerful economic actors with a strong R&D base, it needs to offer less complex funding programmes, there is a need for more outreach and enticing incentives to encourage local businesses to invest in research and it also needs to attract both FDI and human capital which is linked to research and innovation.

1. Introduction

"Research and innovation play a limited role in the economy"

(European Commission, 2020)

According to the 2020 Country Report for Malta, research and innovation remain low in the Maltese economy and these need to be increased, particularly if the island wants to catch up with its direct competitors in the Internal Market and more so with a fast-paced global economy that is continuously changing and developing new products and processes. Global competition is intensifying with new players in the game, and not increasing investment in research and development (R&D) and the new economy is certainly not an option to entertain.

The world economy is in a constant flux, having over the centuries, gone through four industrial revolutions. The first is perhaps the most talked about, as it completely transformed production methods from manual to machines, with the introduction of steam and waterpower. These technologies did not happen overnight but stretched over decades between 1760 and1840. Certain industries were more impacted than others, such as textiles, iron, mining and agriculture. Not all these changes affected countries in similar ways or with the same intensity. For example, in some countries, agriculture remains to this day very much labour oriented. The second revolution for industry was based on technology, particularly pushed by the networks created through railroads and telegraphy, and the revolution of electricity. These all facilitated the quicker transfer of goods, persons, and created significant spillover ideas. The use of electrification led to the modern production line and the development of management theories to increase production. The downside to this revolution is that it led to the displacement of workers by machines and thus increased unemployment. This revolution did not stretch out for 80 years, as the previous one, but was shorter, from 1871 to 1914, until WW1. The third revolution came towards the end of the 20th century and referred to the digital changes happening in computing and communication technologies. Machines and computers continued to take over the work of certain workers. The fourth Industrial revolution, first coined by a German team of scientists, is based on an intensification of connectivity, communication and still-emerging technologies in many fields, some of which have become household concepts but others still needing to catch on and develop further. These include the many areas where robotics can change production processes: the use of AI in our everyday products

and services; quantum computing where the expectations are that computers will become not only faster but also more intelligent; nano and biotechnology, the internet of things, 3D printing, fully autonomous vehicles, drones and many more innovations. A correlation of this is the strategy Industry 4.0, (I4.0), pushed by the German government, which focuses on the computerization of the manufacturing sector. Digitization has also shifted the discussion on the ways that the strategy will impact workers. I4.0 has been adopted by many countries worldwide. Although the fourth revolution might be seen as an extension of the previous one, there are certain features which distinguish the two, including the speed at which industries are impacted, the significant impact on many sectors and firms which is more extensive than any previous changes, and the paradigm shift in how technology policies are adopted by countries. The speed of change is what is intensifying the need to focus on the correct investment in both the relevant research and development sectors and in areas of the new economy. Competition is strong and countries need to ensure they are investing in areas which not only gives them an edge over their competitors but also allows them to stay in the race.

According to the 2022 R&D Global Funding Forecast, the editors anticipate a global investment of $2.476 trillion, which is an increase of 5.43% over the $2.348 trillion invested in 2021. More than 80% of that investment will be spent by the top ten countries of R&D (China, US, Japan, Germany, India, South Korea, France, Russia, UK and Brazil). During 2021 Europe had 19.6% of global R&D, US and China had half of total global R&D, whilst Africa a mere 0.8% (R&D World, 2022). There is consensus that R&D is the surest way for future growth. China has for the past twenty years been increasing its spending, with the US unable to keep up, with the consequence that in 2021 China overtook US for the first time. Asia, will continue to forge ahead and outstrip North America and Europe, whilst Africa, South America and the Middle East continue to languish behind with a mere total of 5% of global R&D. In terms of sources, 64.7% of all R&D comes from internal resources, meaning businesses invest in themselves.

Title XIX of the Treaty on the Functioning of the European Union deals with Research and Technological Development and Space. The Commission is committed towards creating the right environment for such developments to find fruition.

> The Union shall have the objective of strengthening its scientific and technological bases by achieving a European research area in which researchers, scientific knowledge and technology circulate freely, and encouraging it to become more

> competitive, including in its industry, while promoting all the research activities deemed necessary by virtue of other Chapters of the Treaties.
>
> European Commission (2012), Article179(1)

The European Commission has emphasized that though Malta has made some progress in the last decade in terms of innovation performance, nonetheless the level of investment is significantly low and in fact was higher in 2012, when it stood at 0.83% as compared to a lower 0.57% in 2019, marginally increasing to 0.67% in 2020. Malta's rank is 26th out of 27 EU member states. Public R&D investment has unfortunately also been on the decline, ranking Malta penultimate.

Purpose, Scope and Design of the Report

This report is being presented according to the terms of reference of Tender SPD7/2021/021 – Services Tender for the Provision of Evidence-Based Research and Delivery of Training for MCESD, as part of the ESF Project - ESF.04.158. Deliverable 3 is the Preparation of an expert research paper on the expansion of investments in R&D and in the new economy.

The aim is to analyze the present situation in Malta, not only in relation to its target for R&D, but also to understand the supporting policies and structures which are in place as an aid to businesses, government entities, NGOs and higher education institutions. A comparative analysis on a regional and global level will also be presented, to assess the positive and negative elements which can be aiding or hindering more investment in R&D and in the new economy.

The main research question evaluates the factors which are impacting on the decision to increase investment in R&D. What type of funding programmes are in place, what supporting structures would increase interest in R&D, what type of resources are lacking, and what are possible solutions to the issue?

Further to this introduction which includes the methodology and the needs analysis, this thematic report is divided in three other sections. The next section discusses the situation of investment in research and development in Malta, looking at the type of investment, the sectors involved and the amounts in relation to the GDP. It also delves into the wider aspect of innovation. Comparisons are provided to present the EU context. It then analyses the

concept of the new economy, its meaning and possible impact on future economies, businesses and workers. The third section presents results from interviews and a survey and analyze these within the context of earlier sections. The final section concludes and provides recommendations.

Methodology

Desk research was carried out to collate data on R&I statistics, policies, strategies and entities related with funding and programmes. Data was collected from NSO releases, Eurostat and global entities issuing indices. The latest data was used, however, due to the pandemic which affected the economy and investments in R&I, earlier years were also used when these provided a more accurate picture of the trend.

Interviews were held with representatives of the main entities involved with R&I. These included Malta Enterprise, the Malta Council for Science and Technology, the Knowledge Transfer Office of the University of Malta, the Malta Life Sciences Park, the Gozo Innovation Hub, the National Foreign Direct Investment Screening Office, the Chamber of Engineers, the Chamber of Scientists, the Commerce Department, the Gozo Business Chamber, the Chamber of Commerce, and the Ministry for Equality, Research and Innovation. Other experts in the field were interviewed, including academics and consultants. Four focus groups were organized online. A list of the entities involved is found in the Appendices.

A questionnaire was also specifically designed for businesses, and this was sent out by four organisations: the Malta Chamber of Commerce, the Gozo Business Chamber, the Chamber of SMEs and the MCSED. Unfortunately, the response rate was very limited. Thus, the results of the sample cannot be considered as representative of the business population. Nonetheless, some information was gleaned from the open-ended questions, and these are presented in the results section. Qualitative analysis was conducted using HyperResearch.

Secondary data was provided through online databases such as the Malta National Statistics Office and Eurostat. The NSO also provided additional detailed data upon a personal request. Primary data was collected via the interviews, the focus groups and a very limited number of questionnaires.

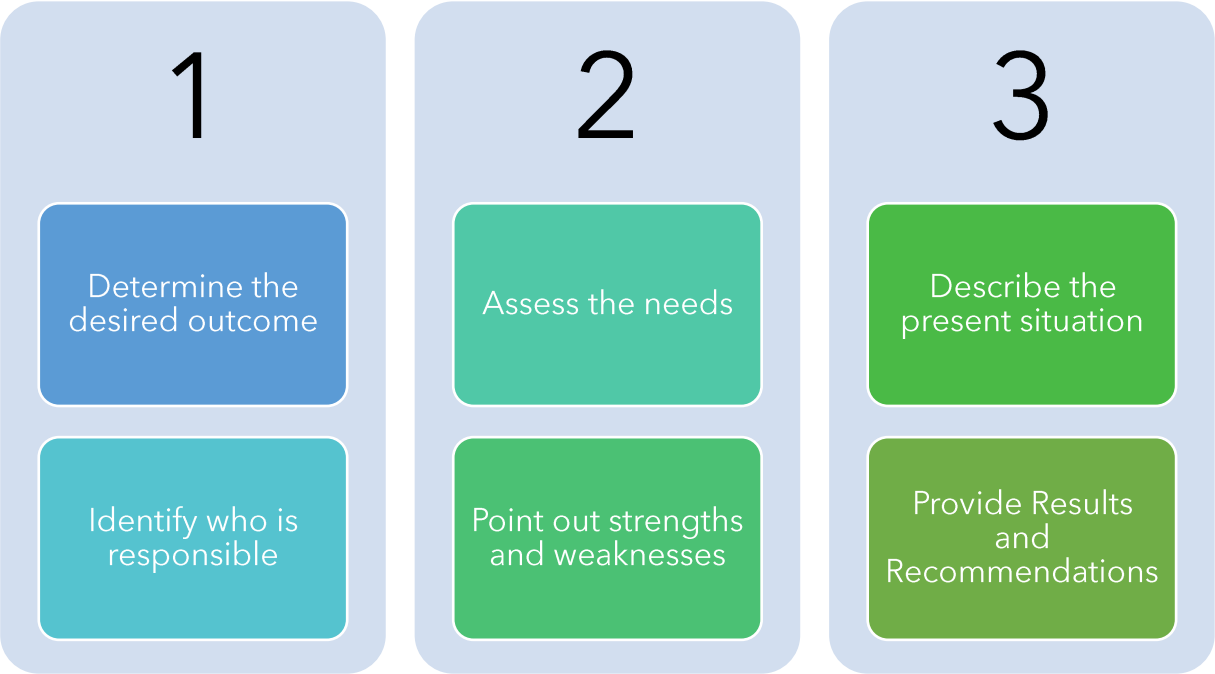
Needs Analysis

Needs analysis means identifying and evaluating needs, that is identifying the gaps and the areas to be prioritized, to develop a plan of action. It should point out any deficiencies or problems and thus discover their causes and find solutions for these problems. In a sense, the analysis evaluates the gap between what is happening and what should ideally be happening, between the reality and the desired outcome.

Preliminary research findings show that although the economy has witnessed significant economic growth, nonetheless the amount of R&D investment has not been able to keep up or more importantly while there has been an increase in volume, this has not translated into a corresponding increase of R&D as a percentage of GDP. There are other worrying trends that include, the number of engineers and graduates in STEM are decreasing, some R&D activities have been moved abroad, an R&D mentality is not part of the business culture in Malta, funding programmes are available but are not seen as being enough or are believed to be too complicated and lengthy as a process, there appears to be lack of publicity on the importance of R&D for society and the economy, the number of students following science topics is not increasing, there is a steady fall in employment in knowledge-intensive activities, the number of enterprises involved in innovation activities remains low, and there has been a drop in R&D investment by the foreign private sector in comparison with local business.

Figure 1 provides the three stages and six steps for the needs analysis. First, one needs to set out the desired outcome, which in Malta's case is first and foremost to increase the amount of investment in R&D and the new economy. Second, those responsible to achieve this need to be identified. The second stage includes first a needs assessment and distinguishing between the strengths and weaknesses of the R&D landscape. In the final stage, there is the description of the status quo and thus measuring the gap between this and the desired outcome. The final step is to provide the results of the analysis and offer recommendations on how to close the gap.

Figure 1 – Needs Analysis



The terms of reference of this report already indicate the desired outcome, that of increasing the level of investment in R&D and in the new economy. Malta's target for 2020 was 2% of GDP, while the EU's target was 3%. The responsibility for this to be achieved rests with all stakeholders in the process, policymakers, supporting institutions, higher education entities, the private sector, the public sector and civil society.

The following sections of this report provide the next two stages of the needs analysis, while the final section provides the recommendations.

2. The Maltese Scene

Investment in Research and Development

> Research and Development is defined as creative work undertaken on a systematic basis to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. (NSO, 2021, p.7)

Although investment in research and development are known to be essential for economic growth, unfortunately the data for Malta is not very encouraging, and according to the 2019 Country Report, "the research and innovation potential of Maltese firms remain limited" (European Commission 2019). There are many reasons for this, one relates to the capacity of the local companies themselves, since 97.4% of all business units are micro, that is employing less than nine people. Although international research and data do indicate that many innovations start out in small companies, nonetheless fruition comes with significant financial backup or complete buyouts of those small business entities and being part of a nourishing network. Another reason is due to the institutional framework, which needs to support innovative companies, particularly those lacking collateral and to provide for more effective measures for local innovative businesses. The 2019 report continues to state that 'access to finance is more difficult for innovative firms without collateral. The effectiveness of existing measures to support homegrown research and innovation remains limited." The 2020 Country report maintains that the Research and Innovation system 'lacks public and private support both in terms of investment and dedication to the field'.

The EU set a target of 3% of GDP to be invested in R&D by each member state, by the year 2020. Malta's target according to its National Reform Programme was 2%. Unfortunately, the island is still very far away from reaching its own lower target.

Research and Development investments in Malta (2019 data) amounted to €80.05 million, just 0.59% of GDP (NSO 2021). Eurostat data for 2020 shows that this increased to €87.188 million, or 0.67% of GDP (Eurostat 2022). This reflects only marginal increases in the past decade with the figure increasing from 0.53% in 2008. The EU27 average reached 2.23% in 2019 and increased to 2.32% by a year later. Of the €80.05 million, 62% of all expenditure was invested by the business sector (or 0.35% of GDP) while higher education accounted for 37% (0.21% of GDP), and government for the remaining 1% (0.01% of GDP). The EU27

average in 2019, was 1.48%, 0.48%, and 0.25% of GDP respectively. Figures for other small member states such as Luxembourg and Cyprus showed higher nominal investment figures at €724.8 million and €177.2 million respectively, translated to 1.18% and 0.71% of GDP. Another small country, Iceland had 2.47% of GDP invested in R&D, meaning €470.257 million.

From the business sector, 43.8% were invested in engineering and technology, while 25.3% were linked to natural sciences. In terms of higher education, the biggest share (13.8%) went to medical sciences. Seven million euro (or 8.7% of total funds) derived from foreign sources, including EU Funds.

The Frascati Manual of 2015, classifies R&D investment under three categories:

- *Basic Research* - experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.
- *Applied Research* - original investigation undertaken in order to acquire new knowledge.
- *Experimental Development* - systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes. (NSO, 2021)

Table 1 shows that more than half of research is basic research, which generally refers to the theoretical search for new information but does not imply any associated application of such knowledge. Government and higher education institutions (HEI) are generally more likely to engage in basic and applied research, while the business sector engages in all three types. Experimental research which largely means new products or processes on the market only accounted for 14.3% or just over 11 million euros. Table 2 shows that higher educational institutions mainly engaged in basic research, government and HEIs did not invest in experimental research, whilst business invested in all types of research.

Table 1 - Research in Malta by Type, 2019

Type of Research	% for Malta	Amount in €000s
Basic research	52.1	41,059
Applied research	34.4	27,551
Experimental research	14.3	11,440

Source: NSO 2021

Table 2 – Research Type by Source of Funding, 2019

€millions

	Basic	Applied	Experimental
Government	0.024	0.737	0
Higher Education	29.269	0.421	0
Business	11.767	26.394	11.440
TOTAL	**41.059**	**27.551**	**11.440**

Source: Eurostat 2022

Table 3 shows the expenditure type for R&D investment. Most of the expenditure was allocated to employment, which translated into 2570 employees working on R&D projects. Of these 1032 were considered as full-timers, while the remainder 1538 were on a part-time basis. Most of those employed were in higher education (1408), while the business sector accounted for 1129 employees, and 33 were working for government. This concords with the bigger portion of research being basic and possibly conducted by educational institutions. Furthermore, there was a gender bias, since 64.3 (or 1652 persons) were male, while 35.7% (918) were females. Most of employees were working in engineering and technology (752 persons), natural sciences (704) and social sciences (463). The actual number of researchers was 1559, with technicians accounting for 492, while 519 persons were as support staff. Ten percent of expenditure went into equipment and instruments.

Table 3 - Expenditure Type

Type	Percentage	Amount in €000s
Recurrent Expenditure	87.7	70,172
Of which: labour costs	***62.3***	*49,900*
other recurrent expenditure	*25.3*	*20,272*
Capital expenditure	12.3	9,877
Of which: land/buildings	*2.3*	*1,839*
equipment/instruments	*10.0*	*8.038*

Source: NSO 2021

Table 4 provides more data for 2019 in terms of the type of R&D by general sectors, compared to Luxembourg and Cyprus. It shows that for Malta engineering and technology is where most R&D is directed, followed by natural sciences and medical and health. Malta invests the least in agricultural sciences. In the case of Luxembourg and Cyprus most R&D goes towards natural sciences, followed by engineering and technology and then social sciences.

Table 4 – Investment Priorities for EU Small States, 2019

€millions

	Malta	Luxembourg	Cyprus
Natural sciences	20.2	**132.2**	**65.2**
Engineering and technology	**35.1**	81.7	56.4
Medical and health sciences	11.0	20.9	10.6
Agricultural sciences	1.2	0	7.5
Social sciences	8.3	74.4	18.5
Humanities	4.2	27.8	6.2

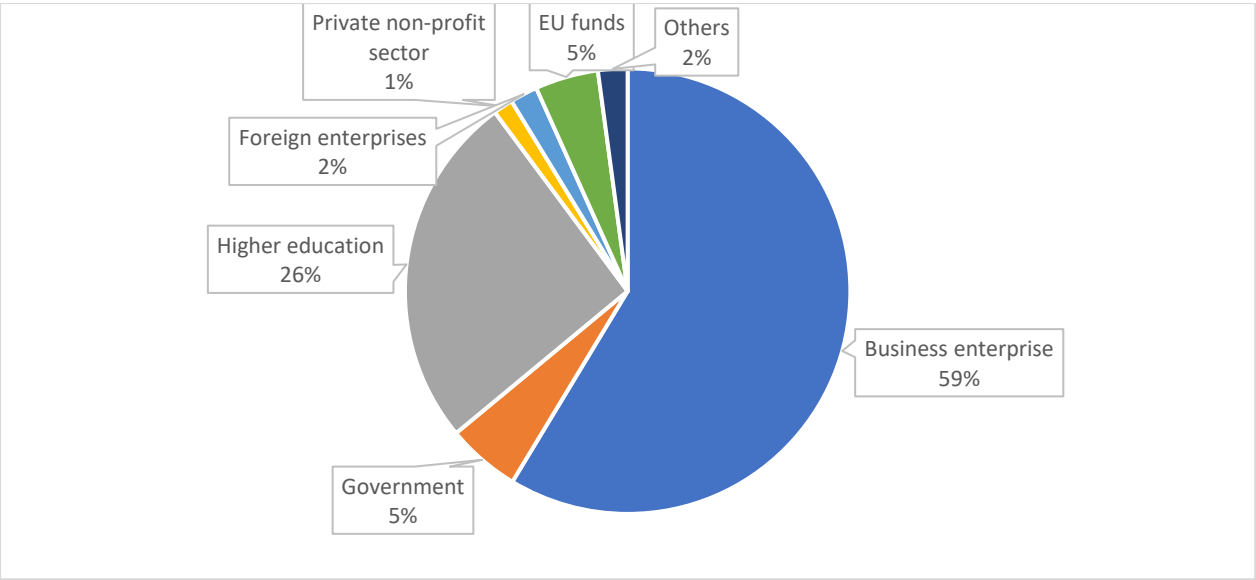
Source: Eurostat 2022

A further distinction made is between intramural and extramural R&D. The former includes 'all current expenditures, plus gross fixed capital expenditure for R&D…whatever the source of funds.". The latter refers to "any R&D performed outside of a statistical unit…should include only internal funds (not from external sources) provided to an outside unit for R&D performance including both where there is an expected compensatory delivery of R&D (exchange or purchase), and where no compensatory delivery is expected

(transfer or grant)". The summation of the former of all sectors reflects the total expenditure of R&D of an economy. Figure 2 provides these funding sources for 2019.

During 2019, government R&D was focused on agricultural sciences, for business it was engineering and technology and for higher education the biggest spend was on social sciences but for the latter (HEI) the spending was spread out on almost all areas.

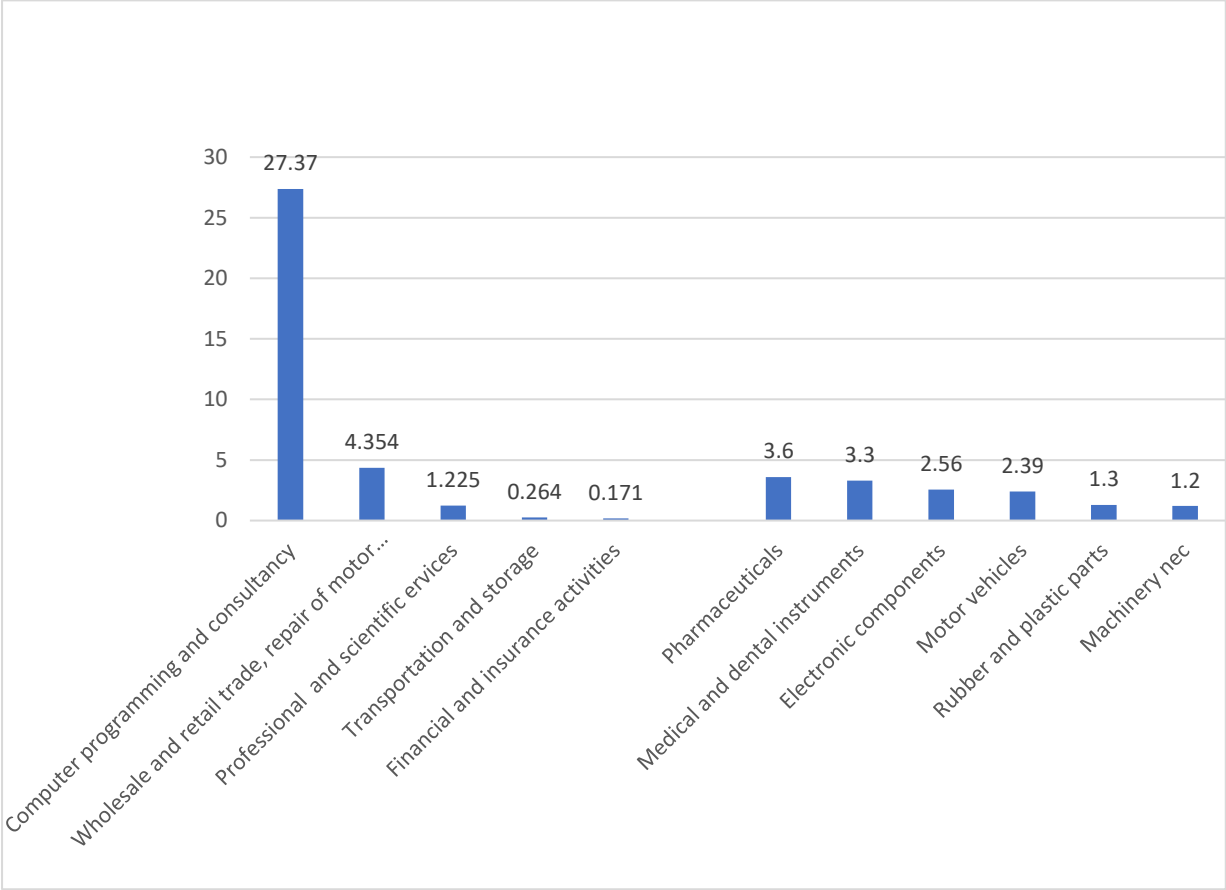
Figure 2 – Source of Funds, 2019



Source: Based on NSO 2021.

The business community invested 49.6 million euro in R&D in 2019, with the focus being on two main sectors: services of the business economy (€37.323 million) and manufacturing (€15.908 million). Figure 3 shows the specific areas of these two sectors. The data shows that at over 27 million euros computer programming and consultancy is the main area where most of R&D is focused. In terms of the manufacturing sector, where the amounts are relatively smaller, the focus is on pharmaceuticals, medical and dental instruments, electronic components and motor vehicles.

Figure 3 – The Focus of R&D in Malta, 2019



Source: Based on Eurostat 2022

As stated earlier, one of the 2010 goals of the European Union was to have EU member states spending at least 3% of GDP on research and development. Ten years later, five countries have accomplished that goal: Sweden, Belgium, Austria, Germany and Denmark. The last on the list of EU27, stands Romania, the only country ranking lower than Malta. This means that there is a significant onus on Malta to expand its investment in research and development. With the EU27 average in 2020 standing at 2.32%, only six member states were above the average, while twenty-one countries were below the average.

Table 5 shows the percentages under four groupings, according to the percentage of GDP spent. They are shown in ranking order starting from column 1, meaning that Sweden spends the most and Romania the least.

Table 5 - R&D as a percentage of GDP for EU27, 2020

Over 3%	2.1 to 3% of GDP	1.1 to 2% of GDP	1% and under
Sweden	Finland	Czechia	Slovakia
Belgium	France	Estonia	Bulgaria
Austria	Netherlands	Portugal	Latvia
Germany	Slovenia	Hungary	Cyprus
Denmark		Italy	Malta
		Greece	Romania
		Spain	
		Poland	
		Croatia	
		Ireland	
		Lithuania	
		Luxembourg	

Source: Based on Eurostat (2022)

There are several variables which show the level of investment in a country, looking at both inputs and outputs. The first input is related to the total value of investment in R&D and this as a percentage of the GDP (presented above). The second input is the share of government outlay on R&D as a percentage of total government expenditure. The Maltese government spends 0.5% of its total expenditure on research and development, again only surpassing Romania, with the highest being Germany at 2.16%. The number of persons employed in high and medium-high technology manufacturing sectors and knowledge-intensive service sectors in Malta in 2020, is a low 3.3% of total employment. Countries such as Germany, Slovenia, Slovakia and Czechia record over 10% of such employment. Other smaller countries such as Luxembourg and Cyprus have even lower numbers than Malta, 0.7% and 0.9% respectively.

As output, one can see the share of exports of high-tech products in total exports. In terms of high technology this involves industries dealing with "aerospace, computers-office machines, electronics-communications, pharmacy, scientific instruments, electrical machinery, chemistry, non-electrical machinery, armaments" (Eurostat 2022). Intra-EU trade is not included in the total exports of a country. For Malta, the share of high-tech exports reached 25.6% in 2018, beaten only by Ireland at 34.7%. Another output refers to

patents, trademarks and designs. Latest provisional data show that there were 65 applications by Maltese entities to the European Patent Office (EPO). This is in the same region of other countries (shown in Table 5) who spend less than 1% of GDP as investment in R&D.

The EU as an economic region also needs to catch up with Asia and North America, seen as its main global competitors in terms of R&D and innovation.

Comparative Indices and Studies

There are other variables which provide information regarding a country's potential in research and innovation. These can be gleaned from several comparative indices and studies. In international comparisons, with a wider range of countries and development levels, Malta is not at the lower end of the ranking scale.

According to the Global Innovation Index (GII) (Dutta et al. 2021), with a score of 47.1, Malta ranks 27th out of 132 countries, and is classified with the group of countries who are considered as best performers, i.e., in the top quartile. Within the high-income group, its performance is considered in line with its level of development, and as such is at par with countries such as New Zealand, Chile, Paraguay, and Southern/Central/Eastern European countries, including Spain, Italy and Cyprus. There is another group within the high-income group which are considered as performing above expectations for their level of development, including the usual high-flyers but also Estonia and Czechia. The index is divided into seven pillars, with each pillar then being subdivided into three headings. These 21 headings, then translate into around 80 indicators. The GII uses a broad definition of innovation based on the revised Oslo Manual 2018, adopted by the EU and OECD.

> An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process). Oslo Manual (2018)

Table 6 pinpoints several important positive and negative aspects of innovation in Malta. First, there is investment in education and the ICT infrastructure, and its energy productivity is also good. Second, dismissing a redundant worker is not costly for business. Third, IP payments and receipts are high when compared to total trade. Fourth, Malta manages to attract FDI inflows, and it has a good number of new businesses being created. Fifth, the country is strong in its creative output, such as national feature films and exports of cultural and creative services (though not goods). The former is due to the heavy marketing and subsidizing of the film industry and the latter is mainly due to the heavy role of tourism in the local economy.

From the troubling aspects, the most serious is possibly the fact that labour productivity growth is negative (ranking at 115). Second there are problems dealing with insolvency

issues (ranking at 105), logistics performance (ranking at 68) and ease of getting credit (ranking a low 118). Third, the size of the domestic market is limiting (ranking at 127). Fourth, the output of the University is not very visible internationally, with a low number of graduates in sciences and engineering (ranking at 69). Fifth, trade in high value products and services is not significant. High-tech products signify a 'high intensity of R&D', but Malta ranks 107 in high-tech imports. Additionally, ICT services and creative goods exports are also low (ranking at 96 and 79 respectively). However, the analysis shows that considering the level of innovation investments, Malta produces more innovation outputs relative to that investment. The country performs best in creative outputs and worst in market sophistication.

Table 6 - Malta's Strengths and Weaknesses in Innovation

Pillar	Strengths	Strengths within income group	Weaknesses	Weaknesses within income group
Institutions (37)	Cost of redundancy dismissal	Cost of redundancy dismissal	Ease of resolving insolvency	Ease of resolving insolvency
Human Capital and Research (41)	Pupil/teacher ratio, secondary*	Pupil/teacher ratio, secondary* Govt funding/pupil, secondary %GDP/cap	QS University ranking Graduates in science and engineering, %	QS University ranking
Infrastructure (18)	ICT access GDP/unit of energy use	ICT access GDP/unit of energy use		Logistics performance
Market Sophistication (63)			Ease of getting credit Domestic market scale, bn PPP$	Ease of getting credit Domestic market scale, bn PPP$
Business Sophistication (14)	Joint venture/strategic alliance deals/bn PPP$ GDP	Joint venture/strategic alliance deals/bn PPP$ GDP	High-tech imports, % total trade	

	Intellectual property payments, % total trade FDI net inflows, % GDP	Intellectual property payments, % total trade FDI net inflows, % GDP		
Knowledge and Technology Outputs (44)		New business/th.pop. 15-64 Intellectual property receipts, % total trade	Citable documents, H-Index Labour productivity growth, % (-3.7) ICT services exports, % total trade	Citable documents, H-Index Labour productivity growth, % (-3.7)
Creative Outputs (9)	Trademarks by origin/bn PPS$ GDP Cultural and creative services exports, % total trade Printing and other media, % manufacturing Generic top-level domains (TLDs)/th.pop. 15-69	Trademarks by origin/bn PPS$ GDP Cultural and creative services exports, % total trade Printing and other media, % manufacturing Generic top-level domains (TLDs)/th.pop. 15-69 National feature films/mn pop. 15-69	Creative goods exports, % total trade	Entertainment and media market/th pop, 15-69

Source: Global Innovation Index 2021 *data older than base year

There are several facts to analyze here. Government and businesses may be investing but there are certain rigidities in logistics, access to finance and insolvency of unprofitable companies which may be limiting the efficiency of the private sector. Labour productivity has been on a downward slope for several years and the fact that high-tech imports and

graduates of science and engineering are both low, do not augur well for future productivity levels.

When compared to its direct competitors in the Internal Market, Malta needs to extensively improve its role in terms of R&D and innovation. The EU Innovation Scoreboard assesses the strengths and weaknesses of national innovation systems, also analyzing inputs and outputs. Countries are classified under four groups: innovation leaders, strong innovators, moderate innovators and emerging innovators. Malta is a moderate innovator. The EIS is divided into 12 dimensions: human resources; attractive research systems; digitalization; finance and support; firm investments; use of information technologies; innovators; linkages; intellectual assets; employment impacts; sales impacts; and environmental sustainability. Malta is above the EU27 average on six dimensions and below average on six others. The two indices (EIS and GII) have some similar indicators.

Malta's top three indicators are trademark applications, environment-related technologies, and employment in knowledge-intensive activities. However, the island has below average shares in in-house product innovators without market novelties (meaning a company has introduced an innovation to itself, but has not taken it to the market), and innovators that do not develop innovations themselves (meaning a company has introduced an innovation but not one produced by itself, in essence it does not have in-house innovation capabilities). This signifies two things: one that while some companies may be developing innovations, these are not exploited in the market; the other is that there appears to be limited in-house innovation capabilities.

According to the pillar of finance and support, Malta has seen a decrease of 23.6% between the period 2014 and 2021. Malta saw the biggest decrease in performance when compared to 2020, at a high 65.3%. This pillar measures R&D expenditure in the public sector, government support for business R&D, and venture capital expenditures. Another pillar, firm investment also puts Malta on a low rung. This measures R&D expenditure in the business sector, innovation expenditures per employee, and non-R&D innovation expenditures. Another area where Malta does not do well is in the Sales Impacts dimension. This includes medium and high-tech goods exports, knowledge-intensive services exports, and sales of innovative products.

Malta's strengths are in environmental sustainability (resource productivity, air emissions by fine particulate matter, and environment-related technologies), use of IT (enterprises

providing ICT training, and employed ICT specialists) and intellectual assets (PCT patent applications; trademark applications; and design applications).

In 2019, the Chamber of Engineers in Malta conducted a study on the factors which are leading to the dwindling of the number of engineering students at the University of Malta. In fact, during 2017-2018 only 20 students had applied for the electrical engineering course at the University. This was at a time when the economy was booming, and local businessmen had to resort to the importation of foreign engineers for key positions in their business enterprises. One of the results of the study is the low rate of 6.8% of secondary students who choose the combination of Physics and Pure Mathematics (needed for an engineering course), and this has remained fairly stable over the past years with a slight increase in the past six years. However, the number of University of Malta applications for engineering has been declining. Another report by the Chamber of Engineers (2021) lists five factors where Malta is facing hurdles: human resources and brain drain (low number of students in STEM subjects and lower salaries locally when compared to countries abroad and also the lack of career trajectories for post-graduate studies); industry aptitude for research and innovation (reliance on foreign R&I and not local incubation); risk management (R&I is a long-term investment linked to high risk); R&I projects, local and EU (local industry lacks capacity and skills to apply for research projects, research is mostly conducted by the University of Malta); and marketing and public relations (need for more marketing of the importance of research for society as a whole). The Chamber further points out that:

> Nevertheless, it must be emphasized that the actions required must not be limited to making funds available, but also to create the right ecosystem to attract new businesses (research-performing) and help existing ones to diversify (beyond just providing research funding).
>
> Chamber of Engineers (2021), p.12

Eurostat data shows that Malta has a low rate of students in STEM related areas (11 per thousand of population aged 20-29) compared to an EU27 average of 20.8. Only Cyprus and Luxembourg have lower numbers, 10.2 and 3.9 respectively. The study makes certain recommendations: Malta as an innovation hub, particularly for the Southern Europe region; incentives in the form of tax rebates; other forms of incentives to mitigate against the risk and long-term factors which investment in R&D entails; include R&D&I as a condition in tender for capital projects; a tripartite space in the form of a National Research Centre; support of a business nature to researchers to encourage them into entrepreneurship;

boosting of public funding particularly for doctoral and post-doctoral research and also for participation in European Research Areas; facilitation with more public engagement and dissemination of research potential; and finally increased promotion of the Malta Intellectual Property Awards.

Another important study on the research and innovation system in Malta was conducted by the European Commission in the form of a peer review. This was requested by the Maltese Government under the Horizon 2020 Policy Support Facility (PSF). The report sees investment in R&I by both the public and private sector as urgent.

> More leadership, participation, synergy and transparency together with long-term investment are vital to Malta's R&I future, and the sooner the better.
>
> European Commission 2019

R&I investments do not produce immediate results or benefits and thus there is a need for long-term planning. The experts also indicated a need for a reform of the education system at all its levels. They maintained that transparency and strategic changes in how the funding is allocated is needed. The experts called for 'open minds and political boldness' to ensure that more investment is undertaken by both the public and private sector, as the future prosperity of the country depends on this. Since R&I impact all sectors of the economy, a Ministry dedicated solely to Research and Innovation, a R&I Champion, was recommended.

The experts pointed out that at a time of high economic growth and low unemployment governments tend not to think of the longer term, however, it was advised that R&I be embedded in the development strategy of the country, so that the country and its indigenous companies would be able to compete in a global knowledge-based market. The report also recommends a new Malta Research Fund for public research institutions whilst calling for incentives to encourage more private sector investment and public-private partnerships. There is also a need for more internationalization of the Malta R&I system and for more collaboration with international partners.

Table 7 - Peer Review Recommendations

Recommendations	
1	A specific Ministry for Research and Innovation (a Champion)
2	A Consultative Forum representing all stakeholders (companies, HEIs, public research organizations and society)
3	Smart Specialization Strategy (RIS3) (areas are insufficiently known, more publicity needed)
4	Establishing a Maltese Research Fund (for competitive funding of basic and applied research)
5	MCST as the 'policy intelligence unit' to manage funds (instruments are presently very fragmented and there is no assessment of outcomes)

Source: European Commission 2019.

Table 7 summarises the main recommendations. The report called for more coordination and simplified instruments. There was a need to raise awareness and provide more guidance. The multiple schemes already in place for start-ups needed to be fully integrated into an 'easy to navigate' innovation support system.

The last significant report was published by MCST and is the National R&D Monitoring Report 2019-2020. This follows on the first monitoring report of 2018 and gauges the effect of the 2014-2020 R&I Strategy. The Strategy had set out certain targets to be attained by 2020. These are shown in Table 8, where both the results of the two monitoring reports are presented to show progress. The two areas, highlighted in light green, where Malta has managed to reach and even supersede its target, are in the number of Ph.D. holders as a percentage of the active population and in the number of researchers, expressed in full-time equivalents. In two other areas (highlighted in coral), Malta has seen a decrease from one monitoring report to the other. These areas are employment in knowledge-intensive activities and innovation expenditure.

Table 8 – 2020 Targets and Actual Achievements

Headline Indicators	2020 Target	2018 Result	2020 Result
R&D expenditure as a % of GDP	2	0.54	0.61
Ph.D. holders as a % of active population	0.6	0.89	0.84
No of researchers (expressed as FTE)	900	894	961
Enterprises with innovation activity as a % of total enterprises	50	27.06	37.8
Employment in knowledge-intensive activities as a % of total employment	55	47.1	40.3
Innovation expenditure as a % of GDP	2.5	1.39	1.35
Enterprises with innovation activity in the Core NACE codes as a % of total enterprises	60	33.9	46.54

Source: Adapted from the two monitoring reports. MCST 2018 and 2022.

This section has shown that there are significant areas where Malta needs to improve to increase its research and development potential. Although size appears to be an impediment to a wide- ranging spectrum of R&D, nonetheless the future is likely to dictate that more attention be given to this area, not only because countries will need to keep up with increasing competition worldwide but also because the exploitation of bigger markets in this area may not have been given enough attention. According to Bruno Lavin, co-author of the 2021 GII Report, governments need to prioritise innovation and show that it is important in their policy-making. Furthermore, the EU offers a supporting system to create networks which may not have been realized and exploited fully. Although such networks do exist at the basic research level with higher education, there are also possibilities for industry in belonging and profiting from such networks as well.

The New Economy

The term 'New Economy' "describes aspects or sectors of an economy that are producing or intensely using innovative or new technologies" (OECD 2021). The term was added to the OECD glossary in 2004, as a reflection of the 1990s when the internet and high-tech tools seemed to be on the verge of taking over the global economy, in terms of their ability

to be faster and more efficient in the production of certain goods and services, going so far as anticipating the replacement of many traditional manufacturing ventures as they were known up to that time. Time magazine discussed the new economy as early as 1983, speaking of 'boundless opportunities…in esoteric fields as microelectronics, lasers, fiber optics and genetic engineering', all everyday words forty years later. The concept initially mainly focused on those areas which relied more on the use of computers, telecommunications, and the internet, to not only produce but also sell and distribute the goods and services offered on the market. It was part of the hype surrounding the tech bubble, at a time when technology was seen to be making headway into every company, business and even households. Some merely saw the new economy as related to technology, but others later focused also on knowledge, data, e-commerce and much more.

In a sense the New Economy is new but there have been many 'new economies', as history has shown. Joseph Schumpeter in 1911 classified innovation in five forms: the introduction of a new product or new product quality; the introduction of a new method of production; the opening up of a new market; the discovery of a new source of supply or input; and the creation of a new form of organizational set-up. He coined the term 'creative destruction', meaning that for something new to be created it must destroy what it was replacing. The world economy continues to develop, grow and be innovative. If one looks at the last two hundred years alone there have been so many 'innovations' and disruptions to the status quo of that time. The world has seen different types of inventions changing daily lives.

Whilst the new economy in the 1990s referred mainly to technology and the internet, this now includes any new type of economic activity or the way the economy is organized, or the methods of production, or any innovation which changes the way things have been done since its appearance. This means that the new economy can refer to the streaming economy, the sharing economy, artificial intelligence, the gig and platform economies, cloud computing, data science, etc. Others are seeing all this as Industry 4.0 or in other words, as the Fourth Industrial Revolution.

After the bursting of the tech bubble, certain global tech companies continued to grow and have in fact grown bigger than traditional manufacturing entities. Moreover, the latter have become more automated and more dependent on innovative technologies. Services are

also getting a bigger share of the global economy. So, the new economy of the 90s might have been seen in a different light than the new economy which developed in the following decades and continues to develop now.

Economic activity has intensified online and there are more players and emerging economies in the international arena. All this intense activity in the past two decades has put more pressure on the world's resources but has also provided for more competition and the need for businesses and national economies to keep abreast with developments and accept innovations as part of their new futures. This same activity has also led to more militancy from civil society, who see global warning and the destruction of nature's equilibrium, as brought about by the unrelenting quest by man for more and more. This has pushed the attention to sustainability issues, taking on not just an economic perspective but including a social and environmental dimension. All this with the attention turning to concepts such as the green economy and trying to push innovation towards areas where they do less harm to the world: to safeguard that natural world for future generations, and to present more equitable societies. A balance between the need to push for more and the need to retain global environmental resources has not always been easy to find. However, what remains certain is that change is constant and rapid, and knowledge is the best and most powerful tool for workers and businesses alike.

The truth is that in certain industries there are less people engaged in manufacturing, where some of the work has been taken over by computerized machinery. Yet, economists maintain that whilst jobs will be lost in the coming years, they will be replaced by new types of jobs, more attuned to the technological economy. Some jobs will be lost forever, others will change, yet others will be overtaken by new systems and there will be completely new jobs on the market as well. The World Economic Forum Report of 2020 on the Future of Jobs estimates that by 2025, "85 million jobs may be displaced by a shift in the division of labour between humans and machines, while 97 million new roles may emerge that are more adapted to the new division of labour between humans, machines and algorithms" (WEF, 2020, p. 5).

This new economy includes artificial intelligence and deep learning. This refers to machines that can be programmed to analyze data and provide solutions, but also to continuously learn and use new knowledge gained to solve complicated problems, thinking and learning almost like a human being. While such technology has been accepted as having significant potential to increase productivity, many companies have not

adopted this technology mainly because of the steep expenses involved. On the workers side this means that present skills gaps will continue to increase. This upskilling and reskilling need is expected to impact almost all workers, in whatever field they may be working. This new economy thus requires skills which are not usually taught in schools or are part of the on-the-job training programmes and include, 'critical thinking and analysis, as well as problem-solving, and skills in self-management such as active learning, resilience, stress tolerance and flexibility (WEF, 2020, p. 5).

According to Castells (2004) the new economy is based on three pillars: productivity (the application of knowledge and innovation); competition in a global environment; and performance based on networking. This provides for significant food for thought. One, that innovation and knowledge need investment and if this investment is not available, then productivity is likely to take a downward hit. This is particularly more acute because no person, business or country operates in a vacuum but must compete in the global economy. Moreover, the 17th century phrase no-man-is-an-island remains as relevant as it was almost four hundred years ago and simply implies that performance cannot rest on the activity of one person or one business but needs to be based on the supporting system surrounding that person or business, on the concept of networking. Networking is ever more evident online but existed earlier in person. Nonetheless because of the global reach the online networks transcend physical borders and render the world a smaller place. These networks are the more important for smaller countries such as Malta.

Ten years ago, Industry 4.0 became a strategy which many countries continue to adopt today. In late 2020, the EU issued its Industry 5.0 strategy. This has taken a new perspective, whilst still accepting efficiency and productivity as two of its goals, it pushes for the contribution that industry can make towards society. The new strategy whilst completing and complementing its earlier sister, puts 'research and innovation at the service of the transition to a sustainable, human-centric and resilient European industry' (EC 2021). Whereas the focus of I4.0 was the production process, Industry 5.0 "places the wellbeing of the worker at the center of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet" (ibid.). This new focus is thus wider and includes the worker as a human in the process, and the sustainability of a green-focused economy. The strategy is expected to bring benefits not only in terms of industry but for workers, society and the environment. It covers a more holistic perspective. From a worker's view, it aims to continue to provide training needs and skills, to retain the value and relevance of the worker in an ever-evolving economy, and

also helps to attract the best people to newly created jobs. The strategy also focuses on the physical world, with concepts such as the circular economy, meaning making more efficient and sustainable use of the world's depleting resources. Covid-19 brought new stark realities and Industry 5.0 can be organized to deal with the development of resilience under such shocks, by reviewing for example the existing practices of energy consumption. Many current EU policies feed into this strategy such as the Digital Education Action Plan, Skills Agenda, Proposal for AI regulation, Green Deal, and the Industrial Strategy. A new policy brief on Industry 5.0 is currently being developed by an expert group. The January 2021 Report is titled 'Towards a sustainable, human-centric and resilient European Industry", which in essence sums up the goals which this strategy aims to achieve.

Since the new economy encompasses a wide range of economic activity, it would be difficult to measure the whole range, however, there are certain statistics which can provide an indication of the type of resources being utilized, in terms of inputs and their subsequent outputs. These include indicators presented in Tables 6 and 8 above.

The sections above have set the background information regarding the issue of R&D and the new economy in Malta. It has also presented the situation of Malta in terms of its competitors in the EU and globally. It has presented some studies which have looked at the role of R&I in Malta and the problems associated with this.

3. Research Findings

National and EU Supporting Entities, Policies and Strategies

Malta Enterprise (ME) and the Malta Council for Science and Technology (MCST) are the two main government entities which offer funding programmes for research and innovation. The Ministry for Equality, Research and Innovation (until March 2022) also had a small programme of innovation funding for NGOs and VOs, that is the Community Science and Innovation Scheme. This is only for projects not exceeding €10,000 and the whole programme for 2022 is for the total amount of €150,000.

One of the roles of Malta Enterprise is to offer support and incentives to innovative companies. By November 2021, it had a total of 33 schemes running. These schemes can take the form of soft loans, guarantees for bank loans, grants, fiscal incentives or subsidies. Schemes such as 'Research and Development 2020' are specifically focused on investment in R&D, while Patent Box Deduction established a fiscal regime for income deriving from any form of intellectual property rights. Other schemes specifically target innovations, such as Investment Aid for Energy Efficiency Projects, Smart and Sustainable Investment Grants, Micro Invest, and EUREKA Instruments. Yet other schemes focus on upskilling, reskilling or aid to import skills not available locally (Qualifying Employment in Innovation and Creativity). Other measures relate to family businesses, COVID 19 effects on businesses and schemes regarding the growth possibilities of companies.

MCST is seen as the main entity which manages national funding for R&I. These include: FUSION which incorporates,

- The Internationalisation Partnership Award Scheme (IPAS+) that strengthens the collaboration of Maltese entities with international centres of excellence and support the development of proposals for European R&I funding,
- The Research Excellence Programme (REP) which supports basic research funding through a broad, non-thematic based approach and
- The Technology Development Programme Lite (TDP Lite) providing funds for applied and fast-paced research.

More recently the Covid-19 R&D Fund was established. Furthermore, MCST is the contact point for Horizon Europe in Malta (this is the EU's key innovation funding programme with

a grand EU budget of €95.5 billion). Furthermore, MCST has an internationalization unit which provides for several initiatives leading to collaboration with partners abroad. These include PRIMA, MSCT-TUBITAK, JPI Oceans, SINO-Malta Collaboration, Blue Bio Med, and Third Country Researchers.

Latest data (December 2019) shows that there were 133 projects under the Horizon programmes, involving 179 Maltese entities. This meant a total of €25.3 million in EU funding. In terms of national funding, 246 Maltese entities participated in the commercialization voucher programme, of which 113 applications were provided with funding, reaching €1.9 million. There were 79 applications for the technology development programme, where 44 were eventually funded, accounting for €9.2 million (Ministry for Finance, 2020, p.32).

The National Reform Programme of Malta for 2020 points out that,

> Malta's Research and Innovation (R&I) is currently defined by the National Research and Innovation Strategy 2020, with the primary objective of addressing deficits and gaps in the R&I ecosystem by including more investment in Research and Development (R&D), addressing skills gaps, facilitating science-business links, and including the set-up of a more effective governance of the R&I system. The Malta Council for Science and Technology (MSCT) is currently working on the development of the National R&I Strategy post-2020 and the updating of the smart specialization strategy (RIS3).
>
> Ministry for Finance (2020), p. 31.

The following are considered as the policies and strategies which in different ways relate to R&D and the new economy (the green, sustainable, digital aspects), including policies related to employment and education. Some are awaiting updates or new strategies altogether, as many of these strategies were linked to the year 2020.

- National Research and Innovation Strategy 2014-2020
- National Environment Policy 2012- 2020
- Malta's National Energy Efficiency Action Plan 2012-2020
- National Digital Strategy 2014-2020
- National European Research Area Roadmap Malta 2016-2020
- Operational Programmes for European Regional Development Fund and Cohesion Fund 2014-2020
- Malta National Lifelong Learning Strategy 2020
- National Youth Policy – Towards 2020 (published 2015)

There are other strategies which stretch out beyond 2020

- Framework for the Education Strategy for Malta 2015-2024
- The Malta National AI Strategy (2019)
- Green Public Procurement National Action Plan 2019–2025.
- The National Employment Policy 2021-2030
- National Post-Pandemic Strategy June 2021

The most recent and relevant documents include:

- Malta's Research and Innovation Smart Specialization Strategy (RIS3) 2021-2027 Consultation Document (October 2020)
- Malta's Economic Vision 2021-2031 – A Future-Proof Malta.
- Malta National Space Strategy Consultation Document January 2022.

Older policies (which may need updating) are relevant in terms of the skills needed for the new economy, such as: the National Vocational Education and Training Policy (2015), A Higher Education Strategy for Malta (2015), A Strategic Plan for the Prevention of Early School Leaving (2014), the National Strategy for the Cultural and Creative Industries (2012), and A National Curriculum Framework for All (2012).

Malta's Research and Innovation Smart Specialization Strategy (RIS3) 2021-2027 Consultation Document issued in October 2020 supports five thematic areas considered as important economic niches: health and well-being; sustainable use of resources for climate change mitigation and adaptation; smart manufacturing; marine and maritime technologies; and digital technologies. The goals included in the Strategy relate to 'improvement of the national R&I system, supporting industrial transition and internationalisation' (Ministry for Equality, Research and Innovation 2020, p.65). Funding for these thematic areas is expected to be provided from national and EU sources. EU sources include the European Regional Development Fund (which could aid in the internationalisation initiatives, the research infrastructure, incentives for industry to innovate, and support for R&D excellence). It is acknowledged that EU funds form a significant part of investment in R&I. However, there are also national funds which can be used to complement such investment. Apart from the existing programmes, which are competitive, the strategy also suggests institutional funding for smaller projects. It also calls for more collaboration between industry and academia and the need for more support to business. The final form of funding is for capacity-building in the way of scholarships,

training and reskilling/upskilling programmes. These would mainly be supported by the European Social Fund.

According to Article 179 of the Treaty of the EU, the

> 'Union shall have the objective of strengthening the scientific and technological bases by achieving a European Research Area in which researchers, scientific knowledge and technology circulate freely and encouraging it to become more competitive, including its industry, while promoting all the research activities deemed necessary'.

Articles 180 to 190 set out the activities which sustain this goal. The Framework for state aid for research and development and innovation was laid out in 2014 and is justified on the basis of Articles 107(3)(b) and 107 (3)(c) of the Treaty. On the EU side, the most important Innovation funding programme was Horizon 2020, with a focus on research and collaboration between local and at least two other member states. It was a seven-year work programme and the grant would be disbursed upon approval of the final report.

The new Innovation Fund is the largest ever, featuring a total of €10 billion. These large-scale projects are past the research stage but may not be bankable, but the EU considers them as very innovative in terms of their low-carbon technologies and their flagship characteristics merit funding support. The main objective is not research but rather the application of that research so the focus is on the large-scale operation of industrial assets with breakthrough technologies. The selection criteria have also changed and become more linked to technical, business and financial availability. Lump-sum payments can be made when certain milestones (as part of the project) are reached. And the calls for applications can be adjusted and changed annually. The assessment of the proposals is linked to EU policies and strategies, and the assessment criteria include the GHG emissions avoidance, scalability and cost-effectiveness of the project, the maturity of the project and the degree of innovation involved. If the project is not deemed mature enough then it can still get funded through the EU's Project Development Assistance programme. To assess the maturity aspect, the application needs to be accompanied by a feasibility study which assesses the technical aspect, a business model which considers the economic perspective, whilst the legal perspective will also be appraised.

This section has provided information regarding the policy framework and the institutional support, all required as the basis for the eco-system. The next section provides the results from the various interviews, focus groups and limited questionnaires.

Results of the Interviews and Focus Groups

Annual Country Reports for Malta issued by the European Commission, maintain that local companies do not have adequate access to finance to foster research and development initiatives. There are several local entities, such as Malta Enterprise and MCST, which do offer funds for R&D, and there are also EU funds available under many programmes. National Fusion funds under MCST are all taken up, however funds under the internationalization programme are not fully absorbed, while there is no apparent finite budget under ME. Therefore, the issue may not be the availability of funds, but how difficult such access is envisaged by the local companies, particularly in view of the small size of most of business entities.

According to several interviews held with representatives from ME, there are certain schemes offered by ME which are favoured by applicants. The first is the R&D 2020 mentioned earlier, which also caters as the local funding programme for EUREKA and EUROSTAR. Another scheme which provides for feasibility studies (Exploring Research Grant) is not really an R&D scheme but is considered more as a first step towards R&D. Malta Enterprise deals with two types of R&D: industrial research and experimental development. Through the EU funding programmes it encourages collaborative R&D. Not all applications received eventually end up being funded. Some are turned down because they are not eligible. However, over the years, the number of applications is slowly increasing. When asked why companies do not apply for such funds the ME representative replied that there could be a variety of reasons: the process may be seen as too bureaucratic; small companies do not usually have the capability to fill in forms so they normally hire a business consultant, which can be expensive; schemes may not be known to all companies and many may think the programmes do not apply to them; others may think they are not eligible. In this regard, ME might need to engage in more marketing and a wider, more focused outreach to potential clients. ME also has a programme: Erasmus for Young Entrepreneurs, which offers short training programmes and exchange programmes abroad. One interesting observation made was that during 2020, Covid19's first year, some companies utilized the resources and idle time to switch to more R&D. ME in collaboration with the Malta College for Arts, Science and Technology (MCAST) operate an Incubation Centre for young entrepreneurs, to encourage more entrepreneurial spirit, relevant to the students at MCAST, by helping them set up their own business. ME also engages Relations Managers (RMs), who interface with companies. However, R&D is more

technical and thus needs more expertise by the RMs. The RMs would need to meet with the company and assess its capabilities and the funding process, which may be lengthy and complex, and thus off-putting.

The representatives from MCST explained the various programmes which are managed by the entity. FUSION, derived from national funds, is the most popular and although the amount has been slowly increasing every year, the fund is always taken up completely. The funds have increased from €1.6million to €5.3million in 2022. FUSION is normally considered as the first step before fully embarking on other programmes under Horizon Europe. On the other hand, the internationalization programme funds are not always absorbed, although absorption has been increasing. Before 2019, only one person was employed to run the latter programme, but the number of staff has now increased to a total of five persons. Applications for this depend on the capacity and interest of local entities to engage in internationalization initiatives. There is PRIMA (Partnership for R&I in the Mediterranean) which is based on two sources of funding: one directly from EU funds; and the other from national funds, where there is a commitment of €500,000. PRIMA's focus is on three thematic areas: water, agriculture and farming. MCST provides support in proposal writing (for both PRIMA and Horizon programmes) and this scheme is locally funded. In 2019, the SINO-Maltese fund was launched, where 13 proposals were received and two were approved. The following year also saw 13 applications with three being awarded. At the time of the interview, MCST had 800 open calls. Furthermore, there are seven national contact points, who engage with the private sector. Plumtri.org is a R&I platform for researchers in the Mediterranean. There are tools for partner searches and a monthly newsletter to provide information. The newly launched Research Excellence Programme (under FUSION) has been operating for two years and it has received 72 applications and awarded 18 grants totaling €0.9million. A further 34 applications have already been received this year (2022) and are being processed. The Technology Development Lite Programme was only added in 2021 and in its first call 16 applications were received, with 5 projects granted funding for a total of €0.7million. Under Horizon 2020, Malta managed to receive over €37 million over the period 2014-2020. Its success ranked it in 10th place per number of full-time equivalents researchers.

The range of programmes and the support services offered should be very interesting for anyone wanting to find funding for his or her ideas. But the process can be complicated. For example, PRIMA is more international and thus one needs to find partners. Even if the

project is very good, there is no guarantee that it will get chosen, because of over-subscription and exhaustion of funds. This is due to a ranking system for projects. Thus, if the country's share of funds have already been used up by other projects, some good projects do not get funded. There is intense competition for funding. Success rates are about 15%, (14% for Malta) for EU funding. There can also be issues with state aid and with GDPR legislation.

Many may find it difficult to dedicate their attention to the programmes, due to the many requirements, time commitment, the problem of finding partners, and the time to grant (about eight months) may be too long for someone who has an idea to test out. Furthermore, it is often difficult for Maltese entities to act as leading partners and it is more likely that they form part of a consortium led by another member state. The capacity for coordination is complicated, both in terms of the human resources but also the expertise needed. An added complication is how to form part of a consortium. There are established networks who continue to work with each other and apply as a network for projects. Forming part of these established networks is not easy, as they are often closed networks. Once a consortium becomes established the likelihood is that it continues to work together. But once someone becomes a part of a network than one of the biggest hurdles has been surpassed.

For local funds, the success rate is somewhat higher, standing between 33 and 50 percent. This does not mean that the process is more plain-sailing or that there is no competition. Some entities consider the process very bureaucratic. The private sector began well but that success petered out, as the University of Malta became more efficient in applying for funding. The University has a bigger pool of resources and expertise and even set up a whole unit providing researchers with support services, and thus is more likely to be successful in getting funding. In fact, in the last round, the University got 16 projects funded, while the whole of the private sector got 11. Nonetheless, MCST has noticed that private sector engagement is increasing. The year 2020 also saw more applications being submitted, either because of idle resources during the pandemic or because it was the last year for Horizon 2020.

When companies are not successful, sometimes due to their not reaching the quality desired, they are provided with feedback and encouraged to re-apply. So, the opportunity of resubmission can also be seen as a means of improving on the first application.

The application process is tougher for smaller entities. In fact, larger companies, the University of Malta and MCAST are more likely to be successful in acquiring funding, as they have more time, the resources, capacity and expertise. Some companies in the private sector have become more active. MCST noted that it needed to engage in more outreach and publicity for its programmes. But the companies also needed to be more courageous and apply if they believe in their ideas. One scheme offers the possibility of hiring a consultant (€6000) to produce the documentation needed and the filling up of the forms, although it was acknowledged that it is often much better if the owner of the business does this him/herself since there is nobody better than him/her who knows the company and its characteristics and inner workings.

Experts in the field maintain that research in Malta never developed as a pillar in its own right as an investment. On the contrary it is considered as a cost centre, the meaning being that it is difficult to recuperate the money spent. One of the main problems seen by the experts is the fact that a fully functioning eco-system is not in place, and therefore anyone wanting to engage in R&D is navigating and vegetating on their own. Furthermore, since the local market is small, testing out marketable ideas is more problematic.

According to the EU Commission's 2019 Country Report for Malta, "R&D is largely dependent on foreign direct investment, while domestic innovation is lacking". The latest microdata provided by NSO (personal communication) shows that the gap may be slowly closing in this respect. Table 9 provides the figures for 2013, 2014 and 2019. The figures indicate that the GERD has risen from 50 to 80 million in a period of six years, however this has not increased the percentage to GDP rate. The reason for this is that GDP growth outstripped the additional investments in R&D. The role of business in such investment has increased marginally from 61 to 62% of total GERD. But the share of local resident businesses investing in R&D has increased more, from 28.8% to 44.2%. The amount spent by MNEs whose head office is in Malta has declined to just 0.69%, while the remaining 55.07% were invested by MNEs who have a business unit in Malta. This figure was 84.6% in 2013. This analysis shows that R&D investment has slowly increased (not as a percentage of GDP but in value terms) and that the share by local enterprises has increased more.

Table 9 – Local and Foreign R&D in Malta

€000s

R&D Investment	Description	2013	2014	2019
Total GERD	Gross domestic expenditure on research and development	**50,057**	**60,538**	**80,050**
Of which: Total BERD	Business enterprise expenditure on research and development	30,544	33,459	49,600
Divided into:				
1) Independent business enterprises and all resident groups	Units, part of a group of units resident within the country/economy for which BERD has been compiled only	8,797	9,266	21,943
2) Multinational enterprises	All MNEs or units of an MNE operating with a country/economy	21,747	24,193	27,657
A) Multinational group domestically controlled		3,343	2,014	344
B) Multinational group foreign controlled	Units which are part of an MNE structure, which has its main structure of decision-making, <u>within</u> the country/economy	18,404	22,179	27,313
	Units which are part of an MNE structure, which has its main structure of decision-making, <u>outside</u> the country/economy			

Source: NSO 2021 (personal communication)

Yet the experts agreed that the funding solution is not that difficult, in fact funds have been increasing each year for the past years. Moreover, government could encourage more R&D by offering some forms of tax credits. For example, if a company invests some of its profits back into its R&D department, then that amount need not be taxed and even some of the profit derived from that R&D could be untaxed for some years. All this will serve to

encourage more companies to invest in R&D not only for immediate profits but more so for successful implementation and eventual benefits deriving from that initial investment.

More problematic to set up was the creation and maintenance of an eco-system. Here incentives would be needed as well. The expertise, the framework, the support services, the costs of testing are all issues which need to be tackled together. For example, there could be agreement to have a clustering of testing facilities. One expert had even suggested Quality Centres where ideas could be allowed to develop and then these are leased to industry. Furthermore, clusters based on themes could be developed, for example such as the Maritime Centre of Excellence. Perhaps one of the main elements which are missing are 'ideas', and this could come to fruition if Malta was able to attract more foreign high-level universities. One expert referred to the Barts Medical School in Gozo, which had left €20million in Gozo's economy and to the hospital having trainee medics within it for the first time. One expert specifically said that one must not look at research as a type of literature review. While that is important, the economy needs more than that. Another suggested that Malta needed to build on what it already had, such as aviation, pharmaceuticals and AI/electronics.

The Chamber of Commerce's representative pointed out that in their pre-election document 'Time to Step Up' they offer recommendations for government for 2022-2027. Research and Innovation is referred to on several occasions, including, the role of the Malta Development Bank, Item 19 under Pillar 1 (Economic Recovery, Resilience and Growth). The Chamber calls for support in the form of adequate funding programmes, the promotion of knowledge transfer between academia and industry, incentives to utilize Malta as a test bed, financial assistance for international IPRs to mitigate the high costs involved, and a tax allowance on R&I investments. R&I is specifically referred to in terms in two areas: construction waste, and agriculture and food production.

The next innovation strategy had not yet been approved (at the time of writing) but the consultation period for the Smart Specialisation Strategy (RIS3) was over. The important aspect was the need for different areas to work together, the systems of finance, science, academia and the economy needed to work in synergy. One expert suggested that Malta Enterprise then needed to provide incentives to get research operations fitting into the overall strategy.

Interviews held with several engineers suggested that there were multiple issues pointing to the low level of R&D in Malta: funding, human resources, adequate programmes, the size and type of companies, and the weak 'ecosystem'. But apart from these issues which every interviewee seemed to agree upon to different degrees, one engineer suggested that local businesses do not think big enough. In terms of human resources, data shows that there are less students applying for engineering courses and this could be attributed to other areas in the economy, such as finances and gaming, that were offering more lucrative salaries. However, the number of Masters and PhD students in engineering had been increasing. Yet calls for post-doc positions with the Faculty do not receive applications from locals or even EU citizens, but rather from Asia and South America. Unfortunately, after the training and posting, they tend to return home and that is a brain drain for Malta. The size of the companies makes it more problematic for them to afford the risk associated with R&D. The issue is compounded due to the small size of the local market, which often means that the testing of the new product may not always bring with it the true response to it, making R&D riskier. Furthermore, the culture of local companies is more tuned towards a quick return on investment, while that of R&D is not only riskier but if successful is gleaned in the longer term. One engineer even suggested that some companies were more reserved in their existing knowledge and did not have complete confidence in IP protection. The share of manufacturing companies in Malta had decreased, giving way to more service-oriented companies. This meant that applied and experimental research were less likely to be envisaged or applicable.

The University of Malta has very good structures in terms of research and one can find some very good teams working together. For example, the engineering and medical professions collaborate on several projects. One example is a type of material which is more robust and longer-lasting to be used for hip replacements. Asked about the type of relationship academia has with local businesses, one academic said that the latter are more likely to use the university as a consultant, to solve problems they may have, so asking for the services of experts in the field. At other times the University is used as a testing ground, that is to help in the testing of the feasibility of some product or as a way to synthesis existing knowledge. Business may have knowledge about the type of programmes which several entities offer to those interested in investing in research, and often the businesses see those programmes as adequate but applications are too complicated.

One of the questions asked to the interviewees was what drove some companies to invest in R&D and not others. When it came to foreign companies in Malta, these were decisions

driven by corporate strategies of the head-office. Some had set-up not for R&D purposes but only as manufacturing operations. Yet some had over the years consolidated their R&D in Malta, servicing various functions of the corporation based abroad. Foreign companies were generally pleased with the local workforce as they saw them as flexible and the close proximity also helped.

The Life Sciences Park also hosts R&D activity. This takes the form of R&D laboratories and offering support to R&D, such as customer feedback and support. One example is generic pharmaceuticals where the aim is to develop a different path to manufacture. At first small amounts are involved and this is done abroad. The scaling up is then undertaken in Malta, where iterations are needed (in reality this part is not normally counted as R&D but as part of the manufacturing phase). There were some success stories and these concerned a few local businesses such as engineering, IT and even a furniture maker.

One expert disagreed that there is not much interest from local businesses. Sometimes it is more the issue of quality or inexperience which hinders an application from being accepted. In one instance there were about 50 applications but only 3 eventually were able to move on. According to this expert, our companies are not necessarily capable of R&D, so some do not realize the long-term process involved with deliverables, stages involved etc. The application reflects significant preparatory work which not everyone appreciates, and it involves planning, (including desk research, checking for prototypes, and earlier patents submitted) for the project to be successful, meaning attention to detail and rigour in its preparation. For this reason, one finds that many applications are not up to standard. Applicants are not outrightly refused but asked to fill in the missing gaps. There is also a distinction between R&D for a good and for an IT product. Regarding the eco-system, this expert said that the local culture may be to blame, as the workers are not necessarily given the opportunity to bring their ideas forward. Furthermore, those ideas may not be enough for the country to increase the potential of increased investment in R&D. The expert thinks that local people do not have enough external exposure or confidence in their ideas.

This seemed to concur with some of the thoughts from the Commerce department's interviewee. Knowledge about intellectual property rights was still relatively small, particularly those dealing with patents. It was less of an issue with trademarks and designs. The European Union Intellectual Property Office (EUIPO) generates revenue which is then utilized to upgrade IT systems in national offices. Such IT tools which Malta invested in are very advanced. Each year, the Malta office has a grant to the tune of a quarter of a million

euros from the EUIPO, to disseminate knowledge about IPOs. The Office also offers deployed assistance, meaning EUIPO pay for human resources to directly deal with SMEs. However, SMEs do not seem to see it as important to protect their IP. There is also the impression that this can be an expensive objective. Protection comes at only €115 for ten years, and for SMEs this is lower at €65. There are schemes in place to support SMEs as well. In 2019, the SME Fund was set up and this gave the opportunity for discounts on fees payable. In 2021 this discount amounted to 50% and in 2022 this increased to 75%. In 2022 it is hoped that Malta ratifies the Madrid protocol which means it can also process international IP. Any person anywhere in the world can apply for a trademark/design for protection in Malta. For a patent only EU citizens can apply in Malta. The Department receives on average about 2000 applications for trademarks and designs per year, but only about 10 for patents, as there is a preference to apply at the EU level for patents. From the filing date one has instant protection for 18 months until the market for the product is found. The service is offered online on a 24/7 basis. The Malta office is more focused on the registration process, that is the operational side. There is less attention to strategy or research on the role of IP on the economy. However, evaluation is still present through the annual IP awards. On the EU level, a new directive will provide additional protection to recent innovations in trademarks such as jingles, slogans, holograms etc.

There was general agreement from many interviewees that unfortunately the research culture is not yet ingrained in the minds of local businesses. However, the eco-system whilst certainly not complete, has improved in recent times. R&D dealt with uncertainly and local businesses already had a lot of uncertainty due to the small internal market and the complication of insularity. Furthermore, the time element related to R&D projects did not work in favour of local businesses, who saw the realization of programmes on the ground as taking too long. There also seemed to be the impression amongst several interviewees that not all R&D being carried out in Malta was captured in the statistics. Companies undertaking R&D needed this to be shown as a separate cost centre and this was not always in place for certain businesses, some not having the capability to record their activity as actual R&D and thus such activities flew under the statistics radar. In this sense incremental innovation to improve the workings of businesses could be occurring but not being recorded as such. There was also general agreement that the educational system needed to nurture the creative nature in children more and needed to encourage more children to become interested in STEM subjects from an early age.

Both the Chamber of Engineers and the Chamber of Scientists agreed that there is a need for more marketing of these two important areas within society. More needs to be done to encourage young children to become interested in such potentially high value-added economic sectors. Initiatives such as Esplora and Science in the City help to increase awareness of the role of science in everyday life. But these appear not to be sufficient to increase the number of students who eventually choose these topics at a higher level. More publicity aimed at young children and their parents needs to be provided at regular intervals so that it becomes a part of everyday living.

Malta has several success stories it can offer. The Technology Development Programme which started in 2015 can boast of 59 projects worth around €12million in R&I funding. These have generally included collaborations between the University of Malta and a business entity (such as DataDear, HDMS, Flasc and Innovled). In terms of EU funds, Malta has benefitted from 192 Grant Agreements (such as MARCAN, TAPAS, ProBOS and REDAlert), with the latter two dealing with cybersecurity.

It was also pointed out that from the five recommendations of the Peer Review of 2019, some have already been accomplished while the accomplishment of others is in the pipeline. The R&I Champion (in the form of a Minister dedicated to these areas, even if in 2022 they form part of a much larger Ministry which also includes, Education, Sports and Youths) was set up. The Consultative Forum is expected to be set up once the new R&I Strategy is approved by Cabinet. The new Smart Specialization Strategy has recently been published for consultation. The Strategy still needs more publicity for people to be familiar with what it represents. There is no specific Maltese Research Fund, but funds have been increased and a specific new funding programme was established in 2020: the Research Excellence Programme, with supports basic research and early-stage development of innovative projects proposed by public entities, higher education institutes and industry. The fund falls under FUSION's portfolio, funded by Government and managed by MCST. All policy documents are issued by MCST and it also manages local funds.

> Looking ahead, investment in local R&D can be further incentivised by means of ensuring investment in research infrastructures, improving the international outlook of the Maltese research community, further improving the carrying capacity of research performing organisations, attracting RDI-performing FDI to our jurisdiction including by targeted tax credit schemes, and improving employment opportunities for PhD and post-doctoral graduates. Such measures need in turn to be all securely backed by a strong governance framework, capable to (sic) undertaking the necessary regular evaluation and monitoring.

Dr Pullicino Orlando, Chair of MCST (2022)

Much has been achieved since the 2019 Peer Review, according to the Chair of MCST. Most notable of this was the establishment of a political Champion for R&I, and the broadening of opportunities for funding under the FUSION range of funding programmes. There has also been increased used of evaluation tools, including an evaluation of the FUSION programme itself. The Peer Review was specifically requested in order to inform policy-makers and feed into the post-2020 national R&I strategy, which awaits Cabinet approval.

Most of those interviewed, whilst pointing out the advances Malta has made in recent years, emphasised the need for R&D. Most agreed that the eco-system remains undeveloped, and fragmentation is still present. There is a need for all stakeholders to appreciate better the fact that more attention is necessary, and collaboration and coordination must be of a higher nature. Malta cannot afford to miss out on the opportunity to increase its R&I potential as otherwise it runs the risk of being left out of external networks, which it cannot afford at this particular stage.

> If matters continue as they are and R&I will remain a marginal part of Malta's economic narrative, and over time as our counterparts in Europe and elsewhere invest more and better in R&I, we will become increasingly marginalised, and unable to collaborate internationally.
>
> Dr Pullicino Orlando, MCST Chair, 2022

Results of the Questionnaires

The response rate of the questionnaires unfortunately was disappointing and cannot be considered as representative of the business community. Although several entities sent out the questionnaires with a reminder a week later, this only resulted in a total of 17 responses. The analysis based on these can only be considered as indicative. However, the lack of response is itself data, in that there appears to be disinterest in the topic. This can be due to many reasons, including, the knowledge that the companies do not have the capacity to deal with innovation because of small size, the current unstable situation where other priorities exist, the overload of surveys which businesses are being asked to invest time in, and the fact that R&D is not part of their business model.

Of the seventeen responses, eight were micro, seven were small and one each of medium and large companies. They derived from different economic sectors. Nine entities had

aims of widening their market, while seven planned to invest in new technology and seven more to increase the number of employees. This implies that growth is the aim of half of respondents. Four companies said that they had expertise to fill in application forms for R&D funding purposes, but only three admitted having knowledge on funding programmes for R&D and three entities had the intent to invest in R&D. Only two businesses said that they had staff which were applying for R&D funding, with both businesses being micro. Three companies said that they employed persons to conduct R&D. Only one company said it had the expertise to engage in R&D, only one company had a specific budget for R&D and a R&D department.

Out of seventeen responses, only four indicated that they had invested in R&D in the past ten years, with twelve answering in the negative, and one indicating a response of 'maybe'. This concurred with earlier assertions during interviews that there were entities who were actually conducting R&D but this was not being shown in the official figures. Asked whether they thought that investing in R&D would increase their profit, eight replied a definite yes, five replied maybe indicating uncertainty about outcomes, while four were a definite no.

Asked if they thought that their business was operating as part of the new economy, seven replied yes, and seven replied no. Three entities did not reply to the question, which could indicate lack of knowledge of what the 'new economy' constituted. The businesses were then asked whether they had applied for any form of IP in the previous five years. Two companies had applied for a trademark, one for a design and one for a patent. Asked if they saw the Maltese economy changing much in the next ten years, most replied in the affirmative, three said that this would happen only in certain sectors, and one saw the economy changing but not much. None said that they saw no changes expected in the next decade.

The last two questions were open-ended and asked which areas of the new economy, were likely to grow in the next ten years. These varied across a wide range of sectors. Most responses included, AI, IT services, financial services, gaming, and the green and blue economies. There was also mention of digitalization, metaverse, transportation options, waste management, renewable energy, aviation, e-sports, engineering and electronics.

The last question dealt with incentives that would encourage businesses to invest in R&D. The replies included: financial incentives, tax credit and other fiscal incentives, better market research understanding, funding for industry-academia collaborative projects,

funding of experts to explore avenues to identify and promote new technology, sources of funding to support investment in the tourism sector, schemes focusing on specific areas of expertise, more research, and a continuation of the wage supplement. From the answers one can understand that there is lack of information about the various schemes already in place, including financial, tax, the financing of experts and collaborations. Thus, the few entities who actually made the effort to fill in a very short questionnaire, and thus were interested in the topic, appear to have limited information and knowledge of the schemes and incentives already in place.

Analytical Conclusion

Results shows that whilst the appetite for R&D&I is slowly increasing with local businesses, the Maltese traditional business model does not rely on research and innovation. There are several factors which are influencing and impacting on the level of R&D. There are different types of barriers which may be more complicated to remove, particularly in the short to medium term. These can be divided into four types of barriers: institutional, market, business model and external factors. Figure 4 depicts these barriers.

Figure 4 – Factors Impacting on Level of R&D

From the institutional factors, the most important is the incomplete eco-system. The 2019 peer review revealed the existing gaps in the system, mainly gaps in governance, fragmentation and low levels of funding. One of the recommendations was the need for an R&I Champion and this could be accomplished politically through the establishment of a Minister specifically for R&I. In 2020 a Minister for Equality, Research and Innovation was set up. In 2022, R&I became part of a bigger ministry, the Ministry for Education, Sports, Youths, Research and Innovation. The report also said that there was a need for more synergy between the different entities offering funding and the different stakeholders. However, the feel from the different experts interviewed showed that synergy is still lacking and the overall eco-system whilst improving remains far from ideal. The Consultative Forum has not as yet materialised, although plans appear to be for its establishment once the new R&I Strategy has been approved. Another recommendation was to increase the amount of funds available. While this is slowly being accomplished, for the present, such funds remain inadequate as oversubscription continues. Furthermore, businesspersons sustain that the process is complicated, time-consuming and there is not enough information available. However, there are information sessions continuously being organized and even one-on-one meetings for information can be held, but it seems that more hand-holding is needed throughout the process, which can be lengthy and may put certain businesspeople off. The results from the questionnaires, though limited, suggest that there is lack of adequate

information. Whilst the websites of the different entities offer information, prospective clients feel that this is not enough and that the process is lengthy and very time and energy consuming, and not meant for small businesses. Almost all those interviewed agreed that Malta needs higher levels of funding from both the private and public sectors. Finally, there are social and cultural issues involved, in that the Maltese economy has not been geared towards R&D. It is more likely that local businesspersons import their 'innovation' needs rather than develop them in-house. This fact also transpired from the Global Innovation Index.

Market barriers exist in different forms. As stated earlier, 97.4% of companies are micro, that is employing nine persons or less. The small size of business thus acts as a significant barrier in terms of capacity, expertise, funding power and other resources. Furthermore, local small businesses tend to be focused on the local market and not on a larger European or global market. Many businesses rely on local demand for their products and services, often as retailers of imported goods. The manufacturing sector's role in the economy, as a percentage of the GDP, has also over the past decades declined, with the result that some R&D conducted by foreign companies has been transferred to other countries. According to Section C of NACE Rev 2, representing manufacturing activities, this only accounted for 7.18% of GDP in 2021, down from 11.47% in 2011. R&D is more likely to be found in manufacturing, although R&D in services is also possible. Through R&D the acquisition of a larger share of the market is possible via new products. However, considering the size of the local market and the focus of local business to fulfil national demand, the aim of R&D as a means of acquiring a larger share of the market is not deemed as important. There is not yet an appreciation for the value which R&D can have on the business, on the economy and on society in general. The pursuit of a knowledge-based economy is not possible until a better appreciation of knowledge and its acquisition in its various forms is evident. It is certainly not yet acknowledged that it is only through R&D&I that a country can mitigate and address current and emerging societal and economic challenges.

The third type of barriers are those dealing with the business model adopted by local businesses. First, there is no tradition of R&D. Many businesses have survived for long years based on the importation of technology and adapted for local use. The opening-up of the Internal Market after EU accession, meant a wider market which could be exploited but also more competition for local manufacturers. This should have acted as an incentive

for some elements of R&D in order to be able to deal with the increased competition. Instead, it led to more focus on service provision. R&D is seen not only as risky but also costly, in that returns are not guaranteed and even then, those returns would only be possible in the longer term. Certain industries locally are very conservative and cautious and prefer a lower profit margin than to risk money on an idea which needs to be developed and may never provide a return, but only constitute a cost. A quick return to investment is thus more attractive, although it is a short-term perspective. In a sense, there is little appreciation of the value which R&D can provide for a company to increase its potential and become more competitive in a wider and bigger market. The size of the great majority of companies lead to a lack of internal capacity for R&D. R&D not only requires significant funding but also needs the infrastructure, human resources, expertise, supporting structures, inventive and innovative thinking, workable ideas, an encouraging culture of R&D, and a comprehensive backing eco-system. Capacity building in research is a longer-term investment, which is not yet part of local business acumen.

There are different types of external factors which act as barriers to R&D, external to the business environment itself. One of the pressing issues which is hindering more R&D is the lack of local expertise. The number of graduates of those aged 25-64 is 30.6%, with more females (32.5%) than males (28.9%). At the younger age-group 25-34, it is more promising since 40.1% have finished tertiary education, again more females (44.7%) compared to males (36.3%). However, there are three main problems here: women tend to take career breaks to have a family with some never returning to the labour market or likely to take on part-time work or reduced hours; the number of graduates in STEM subjects is not increasing and thus the resource pool is not getting bigger; and there is a brain drain since the brightest and more adventurous of the younger generation venture abroad as this offers better opportunities and also better returns on their educational investment in terms of higher salaries. Even the University of Malta finds it difficult to source researchers for its many projects and often respondents are neither local nor European, but come from further afield such as South America and Asia. A lack of attractive and competitive salaries was one of the main reasons listed for this. Even when foreign researchers are attracted, they usually take their newly gained expertise and knowhow, and themselves find a wider market for their skills. Therefore, once the contract expires the retention rate tends to be negligible and fresh calls need to be issued for alternative projects. Thus, the expertise that develops and grows with each new project does not necessarily pay off in the economy but is likely to be transferred to another economy which is able to offer better opportunities for further

development of the individual researcher. The final barrier is the limited networking and negligible internationalisation of local companies with other partners abroad. Networking in business is essential, and R&D networks are even more important since one is able to be in the loop of what is happening in terms of technological innovations and research in the pipeline. Such beneficial networking is also lacking because few companies are exposed to innovation-linked activities through internationalisation pursuits. Such networks can be exclusive and thus being a part of them is not always easy. However, there are several means through which such interactions can happen.

The economies of the future, the new economy in its multitude of variations, will create a divide between those who merely embrace technological changes and those who create them, between the followers and the leaders. A country needs to understand and acknowledge the full implications associated with such fast-paced technological change. Being ranked 26th out of 27 countries does not show that Malta is fully understanding the importance of focusing more on R&D&I and on fresh areas of the new economy. However, the 2019 Peer Review was undertaken in the knowledge that this would feed into the R&I Strategic Plan for 2022-2025, and thus policy-makers appear to be aware of its importance.

4. Conclusion and Recommendations

This report has provided some insight into the area of R&D&I in Malta. Whilst the pandemic instigated an unstable situation, the post-pandemic period appears to be gathering momentum and the world whilst still facing instability is surely gearing up for a stronger competitive environment. According to global forecasts, the increase in R&D is being spearheaded by Asia and the competition that this continent has provided in the past decades will continue to intensify, particularly with increased investments in R&D. In 2022 Asia was estimated to account for 46% of global R&D.

Data for Malta is not very encouraging, considering that it remains under the 1% of GDP level, even if Malta had targeted 2% by 2020. This is similar to some other small states in the EU, thus size can be a delimiting factor, however, this should not be used as an excuse. Whilst the figures in volume have continued to increase in the past years, these have not been able to keep up with the level of economic growth. In 2021, Malta's GDP was €14.533 billion, meaning that the EU's target of 3% would translate to €433.99 million, a far cry from the €87.188 million actually invested in R&D.

Figure 4 has shown the different type of barriers which are impeding a higher level of investment. It appears that diverse incentives need to be provided to encourage a new mentality where R&D becomes a part of the Maltese business model. Furthermore, one must also ensure that all investments are recorded, as there is agreement that some R&D investments may not be included in official statistics. Investments in research infrastructures need to be encouraged further through tailored policies. Unless these are built up, it would be difficult to maintain R&D on an ongoing process. The infrastructure can also be sustained by attracting more FDI which includes R&D&I performance.

Whilst the eco-system is slowly developing, the synergy between the different parts of it continue to be elusive. Thus, a more solid governance structure needs to be adopted. The R&D 'Champion' needs to be more visible and the institution needs to provide a strong leadership role within the research community, including academia, business and even NGOs.

With a fast-growing economy, Malta continues to import labour. However, Malta also needs to be selective in the type of skills it wants to import and sustain locally. The aim should be

for high value-added skilled human resources. The Maltese research community needs strengthening, and the fact that it is difficult to attract PhD and post-doctoral graduates may be like other countries, but other countries are able to offer better returns on such human capital investment. Once attracted, such expertise needs to be retained to continue to improve the international outlook of the local research community. Thus, employment opportunities and residency permits for such high-level human capital should be considered on a different level to that offered to manual labour.

The following are the recommendations of this report:

1) **Strengthen the eco-system**. The system should show more synergy between the different parts, which on their own appear to be productive and fruitful. However, the lack of a significant and effective governance structure is hindering the profitable outcome of a stronger whole. The R&D Champion certainly needs more visibility and active policies in place.
2) **Increase and showcase funding schemes.** Whilst there are several schemes for R&D, the lack of interest from most of businesses signifies that knowledge about their potential is still lacking. An information campaign aimed at collective organizations may not be sufficient to bring that knowledge on the ground. A more targeted campaign is needed, one that is not only based on relationship managers but which targets specific businesses which should show more potential.
3) **Incentives for R&D&I.** One of the issues which was brought up in many discussions was the idea that the local business model is not geared for more risk in the form of R&D. Thus, incentives in the form of more tax rebates are needed to encourage more long-term investment in ideas.
4) **Capacity building and networking.** Capacity building is not solely based on funding opportunities, information campaigns, incentives and human capital. Such capacity continues to be updated and maintained through local and more importantly through international networks.
5) **Focus on a wider market.** Many local businesses are small and focused on the national market, where competition is not as tough as wider markets. The bigger the market the more likely the incentive to invest in R&D, because R&D provides an edge over other competitors in the market.
6) **New direction for the local business model.** Competition is increasing globally and certain continents have already surpassed others in terms of the amount of investment they are engaging in. Malta is already well behind its EU counterparts,

while Europe is behind Asia and North America. Local businesses may not have yet appreciated these increased competitive forces, with some feeling shielded because they operate on the small national level only. But e-commerce has already offered competition and it is only a small fraction of the changes which are expected in the coming years.

7) **Working permits for high-value human capital.** Malta is already unable to attract doctoral and post-doctoral level expertise from within the EU. What the island is attracting is further afield and such persons only remain in Malta for the duration of the contract. It is perhaps time to discuss a different type of working permit for knowledge-based workers with the aim of retaining them after the contract expires. A brain drain does not only occur with locally educated individuals but also with employees whose knowledge accumulation is lost when they leave.

This report has shown that whilst there has been progress in terms of R&D in recent years, there remains much to be done to see the fruits of a complete and cohesive R&D eco-system. Malta needs to continue to build up its capacities, its networks, it needs to introduce new and powerful economic actors with a strong R&D base, it needs to offer less complex funding programmes, there is a need for more outreach and enticing incentives to encourage local businesses to invest in research and it also needs to attract both FDI and human capital which is linked to research and innovation.

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6. APPENDICES

APPENDIX 1

List of Entities whose representatives were interviewed

Chamber of Commerce

Chamber of Engineers

Chamber of Scientists

Department of Commerce

Gozo Business Chamber

Gozo Innovation Hub

Life Sciences Park

Malta Enterprise

Malta Council for Science and Technology

Ministry for Equality, Research and Innovation

National Foreign Direct Investment Screening Office

University of Malta – Knowledge Transfer Office

APPENDIX 2

Interview Questions (these varied according to the person being interviewed)

1) What in your opinion is behind the low level of R&D investment in Malta?
2) What factors affect such investment?
3) What would aid local businesses to invest more in R&D?
4) How would you describe the local business model?
5) What is it such a problem to link up business to university research and put it the product on the market?
6) Why are we seeing less people interested in engineering?
7) What are your thoughts on the situation of STEM subjects in Malta?
8) How can we encourage more students in IT and Engineering?
9) How impactful do you think Esplora is?
10) What type of structural problems do you see for R&D investments?
11) What are your thoughts on the culture of research in Malta?
12) Can you give me your ideas on the Smart Specialization Strategy?
13) Why are the local funding programmes 'not appetizing' for businesses?
14) What more can be done by the different entities?
15) Do you think that local businesses are involved in networks which can help in R&D?
16) What can you tell me about our R&D eco-system?
17) Can you tell me something about the idea of centres of excellence?
18) What in your opinion is the level of investment in the new economy in Malta?
19) What type of IPs are mainly applied for?
20) Why don't businesses protect themselves more through IPRs?
21) Are there any impediments to such applications?
22) What type of publicity activity does your department engage in?
23) What more can be done to encourage more appreciation of IPRs?
24) Can you provide some success stories?
25) Any other comments you would like to make.

APPENDIX 3

Questionnaire

ADVISORY MCESD MALTA COUNCIL FOR ECONOMIC & SOCIAL DEVELOPMENT EU funds for Malta 2014 2020

MCESD Expansion of investments in R&D in the new economy

Dear Participant, the questionnaire will only take a few minutes and will help with analysing the reasons behind investment decisions in the new economy and also in research and development. All answers are anonymous and will only be used collectively for research purposes. Thank you.

* 1. How many employees do you have?

- ◯ 0 - 9 (micro)
- ◯ 10 - 49 (small)
- ◯ 50 - 249 (medium)
- ◯ 250+ (large)

MCESD Expansion of investments in R&D in the new economy

Dear Participant, the questionnaire will only take a few minutes and will help with analysing the reasons behind investment decisions in the new economy and also in research and development. All answers are anonymous and will only be used collectively for research purposes. Thank you.

* 1. How many employees do you have?

- ◯ 0 - 9 (micro)
- ◯ 10 - 49 (small)
- ◯ 50 - 249 (medium)
- ◯ 250+ (large)

* 2. In which sector does your company operate?

- ◯ Farming and fishing
- ◯ Quarrying
- ◯ Manufacturing
- ◯ Construction
- ◯ Electricity, gas, steam and air-conditioning
- ◯ Water supply, sewerage and waste management
- ◯ Wholesale and retail
- ◯ Transport and storage
- ◯ Accommodation and food services
- ◯ Information and communications technology
- ◯ Financial and insurance
- ◯ Real Estate
- ◯ Professional, scientific and technical
- ◯ Administrative and support services activities
- ◯ Public administration and defence
- ◯ Education
- ◯ Human health and social work
- ◯ Arts, entertainment and recreation
- ◯ Other (please specify)

* 3. Do you have...? *(tick all that apply)*

- ☐ A research and development (R&D) department
- ☐ Staff performing R&D
- ☐ A specific budget for R&D
- ☐ Expertise to engage in R&D
- ☐ Staff applying for funding for R&D
- ☐ The intention to invest in R&D
- ☐ Knowledge on funding programmes for R&D
- ☐ Expertise to fill in funding applications
- ☐ Aims to widen your market
- ☐ Aims to invest in new technology
- ☐ Aims to increase the number of your employees

* 4. Have you invested in R&D in the past 10 years?

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Other (please specify)

* 5. Do you think if you invest in R&D you can increase your profit?

- ◯ Yes
- ◯ No
- ◯ Maybe

Operational Programme II - European Structural and Investment Funds 2014-2020
"Investing in human capital to create more opportunities and promote the well-being of society"
Project part-financed by the European Social Fund
Co-financing rate: 80% European Union; 20% National Funds

ADVISORY MCESD EU funds for Malta 2014 2020

MCESD Expansion of investments in R&D in the new economy

* 6. Do you consider your company as operating in the new economy?

- ◯ Yes
- ◯ No

* 7. Have you applied for any of the following with the Commerce Department in the past five years? *(select all that apply)*

- ☐ Patent
- ☐ Trademark
- ☐ Design
- ☐ None of the above

* 8. Do you see the Maltese economy changing much in the next 10 years?

- ◯ Yes
- ◯ No
- ◯ Maybe
- ◯ Not much
- ◯ In certain sectors only
- ◯ Other (please specify)

* 9. Which areas of the new economy are likely to grow in the next 10 years?

* 10. What incentives would encourage you to invest in R&D?

Operational Programme II - European Structural and Investment Funds 2014-2020
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ADVISORY

MCESD
MALTA COUNCIL FOR ECONOMIC & SOCIAL DEVELOPMENT

EU funds for Malta 2014 2020

MCESD Expansion of investments in R&D in the new economy

THANK YOU

Operational Programme II - European Structural and Investment Funds 2014-2020
"Investing in human capital to create more opportunities and promote the well-being of society"
Project part-financed by the European Social Fund
Co-financing rate: 80% European Union; 20% National Funds

11. Thank you for participating in this questionnaire. Any other comments are welcome.

APPENDIX 4

Simplified Summary

The level of investment in research and development in Malta remains very low and well below the target set by Malta for 2020, which was 2% and even lower than the target of 3% of GDP set by the EU. The level of investment for 2020 for Malta was only 0.67% of GDP, meaning €87.188 million, ranking Malta 26th out of 27 EU member states.

The expectations of increased investment in research and innovation in the world continues to grow, with a figure for 2022 expected to reach $2.476 trillion. More than 80% of that investment will be spent by the top ten countries of R&D. There is global consensus that R&D is the surest way for future growth.

The aim of this report is to analyse the current situation in Malta, by presenting relevant data as well as to understand the supporting policies and structures already in place. The methodology used relies on published and unpublished secondary data, and on interviews, focus groups and a questionnaire.

Preliminary research findings show that although the economy has witnessed significant economic growth, nonetheless the amount of R&D investment has not been able to keep up, or while there has been an increase in volume, this has not translated into a corresponding increase of R&D as a percentage of GDP.

The report presents data on the level and focus of investment engaged in by industry, higher education institutions and government. It provides comparisons with other small countries and offers insight on the situation of R&I in Malta, showing the country's strengths and weaknesses. Several recent studies, by the Chamber of Engineers and the European Commission's Peer Review of Malta's R&I situation provide a picture of a country which needs to do much more to encourage investment in research and innovation.

Desk research shows that there are several policies and structures in place which should support more investment in R&I, the latest of which is Malta's Research and Innovation Smart Specialization Strategy (RIS3) 2021-2027. The next innovation strategy currently awaits Cabinet approval. Results from the interviews and focus groups show that those

interviewed appreciate that Malta needs to do much more to increase interest and funding for R&I investments. Although there are several success stories, investment in R&I remains marginal to Maltese business, with issues arising over size of enterprises, complicated funding programmes, fragmentation of entities and programmes, lack of interest in STEM subjects by students, lack of expertise and human resources, and the need for better coordination amongst the different service providers.

Overall results shows that whilst the appetite for R&D&I is slowly increasing with local businesses, the Maltese traditional business model does not rely on research and innovation. There are different types of barriers which may be more complicated to remove, particularly in the short to medium term. These barriers can be divided into four types: institutional, market, business model and external factors.

The economies of the future, the new economy in its range of variations, will create a divide between those who merely embrace technological changes and those who create them, between the followers and the leaders. A country needs to understand and acknowledge the full implications associated with such fast-paced technological change. Being ranked 26th out of 27 countries does not show that Malta is fully understanding the importance of focusing more on R&D&I and on fresh areas of the new economy. However, the 2019 Peer Review was undertaken in the knowledge that this would feed into the R&I Strategic Plan for 2022-2025, and thus policy-makers appear to be aware of its importance.

The report provides seven recommendations including: strengthening the eco-system (to champion R&D); increasing and showcasing funding schemes; creating incentives for R&D&I; capacity-building and networking; focusing on a wider market; the need for a new direction for the local business model; and the provision of different working permits for high-value human capital.

Whilst there has been progress in recent years, a complete and cohesive R&D eco-system would bear more benefits to the Maltese economy. Malta needs to continue to build up its capacities, its networks, it needs to introduce new and powerful economic actors with a strong R&D base. The country also needs to offer less complex funding programmes, more outreach and enticing incentives to encourage local businesses to invest in research, and it also needs to attract both foreign direct investment and human capital which is linked to research and innovation.

APPENDIX 5

Press Brief

MCESD engaged IDEA Advisory to conduct research on investments' expansion in R&D in new economy. Results indicate that Malta needs to do more to increase interest and funding for R&I investments. Although R&D&I appetite is slowly increasing, R&I investment remains marginal to Maltese business. Economic growth has not translated into an increase of R&D as a percentage of GDP. Recommendations therefore include; a cohesive R&D eco-system, enhancing funding and incentives, restructuring the local business model, and attracting high-value human capital.